ARCHITECTURE HERITAGE and DESIGN

Carmine Gambardella

# XXI INTERNATIONAL FORUM

## Le Vie dei Mercanti

World Heritage and Dwelling on Earth

GANGEMI EDITORE SpA
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Carmine Gambardella
WORLD HERITAGE and DWELLING ON EARTH
Le Vie dei Mercanti
XXI International Forum

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# WORLD HERITAGE and DWELLING ON EARTH

Le Vie dei Mercanti_XXI International Forum

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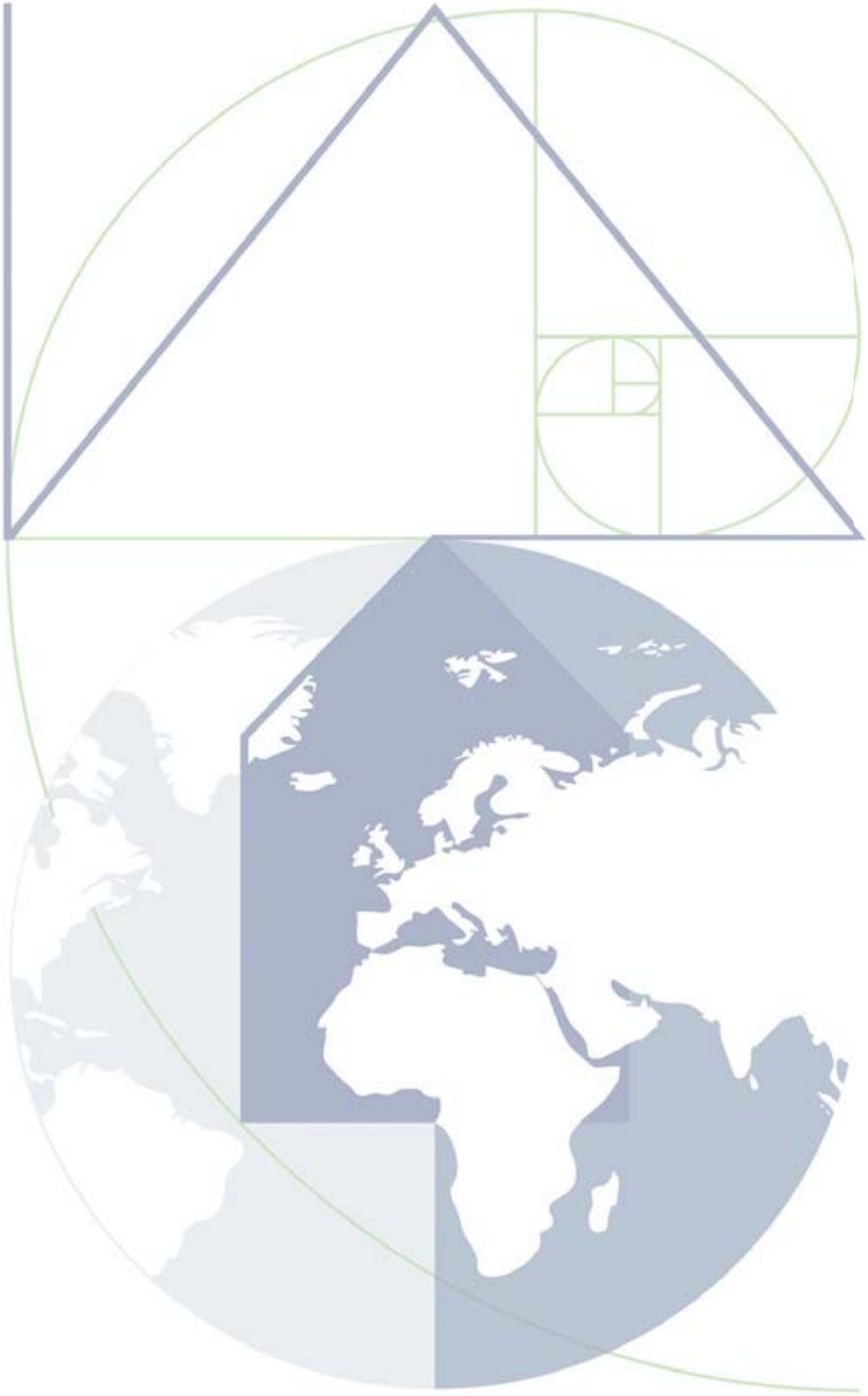

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# WORLD HERITAGE and DWELLING ON EARTH

**Le Vie dei Mercanti**

**XXI International Forum**

Naples | Capri
25 - 26 - 27 May 2023

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## Peer review

Scholars has been invited to submit researches on theoretical and methodological aspects related to Smart Design, Planning and Technologies, and show real applications and experiences carried out on this themes. Based on blind peer review, abstracts has been accepted, conditionally accepted, or rejected. Authors of accepted and conditionally accepted papers has been invited to submit full papers. These has been again peer-reviewed and selected for the oral session and publication, or only for the publication in the conference proceedings.

## Conference report

200 abstracts and 330 authors from 30 countries:

Albania, Australia, Belgium, Bosnia and Herzegovina, Brasil, Bulgaria, California, Chile, China, Cipro, Cuba, Egypt, France, Germany, Greece, India, Italy, Japan, Jordan, Malta, New Jersey, New York, Poland, Portugal, Russian Federation, Serbia, Spain, Texas, Tunisia, Turkey

## XXI FORUM WORLD HERITAGE and DWELLING ON EARTH

Abitare la terra! Questo è l'obiettivo essenziale, sintetizzato dalla denominazione della conferenza, cui abbiamo continuamente teso con i Forum "Le Vie dei Mercanti" lungo gli ultimi ventuno anni. Ancora oggi, questa rimane per noi la stessa prospettiva di lavoro. Un intento da perseguire con ancor più forte convincimento e con persino maggiore efficacia, dal momento che tutti noi siamo coscienti di trovarci in uno stato di emergenza con lo scenario drammatico aperto dai cambiamenti climatici.

Quindi, come agire adesso rispetto a questo imperativo globale?

Per prima cosa, mi piacerebbe partire dal lavoro che abbiamo fatto in tutti i Forum annuali, dagli approfondimenti interconnessi sulla transizione ecologica, la contaminazione, il patrimonio culturale, i disastri ambientali, per ciò che concerne il loro impatto sul World Heritage. In tale modo, la preoccupazione per l'abitabilità della nostra terra ha non solo integrato capacità, esperienze, buone pratiche di ricercatori e accademici, ma ha anche creato una comunità scientifica con provenienze da ogni parte del mondo che fosse in grado di interagire in modo interdisciplinare. Ci siamo fondati sul convincimento che un'azione collaborativa richiedesse, oltre una prassi di controllo, una profonda fiducia nella capacità umana di riuscire a difendere il proprio patrimonio ereditario rigenerandolo con forte determinazione. Questa è la migliore strategia per trasmettere al futuro i beni che ci ha consegnato la storia e che noi dobbiamo difendere. Lo scopo perseguito è ovviamente non solo di quello potere agire in anticipo rispetto a un disastro ambientale, ma anche di promuovere nel nostro mondo un processo progettuale in grado di ridisegnare la relazione tra ciascun uomo e l'ambiente in cui vive.

Ribadendo in ciascun Forum che "il futuro è un eterno presente", abbiamo continuato a guardare a ciò che verrà con ottimismo, con la speranza che, cominciando sin d'ora con azioni effettive e coscienti, noi potessimo porre le basi per il mantenimento di un equilibrio globale. La recente pandemia ha mostrato come, al di là delle strategie resilienti per neutralizzare processi produttivi che si sono mostrati ostili al benessere ambientale, dovessimo ricercare una nuova omeostasi nel nostro ambiente abitabile. Solo lavorando insieme in questa direzione, potremmo efficientemente riadeguare via via le reazioni, in modo da neutralizzare persino gran parte degli impatti ambientali nella ricerca di un nuovo equilibrio.

L'argomento del Forum di quest'anno invita i ricercatori a riflettere sulle buone pratiche implementate con progetti operativi, strategie o proposte progettuali. Obiettivo principale è contrastare il processo che ha portato le persone e l'ambiente in cui vivono alle condizioni inaccettabili che riusciamo fisicamente a individuare con chiarezza nel degrado territoriale e paesaggistico. Inoltre, bisogna pensare a nuove strategie per un progetto difensivo che possa realmente dimostrarsi efficace. Ma ciò che è ancora più importante, una volta resosi conto dell'urgenza della situazione, è che l'enorme responsabilità ambientale ci impone di non fare affidamento su soluzioni semplicistiche. Non c'è alcuna semplice prestazione tecnologica che da sola possa essere assunta tout court come soluzione definitivamente ottimale, ma bisogna intervenire attraverso una dinamica osmotica di conoscenze e tecnologie. Solo attraverso un processo di conoscenze continuo le persone possono misurare lo stato del loro benessere e allo stesso tempo agire come garanti della qualità terrestre. Una nozione di "misura", fondata su una dinamica perpetua di conoscenza, può mostrarsi affidabile promuovendo nuovi modelli di sviluppo fondati su un rinnovato Umanesimo.

Prof. Carmine Gambardella
General Chair XXI Forum 'World Heritage and Dwelling on Earth'
President and CEO of the Benecon University Consortium
UNESCO Chair on Landscape,
Cultural Heritage and Territorial Governance

## XXI FORUM WORLD HERITAGE and DWELLING ON EARTH

Abitare la terra! Dwelling on Earth! That is the essential goal, synthesized by the title of this conference, towards which we have been working with “Le vie dei Mercanti” forum over twenty-one years. It still remains today the same perspective for us. An intent to be pursued with greater commitment and providing even higher effectiveness, as we all are now aware of being in an emergency with the dramatic scenario opened by climate change.
Therefore, what are we to do now with respect to this global imperative?
First, I would like to start from the work we have done in every annual forum, the interconnected focus on Ecological Transition, Contamination, Legacy, Knowledge and Disaster, as regards their impact on World Heritage. In that way, the concern for the habitability of our Earth has not only integrated skills, experiences, good practices of Scholars and Academics, but has also created a scientific community from around the world for discussing such multidisciplinary topics. We had the conviction that collaborative action requires not only practices for control, but also a reliance on human ability to ever succeed in defending his patrimonial value with the strong determination to re-design our everyday places. This is the best way for transmitting to the future the values that heritage has passed on to us and we must protect. The pursued goal is obviously not only to act in advance with respect to an environmental disaster, but also to promote in our world a design process in order to re-design the relationship between each man and his living environment.
Emphasizing in each forum that for us the future is as an eternal present, we have continued to look at the future with optimism, with the trust that, beginning now with effective conscious actions, we can put the basis for maintaining a global equilibrium. Recent pandemic has shown that, apart from resilient strategies for neutralizing productive processes which showed to be hostile to the environment, we need to search for a new homeostasis into our habitable environment. Working towards this direction, we could effectively adjust responses to environmental changes, in order to neutralize even most of their consequences for reaching a new equilibrium.
So, the topic of this year’s forum invites researchers to reflect on good practices implemented with operative projects, design proposals or strategies. The main goal is reversing the trend which has led people and the environment in which they live to the unacceptable conditions we can physically recognize into territory and landscape decay. Then, we must think about new strategies for an adequate defensive design which can ultimately provide an efficient aid. But which is more important, once we have suddenly become aware of the urgency of the situation, the new enormous environmental responsibility requires us not to rely only on simple solutions. There is no easy technological performance to be assumed as a definitively optimal solution. Only the continuous practice of a “measure” that has been built upon continuous education process may give reliance; people, only with an adequate formation, can measure the state of their wellness and at the same time they can act as the guarantors of earth quality, for a new development model based on a renovated Humanism.

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Le Vie dei Mercanti
XXI INTERNATIONAL FORUM
18 • 19 • 20 May 2023 Napoli Capri

# World Heritage Sites in Germany and Dwelling on Earth

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## Abstract
Many times our civilization has neglected that the locations which humans have chosen for their habitats are already inhabited by other species. On the territory of Germany, there are 51 listed World Heritage sites (WHSs), out of which 48 are cultural sites, and there are 8 more on the tentative list. Although, not one of the sites is categorized as “mixed”, the landscape is significant in each case. Our initial hypothesis was that none of the heritage sites would have survived without balance with nature, therefore we examined all 48 cultural heritage sites, looking for a better understanding of the relation between the anthropogenic and natural environment of WHSs. Among other factors, we researched if choices of material and construction technics reflected respect for the natural environment. In addition, we analyzed a case study of sites in the wider area of Harz Mountain: Quedlinburg, Goslar and Alfeld. Our aim was to take “a second look” at those sites, however this time on other values of these locations and in particular their balance with nature. We looked for those values that are deeply woven into their essence and almost "taken for granted", and which disclose their genuine relationship with nature.

**Keywords:** World Heritage, Germany, biosphere, landscape, sustainability

## 1. Introduction
Care for nature is high in the priority of global actions [1]. Using WHSs in Germany [2, 3] as a matter of research, we looked for patterns and accumulation of similarities in relevant common characteristics connecting the built heritage regarding the natural environment and analyze the chosen case studies.

In Germany, WHSs are distributed all over the country and treated with respect and according to the agreed rules and high standards; laws about nature and environmental protection are well-developed and reinforced in practice; the pollution is low and strictly monitored. All that gave us almost ideal conditions for our research and our AI experiment.

## 2. Materials and methods
The cultural sites in Germany occur mostly in the Rhine-Danube valley, in big cities, in central Germany (in the ring including Harz, defined by its northeastern border), and diagonally from there towards the northeast including the Berlin area (Figure 1). Nowadays, they are connected in cultural routes which of different themes: industrial, wild natural landscapes, Middle Ages including Roman heritage, religious, Hanseatic, Romanticism, Stone Age and far past[3]..

Firstly, our focus was on materials and structure in correlation with technics, and if they are in balance with nature. The focus was on the recyclability of materials and the natural origin of their components

(for example concrete is made from natural elements but only partly recyclable, however, it is reusable under certain conditions; glass is made of natural elements and fully recyclable) and endurance of construction and reparability. Regarding structure, with construction technics taken into the account, we analyzed three categories: long-term resilient, repairable and replaceable structures.

As a control if the variables were set well, we compared the results with direct impact on the environment of dominant materials (e.g. traditional cement-based concrete is devastating, stone is environment-neutral, and glass is environment-friendly).


**Fig. 1:** Distribution of WHSs in Germany [3].


**Fig. 2:** The biosphere reserves in Germany [4].

For statistical analyses, we used SPSS software. The variables were defined as intervals for chosen values. That was considered a reasonable operational strategy concerning the diversity and variations for each material in practice. In the following steps, we analyzed if German WHSs leave an impression of care and respect for the natural environment, based on case studies of WHSs in the Harz Mountain.

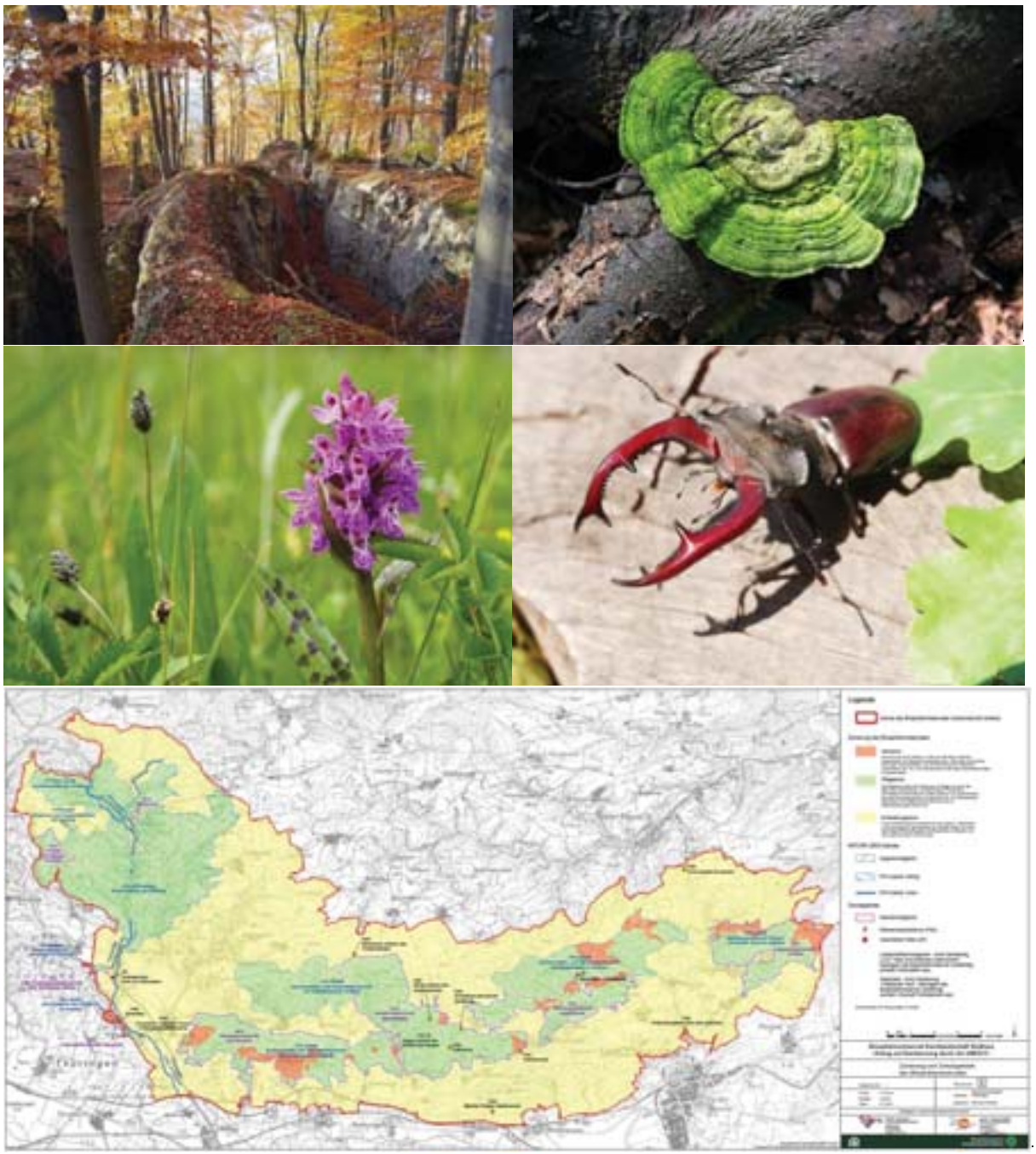

**Fig. 3:** The biosphere reserves Südharz [5]

Harz Mountain has both cultural and natural values (Figure 2 and 3). It is clearly geographically distinctive because east from there the terrain is prevailingly flat along the same geographical width all the way from the Atlantic Ocean. In this area, there are no huge cities or navigable rivers which indicate the presence of a different type of quality woven into urban areas and authentic historical concept of vernacular spatial development. The protected area of nature, Karstlandschft Südharz, covers approximately 300km$^2$(Fig. 3). Harz is characterized by “a variety of landscapes, geological rarities and a diverse flora and fauna…It is the unique natural landscape of gypsum karst and beech forests and the historically shaped cultural landscape with meadow orchards, castles, churches and copper slate heaps Around 1500 ferns and flowering plants and a large number of mosses, lichens, algae and fungi have been identified so far, including a large number of protected and endangered plant species” [5]. In this area, we examined the following cultural sites (Figure 4):

- Gosslar, known for the pre-industrial mining tradition as much as for more than 1500 half-timbered houses which are well-preserved;

- Quedlinburg, a unique medieval city with over 2000 half-timbered houses built over eight centuries, the castle hill with the Collegiate Church and the castle Münzenberg.
- The Fagus factory in Alfeld in the wider area of the Harz Mountains is considered an iconic example of industrial architecture from the Bauhaus.

Here, we used visual analyses to identify the presence of natural elements: greenery, water and earth, in images of WHSs.

We also created AI image of a “typical” representative of the WHS from Germany based on the image feed of all 48 world cultural heritage sites for the purpose of comparison with the coming WHS site, i.e. those from the Tentative list. We tried several AI applications, including our own programming using open-source AI software and self-made algorithms. In addition, we used software for the identifying of species to identify greenery on images.

**Fig. 4:** The Upper Harz Water Management System (up right), Fagus factory in Alfeld (up left) and Quedlinburg (the two photos down) [2]

## 4. Results

Firstly, the cultural heritage sites gather around the same points as natural heritage but do not overlap with them which are well visible on detailed interactive UNESCO map [6].

The representation of environment-friendly materials and structures is high and satisfactory. Results of the cumulative impact of different aspects compared to direct measuring gave similar results.

From visual analyses, the results were also good – elements of natural surroundings, both each and cumulatively, are well represented. Similarities of climatic influences, and therefore flora and fauna, are arguments in favour of the conclusion that these results are valid not only for the area of Harz Mountain but for the entire territory of Germany.

Our AI experiment gave ambiguous results. Although we did not get images which were sensible, or visually attractive regarding built structure, many of those attempts revealed recognition of greenery as dominant natural element. We couldn`t get images which will be adequate for comparison with sites from the Tentative list, as we originally intended. However, we changed request and ask for “the least

common denominator" and the result was image in figure 5. Considering that it did not represent any architectural object, we changed the request and ask for typical representative of the group and the response was as shown on figure 6.

**Fig. 5:** "The least common denominator" of WHSs Germany images

**Fig. 6:** Typical representative of WHSs Germany

Recognition of species revealed high repetition of several autochthone species. We focused on greenery as an indication of life apart from humans, considering that only small animals live in urban areas.

Our quest for the non-disclosed value of WHSs revealed that World Cultural Heritage sites cultivate values of the importance of the biosphere, they leave an impression of respect for the biosphere; however, the natural environment in those locations is cultivated and adapted to the needs of people.

## 5. Discussion and concluding remarks

Generalization regarding WHSs opposes their very essence. Similarly, the results, as well as the methods used in this paper, cannot be generalized. For example, the presence of greenery cannot be used as a manifestation of natural environment or a precondition for the presence of fauna elsewhere; cultural sites in deserts do not have greenery, yet they have wildlife and correlation with nature.
Finally, the research results were surprising to some extent and raised certain concerns, which convinced us that there is a lot more we should learn about dwellings on Earth.
Furthermore, we realized that our civilization reached the stage when, for the very first time, all living beings on our planet became subjects of honest concern.

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[3] https://www.germany.travel, April 2023

[4] https://www.unesco.de/kultur-und-natur/biosphaerenreservate/biosphaerenreservate-deutschland, April 2023

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# Territorial restoration and redevelopment. The case of the Pentimele Hill

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## Abstract
The issue of degraded territorial environments redevelopment is quite complex. Attention is often directed to urban areas (abandoned historic centers, neighborhoods characterized by modest architecture and housing problems, old industrial areas, suburbs that have grown up without a logical plan, agglomerations that have suffered disastrous phenomena from natural disasters such as floods or earthquakes). And there are now numerous urban regeneration experiences that follow a cultural current aimed at limiting the expansion of cities and the consumption of precious land. Less attention is paid to the redevelopment and care of valuable territorial and environmental areas which, for different reasons, have undergone an action of impoverishment or desertification.
The paper focuses precisely on this issue, with the aim of bringing out the opportunity for targeted and coordinated actions that can give new life to interesting ecosystems. Some bibliographical references are proposed and an integrated planning methodological approach is outlined, based on multidisciplinary contributions, aimed at the restoration and environmental regeneration of a degraded land. Finally, an emblematic case study is proposed for the planning of balanced measures for the environmental regeneration and enhancement of a hill located on the edge of the city of Reggio Calabria, which has long been left in a state of abandonment and is now almost deserted due to several fires over the past decades.

**Keywords:** Urban regeneration, environmental restoration, planning, ropeway, tourism

## 1. Introduction
The subject covered in this paper concerns the approach to redevelopment initiatives for degraded or declining territorial environments. There are many urban regeneration experiences and researches aimed at affirming eco-sustainable cultural values, to limit the improper expansion of cities and the consumption of precious land, as well as the renewal of particular urban areas: abandoned historic centres, neighborhoods characterized by housing and social unease, abandoned industrial areas, suburbs grown out of plan criteria, areas that have suffered ruinous phenomena due to natural disasters.
Reconstruction, revitalization, renewal, redevelopment and regeneration are terms taken as objectives in policies aimed at overcoming urban decay since the post-war period [1]. Today the city is seen in a global sense, a complex system in which economic and environmental issues interact [2].
This contribution focuses attention on initiatives for the regeneration and care of valuable territorial and environmental areas which, for different reasons, have suffered an action of impoverishment or desertification over time. We aim to bring out the opportunity for targeted and coordinated actions that can give new life to interesting ecosystems.
Some references from the bibliography are proposed and an integrated planning methodological approach is outlined, based on multidisciplinary approaches, aimed at the restoration and environmental regeneration of a land. The approach is applied to an emblematic case study, the

planning and identification of measures for the environmental regeneration and enhancement of a hill located on the edge of the Reggio Calabria city (Italy), which has long been left in a state of neglect and is now almost deserted due to of numerous fires occurred in the past.
The prefigured actions concern in particular the restoration of the greenery according to effective agronomic criteria, the accessibility to the summit through non-invasive routes, including an overhead cableway line, the enhancement of some existing structures, the design of some limited services for the community and the tourists, a set of actions to protect the hill from fires, landslide risks, attempts at overbuilding for residential or other purposes.

## 2. The theme of planning aimed at environmental regeneration and redevelopment

The regeneration of a territory has taken on a very broad meaning, but clearer than in the past. It is not just a question of acting for the physical redevelopment of a degraded area, but of including a wide range of impacts on the community in the planning: economic growth and employment, opportunities for mobility and social relations of the inhabitants, production of culture, enhancement of the landscape, ecological sustainability, affirmation of the common good, local identity. A mixing of material aspects combined with immaterial elements is determined in the practice of the transformation of the land, particularly in the urban context. Regeneration, in other words, implies initiatives and measures aimed at activating local resources, through processes capable of linking physical transformations with cultural, environmental, social and economic development [3].
A conception of regeneration is affirmed as a dynamic process made up of balanced and coordinated actions distributed over time, focused on strategic objectives shared by the community.
In the past, and especially in times of crisis, the transformation of the territory was often based on the construction of new structures and infrastructures, as driving factors for reacting to decline and relaunching growth. To overcome phases of recession and crisis, the focus was on expansive policies, through large works, as happened with the Keynesian policies of the new deal in the USA following the crisis of 1929, or in the post-war reconstruction in Europe (Marshall Plan, Structured planning in the former Soviet Union). In Italy, US support resulted in the creation of industrial enterprises in some regional areas and in a building expansion that favored economic and social development (boom of the 60s). Something like this seems to be recurring in our times in Italy with massive investments such as those of the PNRR and resource-devouring interventions such as those destined for large infrastructures.
In some areas of the planet (China, India, Turkey, South America, South Africa) a stale development model continues to be followed which is revealing all its limits: exaggerated consumption of resources, unbridled industrial competition, new forms of colonialism, exacerbated environmental degradation). One of the most serious consequences is a global climate crisis which is causing unexpected and devastating phenomena such as extreme events, meteorological imbalance, melting of glaciers, new large migrations of peoples. Unfortunately, armed international conflicts are not beneficial which, on the contrary, fuel a waste of considerable economic resources as well as extensive phenomena of destruction of the territory.
Populations tend to concentrate more and more in large urban areas (some have reached megalopolis dimensions in a short time); but often the territories are subject to physical degradation which negatively affects the life of millions of people with phenomena of marginalization, creation of suburbs without identity, bidonvilles and ghettos, social segregation, abandonment of vast industrial areas.
Today the awareness is emerging that the past development models are not good. There is an opportunity to act to overcome the crisis. There is once again more attention to territorial policies, aimed at transformation and balanced development. The territory needs care and regeneration policies, within the framework of the principles of eco-sustainability (ecology and transfer of values to future generations) and even more of social equity (fairness and justice).
Sustainable development has been defined in the report "*Our Common Future*" [4] of the World Commission on Environment and Development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". It seeks to reconcile economic development with the protection of social and environmental balance. In 2001 the EU adopted a strategy for sustainable development. It was updated in 2006 providing "*a long-term vision for sustainability in which economic growth, social cohesion and environmental protection go hand in hand and are mutually supportive*".
Social equity qualifies as the guarantee of giving all citizens the possibility of achieving the same level of life quality, making available means commensurate with the needs of the individual, especially those in disadvantaged conditions.
Investing in the territory can be an opportunity to affirm a new centrality of land planning, assuming new urban policies able to relaunch, in the general framework of regeneration, the subjects of habitability and sustainability: new ecology, zero land consumption, stop settlement dispersion, rationalization and integration of network services, intelligent organization of mobility, protection of

water and natural resources, renewable energy sources, productive recycling of consumables, solidarity and social inclusion, particular attention to care works.
It is a considerable challenge aimed at determining new conditions for development, also creating economy and job opportunities around virtuous strategies for the transformation of the territory, with primary attention to the landscape. The role of the landscape in declining urban areas establishes itself as a guiding criterion and as a strategic element for projects aimed at recovering the identity of the city parts that have lost their original use and are looking for a new life. Landscape should be seen in broad terms, including the meanings of scenery and environment [5]. As an expression of structural characteristics of urban transformation over time - that can be understood by analysing the stratifications and provenance, but also as a future perspective – the landscape will play a new role in a specific area, starting from its position in the system of territorial relations. The use of landscape as a design material multiplies its values in an interpretation of urban transformation as regeneration rather than renewal [6; 7].

## 3. Methodological approach to integrated planning

The approach to the redevelopment of a land, in the light of the introductory considerations, can only be an approach based on the integration of multiple technical culture components: not only urban planning, but also geography, geology, ecology, climatology, biology, botany, agronomy, engineering, medicine, information and communication. Without forgetting aspects of humanistic and immaterial culture such as historical memory and identity, sociology, ethics, jurisprudence.
Once the context of interest has been identified, an in-depth analysis of the territory and its constituent components will be appropriate, as well as historical research to understand the evolution of the environmental and anthropic system over time. These analyses will provide fundamental elements for defining the goals of the policies, the strategies to be followed, some general criteria applied in the plan design. In the case of a fragile land, the measures aimed at enhancing the sites, at environmental protection, at the creation of facilities able to promote accessibility without invasive works, limiting soil consumption and unjustified overbuilding, will be particularly important. Actions for welcoming residents and providing services to visitors must be balanced, measured in relation to the ecological footprint, and related to the environmental capacity of the territory.
In an area intended for a light and sustainable tourist use, structural and high-impact settlement forms will be avoided, favoring light and pleasant measures. People presence limits will also be set in order to avoid deleterious concentrations and risks relating to excessive crowding, both from the point of view of environmental protection and from that relating to people's safety. Of course, extensive use can be made of Information and Communication Technologies (ICT) also for the purposes of land supervision and control, risk prevention, and the offer of information services to users.
Such an approach necessarily requires an authoritative guide in the planning phase, able to manage a disciplined interaction between the different skills and to coordinate multidisciplinary contributions.

## 4. The case study of the Pentimele hill

### 4.1. The context of interest. Characteristics of the land and historical events

The hill of Pentimele is located on the northern suburb of the Reggio Calabria city, on the shores of the Strait of Messina. It has remained immune from the building expansion that characterized the 50s and 80s, often in an abusive regime, so that it represents one of the few large areas free from building on the coastal/hilly strip. The hill, which reaches about 300 m above sea level, appears today bare, with partly barren slopes and partly characterized by soil instability phenomena. It appears as a kind of no-man's land, which in the past has undergone uncontrolled deforestation and devastating fires which have led to the disappearance of the typical Mediterranean maquis. In recent times, an artificial pine wood (stone pine) has been created at the top. An unfortunate choice according to some experts, given that the roots of pines tend to make the soil acidic and therefore restrict the growth of undergrowth plants.
At the end of the 1990s the hill became part of a 450-hectare Urban Park (Urban Project, 1998), but no action has ever been implemented.

**Fig.1**: Pentimele hill. Aerial photos (Google Earth)

In 2000, the municipal administration published a call for tenders for an international competition for ideas for the "*design of the urban park of the Pentimele hill*". The intention was to create a park with areas for leisure, culture and tourist activities compatible with the primary objective of safeguarding and promoting the naturalistic, landscape and historical values of the hill. The following specific purposes were prefigured: the recovery and valorisation of two military forts and some disused quarries, the territorial integration between the hilly area and the coastal strip, the adjustment of the access roads, the environmental recovery of the degraded spaces with the creation of a botanical garden with Mediterranean plant species, a station for the observation of migratory birds, the identification of activities for social entrepreneurship compatible and possible integration of existing agricultural activities. 17 project proposals were presented and 3 winning projects were identified, but the ideas remained on paper.
The hill, located on the border of the Aspromonte National Park, is included in the 2000/2006 Rural Development plan aimed at protecting the landscape with actions to enhance the territory in its integrated forms of environmental recovery, eco-compatible tourism and sustainable agriculture [8]. Recently, the Municipal Authority presented a much less ambitious project to the Ministry for the Environment, simply to create an urban forest.

### 4.2. Environmental recovery, goals and specific criteria

The goals identified in the 2001 competition remain valid, in a general context of redevelopment of the area from an environmental point of view, with a substantial and oriennted growth of the green spaces, a stabilization of the slopes, a biological repopulation which also contemplates the presence of animal components, an enhancement of the hill in terms of tourist use.
From a strictly environmental point of view, the protection and enhancement of biodiversity assumes a scientific and cultural significance and can only contribute to cultural and economic development [8]; this implies that the characteristics of the flora and vegetation should be similar to those present in the surrounding area, also considering the cultivated tree species and the fauna linked to the local vegetation. In the choice of reforestation, the use of plants and shrubs capable of stopping the phenomena of hydrogeological instability and stabilizing the most fragile fronts also appears to be important. In fact, it should be noted that the hilly area is of sedimentary origin, with a prevalence of sand, gravel and conglomerates dating back to the Pleistocene.
Sector experts have suggested the choice of sclerophyllous (dry-resistant) plants typical of the Mediterranean environment: shrubs such as myrtle, rosemary, lentisk and trees such as strawberry trees, cork oaks, olives, almonds and carob trees. In flat or slightly sloping areas where there is soil, conifers (especially Aleppo pine) can be planted. In slightly better situations, hop hornbeam, field elm, manna ash, pittosporum and phillyrea plants could find a place. The downy oak, the hackberry (excellent for birds), the liquidambar (for the autumn foliage), the tilio platyphyllos, the opal maple, the carob should also be fine. Cedars (from Lebanon or the Atlas) could also be used. There could also be space for oleander and prickly pear plants. The latter can carry out an action of fixation of the soil surface and make possible the natural birth of other species in the medium term. it could also create wooden structures (not very high espaliers) and plant bougainvillea or climbing roses in order to form flowery walls. In the initial phase, holm oaks or other deciduous trees that are slower growing should be excluded.

### 4.3. Accessibility through non-invasive infrastructure

The hill of Pentimele is difficult to access today. The sparse vegetation, the morphology of the territory with some parts rather steep, the nature of the soil (mainly sandy formation) did not favor the creation

of a quality access road. Currently the driveways are basically two, one (via Lupardini) that departs from the SS 18 in Località Pentimele (North-West) and climbs, with a rather tortuous and difficult slope, up to the top of the hill, a second that starts from the city center (through Viale della Libertà and Via Lia), with a strong slope, and reaches the south side of the hill and then stand horizontally on a minor road in the direction of the village Vito Superiore. In both cases, the infrastructure is fragile and of low quality.

A better accessibility of the hilly territory could be ensured by three complementary types of solutions:

a. an improvement of the existing road system with some corrections to the route and some containment works in critical points, with the typical technique of mountain roads; the road should have characteristics such as to guarantee the transit of emergency vehicles such as means of the firefighters, civil protection, medical aid, minibuses, preferably electrically powered; a controlled access system is also considered appropriate in order to avoid excessive attendance by motorized vehicles, adopting closing bars to unauthorized traffic with video monitoring devices and management of the latest generation Pedestrian Area or Limited Traffic Zone (LTZ) type;
b. some footpaths for hikers, suitably marked and equipped; in particular, it would be appropriate to enhance the Sentiero Italia already traced and codified by the CAI, the Italian Alpine Club; the network of paths could also guarantee a fire barrier function to prevent the spread of any fires;
c. a cableway connection, to reach the summit in a few minutes (the mountain station would be located at an altitude of 285 m), leaving the private vehicles in park-and-ride parks, suitably sized, adjacent to the valley station. The cable car would be an effective means of transport, free from polluting emissions, silent, respectful of the environment. It would also represent an opportunity for a high-quality panoramic view of the city and the whole Area of the Strait. The cable car would in fact allow to enjoy the incomparable spectacle of the city and the Strait of Scilla and Cariddi, one of the most beautiful panoramas in the world. In a single glance it could be possible to admire the land lying on the extreme slopes of the Aspromonte together with the Sicilian coast with the Peloritani Mounts and the smoking Etna massif in the background.

Two alternative ropeway system proposals have been identified (Figs. 2 and 3), distinguished by the positioning of the valley station: Proposal A) with a base station in correspondence with the university (**Feo di Vito**), Proposal B) with a base station in correspondence of the Citrus Fair **(Fiera Agrumaria)**. The following figures give an idea of the two solutions on the map. Solution A develops in a South - North direction, parallel to the coast; in the case of solution B, the trend is based on a North West - South East direction and provides for the overcoming of three important infrastructures (railway, access viaduct to the motorway junction, A2 motorway). The two solutions differ slightly from a structural point of view:

- line A (Feo di Vito): valley station at 57 m above sea level, difference in height of 228 m, route length 1,123 m, gradient: 20.9%;
- line B (Citrus Fair): valley station at 15 m above sea level, height difference of 270 m, length of the route 1,132 m, gradient: 24.5%.


**Fig.2:** Alternative routes of two ropeway systems

**Fig.3:** Location of the valley stations (Feo di Vito; Fiera Agrumaria) of the ropeway

The design solution could be limited to a single cable ropeway or to the two systems that can be built in successive phases, also in relation to the success of the first initiative.
As a design solution for the Pentimele ropeway, it was assumed a system similar to that of Medellin in Colombia, i.e. a continuous motion system with twenty-four cabins operating during peak hours, each capable of accommodating 8 people. Assuming a line length of 1120 m (practically the same for both layout A and B) and an average speed of 16 km/h, the journey time between the terminal stations is approximately 4.2 minutes, the lap time 8.4 minutes and the transport capacity is of the order of 1,400 passengers/hour per direction (Tab.1).

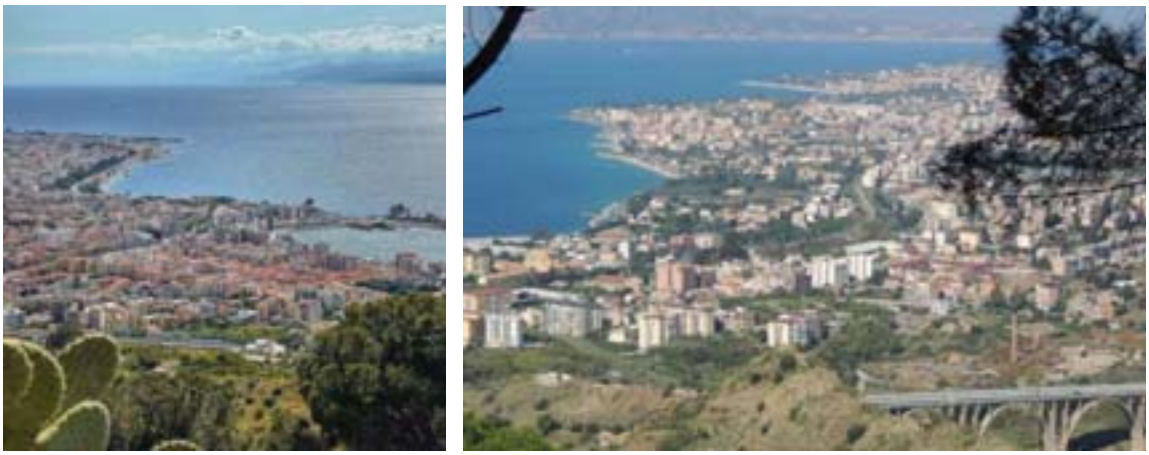
**Tab.1: Technical characteristics of the ropeway system**

| | |
|---|---|
| Track length (m | 1,120 |
| Commercial speed (km/h) | 16 |
| Lap time (minutes) | 8.4 |
| Cabin capacity (seats) | 8 |
| Number of booths online (maximum/average) | 24/12 |
| Maximum theoretical frequency (rides/h) | 176/88 |
| Average headway time (seconds) | 20/40 |
| Line capacity per direction (seats/h-direction | 1,368-684 |

The system allows for a functional flexibility; the number of cabins in line can adjust to demand levels. For example, in the off-peak hour, instead of moving 24 cabins, a dozen can be sufficient. Therefore the line capacity per direction can be halved (about 700 passengers/hour per direction).

### 4.4. Enhancement of site

The panoramic position of the hill, with a privileged elevated position over the Strait of Messina, is characterized by a spectacular southern view with Etna volcan in the background and the urban center of Reggio Calabria with its port (Fig.4), but also towards the north in the direction of peripheral districts and the marine bottleneck of Scilla and Cariddi (Fig.5).



**Figs. 4,5:** Panoramic views towards the sea from the top of Pentimele hill

On the top of the hill there are currently two forts dating back to the nineteenth century (Figs.6 and 7). They are two mighty structures arranged as a lookout over the Strait of Messina, military bastions, twin in shape but about 400 m away, made of bricks and natural stones, also known by the names of "Pentimele Battery" the one to the North and “Battery Pellizzeri” the one to the South. In recent times they have been partially restored. The two buildings, marginalized with respect to the city context,

have interesting potential, and could be venues for different cultural events (public meetings, theatre performances, art exhibitions, musical events, etc.).

**Fig.6:** The forts of Pentimele

**Fig.7:** Aerial views of the North and South forts

Not far from the forts is the monument dedicated to Saint Paul (Fig.8) that from Reggio in 61 AD gave rise to the spread of Christianity in Italy and Europe. The first stone of the monument, consisting of a statue and a marble column), was placed in 1961 in the occasion of the nineteenth centenary of the landing of St Paul, but the work was made 30 years later (however, with the column erected only in part). The monument was to be highly symbolic: visible from all the Reggio Calabria coast and from the other side of the Strait from Ganzirri to Taormina, illuminated at night in such a way of lighthouse, a signal for the sailors of the Strait, bearing witness to a message of great spiritual value

**Fig.8:** The monument dedicated to St Paul of Tarsus

The three sites corresponding to the monuments, as indicated in the map in Fig.9, placed a short distance, identify an overall area that strengthens the identity of each component. It is possible to push their enhancement initially through the qualification of the connection path suitably equipped, and then dwell more specifically on the implementation of social utility measures (equipped park, common areas, minimal and ecological buildings, light transport system).

**Fig.9:** Project area on top of the hill

### 4.5. Light installations for visitors

A design of a village with minimal services for welcoming visitors could be envisaged. The tourist presence should be supported, but avoiding excesses and the risks of negative overload on the environment.

The summit area should be equipped with services dedicated to the reception and permanence (from a few hours to the whole day) of visitors; in particular rest areas, infopoints, mobile phone recharge sites, recreational and play facilities for children, first aid, kiosks for refreshments and food, newsstands, craft stands, toilets, scattered fountains, picnic areas, swimming pools, small sports facilities. For longer-term hospitality (overnight stays), minimal removable houses and spaces for camping tents could be created, with related services. Equipped outdoor spaces (squares/theatres/fairs) or indoors (theatres/cinemas/ conferences/exhibitions) must be provided; they could in part be located inside the forts. The spaces should be sized so as to avoid excess attendance, have small dimensions, guarantee harmony and quiet, be easily evacuated safely, and be subject to an orderly selective programming and a chronological promotion of event planning.


**Fig.10:** Light reception services (mini-lodgings, picnic areas)

On the larger territorial dimension, the management of the belvedere area will be privileged, creating some spaces overlooking already at the landing point of the cable car; the creation of these spaces should follow a logic of natural steps, with light works for the slopes arrangement, in order to allow wide and contextualized panoramic views. Spaces equipped with adequate vegetation, floral species, pergolas distributed in such a way as not to appear monotonous and allow coolness and shade, with a draining solid floor surface (composed of grassed gravel, grassy grating). With its ridge-like reliefs

facing the Strait, the hill offers unique scenarios that can be admired from various vanishing points along equipped paths and trails, allowing for a relaxing immersion in the greenery of the new woods.
It will be possible to realise limited natural areas, with certain aims already partly emerged from the imagination and studies of the local community: a botanical garden with Mediterranean plant species, an area for the repopulation of some species of insects, a "butterfly house" or a greenhouse where butterflies can enjoy an ideal habitat even in the presence of visitors, park for local crops (olive trees, bergamot, vines, typical fruit, aromatic plants), site for monitoring migratory birds.
The area will be equipped with water supply systems to ensure permanent water for both people and plants according to rational cyclical irrigation programs. Taking care to achieve eco-compatible solutions, it is desirable to build modern systems for the production and use of renewable energy (solar panels, mini wind turbines) in order to guarantee the energy independence of the village, respecting the most advanced environmental sustainability parameters.
A non-negligible component of the supply concerns the telecommunications sphere. Actions can be multiple and addressed on two main levels: A) the optimal management of the area guaranteeing the functionality of the services, the centralized monitoring of the territory, the continuous protection of the environment also in terms of security; B) a web portal that provides for the digital exchange of information between the village and the outside world.

### 4.6. Environmental protection measures

For the purposes of protecting the regenerated environment and the presence of tourists on the hills, it is necessary to think of a coordinated set of measures and equipment; the primary components of the protective system include a heliport, an organic system of firebreaks and water pipes, a monitoring and control system for access routes.
A heliport runway can be located on the edge of the hillside village, with a helicopter landing pad size according to the indications given in the regulation for the construction and operation of heliports elaborated by ENAC, the National Civil Aviation Authority. The air vehicles can be used both for first aid functions for people, and as a support base for emergency firefighting, and in the case of emergencies.
Monitoring and control systems with extensive use of video sensors (and of other kind) appropriately distributed are useful for preventing illegal behaviour, vandalism, triggering fires, abuses to the detriment of the environment and people; therefore to activate forms of immediate intervention by the police in case of need. It will also be possible to make use of a drones fleet equipped with cameras for filming even at night. The control station will be located in an optimal position, not far from the helicopter base.

**Fig.11:** Heliport, monitoring and control systems with drones (source: https://www.montagna.tv/187351/)

The maintenance of green areas is a strategic operation, aimed at preserving the design idea and the status of the green zones. An area management and maintenance plan is therefore needed. This activity reduces the need for emergency actions and prevents possible dangerous events, as well as improving the quality of the greenery. Usual maintenance solutions are: irrigation, fertilization, pruning, antiparasitic treatments. Irrigation is essential for the survival and correct development of plant species; other actions could be occasional, and depend on the type of plant species.

Irrigation is a technique based on the artificial supply of water to a land to fill the deficit or irregularity of rainfall. The amount of water to be supplied depends mainly on the characteristics of the soil and the needs of the different species of vegetation. There are essentially three irrigation techniques: sprinkler (herbaceous plants, turf), drip (potted plants, hedges, bushes and rose gardens), radical (tree plants). Evidently it is necessary to set up a network irrigation system, suitably fed by dedicated water basins.
In order to prevent and stem the spread of any fires in the regenerated wooded area, it will also be advisable to create firebreak lines. In particular, tracks could be built that follow the contour lines at the foot of the hill and along some axes from upstream to downstream, such as along the ropeway route.

## 5. Summary considerations and conclusions

A territorial restoration and redevelopment project by its nature can only be complex. The case study addressed, aimed at the recovery of a degraded hill, lends itself well to bringing out a multiplicity of issues that necessarily require multidisciplinary skills and contributions. Positive and encouraging factors can emerge in plan assessments and project checks, but it is necessary to avoid easy enthusiasm and always relate the efforts of the imagination to concrete reality. With reference to the cableway transport system project, there are evident positive impacts that can be generated such as the shortness of the route and the better accessibility to the hill, the reduction of the pollution phenomena typical of private motorized vehicles, the image factor and the potential tourist attraction, even a good level of effectiveness. But an advanced technological transport system is not enough to change the characteristics of an area left abandoned for decades. It is necessary to pay attention to numerous other aspects; for example, the demand for tourist mobility which certainly cannot be satisfied just in terms of the transport supply and which by its nature changes over time and depends on numerous socio-economic parameters; the territory that cannot be trivially reforested and that needs differentiated, complementary and coordinated actions to overcome the state of degradation; the ability to manage the land with diversified expert personnel organized in a disciplined manner; the availability of resources for the continuous maintenance and harmonious growth of the ecosystem even in the presence of human activities such as those typically touristic, even if not mass-produced. The implementation of integrated transport-land use planning, with collaborative knowledge acting in synergy and collaboration, on shared objectives, will be crucial for a successful initiative. And the role of decision-makers is of fundamental importance for the land governance and the process of its transformation.

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# Drawing the walls of time and space: the Fontana dei Ciechi at Bonefro

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## Abstract
This study, focused on one of the historic fountains in the village of Bonefro, grew out of the desire to give new impulse to small cultural sites in Molise and is aimed, as suggested by the Piano Nazionale di Ripresa e Resilienza (PNRR) - National Plan for Recovery and Resilience, at enhancing the architectural heritage of the rural landscape, as well as the recovery and development of a new post-pandemic tourism. The study is based on archive documents and published material available in the Molise's cultural centres, as well as on the information published in the General Catalogue of Cultural Heritage. This research also involved an architectural survey using the 'Structure From Motion' method, which uses a dataset of ground and aerial images that are georeferenced and scale-adjusted in post-processing using topographical points. Additionally, the presence of an earlier architectural survey, made using traditional methods, allowed us to compare the results obtained in the past with those we attained using advanced survey techniques. The processes of discretizing and measuring, and of graphic synthesis have therefore produced an integral vision of the historical-architectural knowledge of the fountain, conveyed with traditional line drawings and three-dimensional models created through the processing of photographic images and aerial videos, which clearly show it's identifying characteristics, archetypal features and geometrical matrixes become evident.

**Keywords:** Fontana dei Ciechi, Bonefro, Architectonic Survey, Digital Photogrammetry

## 1. Introduction
The evolutionary history of humans teaches us that the greatest worry of the first groups of sedentary humans was to find drinking water. As a result, this concern has always influenced the choice of places where they settled. Later, water supplies were also addressed in printed stories, and among books written in the distant past in which this vital issue was addressed, we would like to mention *De architettura Libri X* written by Marco Vitruvio Pollione [1] (80–15 BC) and *Naturalis historia* by Pliny the Elder [2] (23–79 AC), to mention two well-known classics. In Molise this common sense rule was obviously never broken. All inhabited centres were founded near a river or one or more sources of fresh water capable of meeting the daily needs of the population, a positive balance still largely unchanged. Not only do urban aggregations all still have working public fountains within and outside the urban perimeter which are often representative constructions of local identity and the collective imagination, their presence also recurs not only in legends and popular traditions, but also in literature and iconography, where they are celebrated as a fundamental stopping point for drawing supplies, meeting, and interaction. The vital and social role of fountains recognized by the people of Molise is to some degree also due to the strategic unifying vision implemented by local administrations for locating these constructions and in the care placed on their design and realization. Today, the repertoire of fountains in Molise contains a decent number of examples consisting of both rural constructions, mostly situated along the drover's roads [3] or immediately next to inhabited centres, i.e. urban constructions. In addition, beyond their location, the morphology, architectural appearance, and construction materials of

the two types of fountains are also relevant. In examples of the rural type, the function of distributing drinking water tied mostly to the animal world often predominated over any other aspect, while the ornamental function was often favoured in urban fountains, with the result that select materials were used and architects and stonecutters were involved in their design and construction.

### 1.2 Bonefro and its Seventh-Century Rural Fountain

Bonefro is a municipality of little more than 1000 inhabitants in Central Italy, in the Province of Campobasso, located along the Celano-Foggia drover's road running towards Municipality of Sant'Elia a Pianisi. The historical core is located on the right bank of the Roma stream above a spur of calcareous rock about 631 m above sea level, dominating the surrounding territory marked by the path of the Varco stream and the green path of the drover's road. From here on clear winter days, the Isole Tremiti can be observed, immersed in the Adriatic Sea. An interesting fact states that in the decades straddling the unity of Italy, this settlement was fertile terrain for the revolutionary movement and banditry. The origin of Bonefro is still uncertain, but historians date it to the period in which part of the Italian territory was dominated by the Lombards [4], i.e. between the first half of the sixth century and the second half of the eighth century. In this respect, however, we note that the remains of human activities were found relatively recently. If analysed and studied by multidisciplinary teams, these could hold surprises and move the founding of this human settlement to historical periods predating the one attributed by historians. Although the hamlet is very old, its archival documentation is sparse and discontinuous. There are many causes of this regrettable situation, but they can almost always be traced to the bloody facts that brought mourning and destruction to Bonefro, triggered at times by nature [5], with repeated and intense earthquakes and at times by man [6], through campaigns of invading armies to conquer the territory, not the least of which were the Saracens. The oldest archival document we know of that mentions Bonefro is dated 1049. This deed shows that this hamlet in Molise, then known as Castellum Binifri, was added to the administrative district of Capitanata. The toponym was then simplified and shifted to Binifero, from the Latin *vinifer ossia*, 'wine producer', i.e. land where wine was produced. More direct evidence of Bonefro's past is contained in the document with which King Ladislaus of Naples (1377–1414) granted the hamlet and its lands as a fiefdom to the Boccapianola family in 1405.

We have found indirect information on Bonefro in a book written by the theologian Giovani Andrea Tria (1676–1761), which concentrates on the Diocese of Larino and was printed in 1744 [7]. Browsing the pages of this literary work, we learn that Bonefro, defined with the toponym Benifro, was cited as one of the castles of the Contrado di Pantasia in a document housed at the Abbey of Montecassino, dating to the time of Abbot Richerio (abbot of Montecassino from 1038 to 1055). This same work also shows that the hamlet of Bonefro, called Benafrum, was cited in the *Catalogus Baronum* compiled under William II of Sicily (1153–1189), William the Good [8] as a fiefdom pertaining to Capitanata. From this brief archival documentation, we see that the name Bonefro was assigned to this settlement after its founding, an event that honestly is not surprising since this also occurred with many other Italian settlements. As can be read in the brief review above of the toponym Bonefro, tracing the history of a place name after some time is an interesting cognitive process that often holds pleasant surprises, not only with respect to the origin of the name, but also is formation, distribution, and meaning. Starting along this scrupulous path for Bonefro is, however, a difficult enterprise without falling into slippery generalizations given that, as mentioned above, there are limited documentary sources available from scholars that are not often clearly pronounced [9]. Nevertheless, what can be said for certain is that the change to the toponym used to identify this settlement is located in a historical period after the early eighteenth century, given that on the map of the Diocese of Larino published in Tria's volume, this hamlet is reported with the toponym Bonifro, while it is called Bonefro in the pages that mention historical, morphological, and architectural traces (Fig. 1). At this point, having noted the difficulty in pursuing this path of research, we take a step back, since for us the topic of the changing toponym of Bonefro is secondary and we shift our attention to the urban design of the hamlet before analysing the Fontana dei Ciechi, the subject of our investigation. The historical centre of Bonefro, called 'Terra Vecchia' by inhabitants, encompasses in its horseshoe shape not only civil residences, but also the castle, built in the mid-tenth century, and the Church dedicated to Santa Maria delle Rose, probably built in the thirteenth century. The urban layout of Bonefro opens to the surrounding territory through four urban gates, three of which are vestiges of the feudal period and one expresses more modern needs: Porta Molino, Porta Piè la Terra, Porta Fontana, and Porta Nuova. With the passage of time, the urban evolution of Bonefro expanded into the areas adjacent to the historical core, which the oral tradition of Bonefro's inhabitants call: 'Il Piano' [the plain], 'Il Monte' [the hill], 'Le Lame' [the blades]. In the early eighteenth century, the new urban lands of Bonefro and its historical core were combined in a single urban design through a space for interaction, organized into areas for leisure, the market, and local mobility, carved out of the flat areas connecting the different built areas, which is called Piazza Municipio today. Finally, with the reconstruction of the Monastery of Santa Maria delle Grazie of the Order of Friars Minor Conventual - a religious complex dating to the sixteenth century - which began in 1703 [10], the built area of Bonefro reached its definitive layout, which is still visible today (Fig. 2).

Above **Fig. 2:** Excerpt of the municipal territorial map of Bonefro showing the main monuments: 1. Church dedicated to Santa Maria delle Rose; 2. Castle; 3. Monastery of Santa Maria delle Grazie; 4. Fontana dei Ciechi.

Left **Fig. 1:** Map of the Diocese of Larino, 1744.

As already highlighted, the springs and fountains in this settlement in the Province of Campobasso, as in other municipalities in Molise and Central Italy, are always configured as important points of territorial reference. The fountains, today historical evidence of a more or less continuous past, are situated at various points of the towns and related agricultural areas since they constituted fundamental stops along ancient paths of country life. In particular, those situated along the extra-urban roads near entrances to the hamlets represented the last point of water supplies for people and animals before entering the countryside.

With regard to the Fontana dei Ciechi, archival documentation [11] shows that construction began under Mayor Nicola Agostinelli in 1812 as a solution to the people's request to have drinking water available in sufficient amounts in every season. The location of the structure in the Contrada dei Ciechi, which lends it its name, was chosen by the local administration because a vein of underground water sprang up here, in an area called the 'Pantano' [the swamp] by the locals, adjacent to the rush stand of the former Friars Minor Conventual. The spring was perfect for meeting the peoples' request, both due to its position - the site was close to the settlement and could be reached by travelling along an access road to Bonefro, today's Via Ettore Lalli - and due to the quality and quantity of water: fresh, abundant, and constant year round. The fountain was designed in 1815 and it was built in the following year, assigning the task to master stonecutter Arcangelo Fagnano, a native of Pescopennataro.

At this point, it is worth recalling that any product of the human mind becomes objective and independent of its designer when it is made of a stable material and that for those who are interested, the constructions of the past are striking with their architectural unity, obtained with a balance and interaction of materials, structures, function, form, style, and matter. With regard to this last aspect, the history of construction teaches us that each material has a production cycle prior to its installation.

As the archaeologist and historian from Parma, Tiziano Mannoni [12] (1928–2010), writes, 'in nature there are no construction materials, just natural resources that can be turned into materials' with physical/chemical properties suitable for this scope. First the natural resource is 'cultivated' where it is extracted, then it is converted into 'raw material' that is easy to transport, and finally it is turned into a 'construction material' ready to be used, at times changing its shape, as with stone, or the initial composition, as with bricks and mortar. In addition, studies on historical construction have long clearly shown that this area of human ingenuity cannot be completely understood if the reflections made here remain focused on the shapes, architectural styles, urban layout, and do not also extend to the archaeometric data and construction ability, which have known how to bend local resources to the practical functions of life.

In the Central Apennines where construction techniques were the fruit of a body of knowledge passed down through humble and necessary everyday works, the raw materials to build shelters for people and animals and related works were limited. In Campobasso, Molise, and mid-Biferno, the geographical area where Bonefro was located, people had timber and stone available for these purposes, in practically unlimited amounts that left no alternative for their use.

Used in blocks for masonry or in chips for cobblestones, the rock transformed by skilled hands often made human and divine spaces similar in beauty. Here, the use of 'space' is intended as the three-dimensional organization of the elements that constitute the place [13].
This material culture imposed by environmental conditions naturally also influenced the construction of the nineteenth-century fountain of Bonefro. The preliminary study made by observing photographs showed that the fountain - pertaining to the wall type - was made of load-bearing masonry, for which blocks of local light-coloured, squared stone were assembled following a design with regular courses solidified with beds of lime mortar [14].
Following this, we used a survey of the fountain to obtain the metric characteristics and its geographical position with the World Geodetic System 1984 (WGS 84) for spatial referencing. In particular, this analysis showed that the Fontana dei Ciechi is 4.00 wide and about 5.00 high, and the thickness of the wall is about 0.60 m (Fig. 3).
With regard to the spatial location of the construction, the geographical coordinates extracted from our positioning system (GPX) are the following: 14.936184327 longitude and 41.707466506 latitude.
The architectural configuration of the elevation of the Fontana dei Ciechi shows an evidently classical design divided into four horizontal bands: the base, central body, entablature, and tympanum (Fig. 4). There are two rectangular drinking troughs for animals at the sides made of light-coloured stone masonry, made of the same quality as that of the fountain, with similar shapes, sizes, and volumes of water, which they receive indirectly from the fountain channels.
To better describe the architectural apparatus, we see that the base of the fountain consists of a rectangular volume measuring 4.00 m wide, 0.75 m deep, and 0.70 m high. At the top of this, we find a surface for users to rest water containers, equipped with holes to drain off extra water, which is conveyed to the drinking troughs at the sides. The central body of the fountain rises from the base.
The surface, consisting of 11 stone courses, is marked by four equidistant pilasters with stylized bases and capitals that support the entablature. Between one pilaster and the next are bronze, continuous-flow channels with zoomorphic designs.
The entablature is marked by the pilasters below. It consists of the architrave and cornice, whose design derives from the juxtaposition of a dense series of stylized moulding and which projects as in classical architecture. The tympanum is organized around an elliptical cornice free of a noble coat of arms, set in a wall facing outlined and delimited by moulding at the centre of the fountain.
To the sides of this architectural element we find the connecting volutes. The structure organized thus is topped by five decorative pyramidal and spherical pinnacles situated on prism-shaped bases.
The seismic events in this century extrapolated from the Italian Seismic Bulletin published by the National Institute of Geophysics and Volcanology (INGV), shows that the Municipality of Bonefro did not escape unscathed from the earthquake that hit the Molise Region between the end of October and beginning of November, 2002 [15] (Fig. 5).
The diagrams surveying the damage [16] to monumental goods in the earthquake area, in the Bonefro section, also contains a note on the Fontana dei Ciechi. In particular, the descriptive notes on its state after the earthquake state that the fountain showed architectural damage at the highest point: part of the top detached from the rest of the construction and some constituent elements were irreparably damaged when they hit the cobblestones below.
The architectural and functional recovery of these constructions involved a rather long investigation and operational process, which ended for the Fontana dei Ciechi in Bonefro in 2016, as stated in the engraving on the back face of the new central pinnacle (Fig. 6).

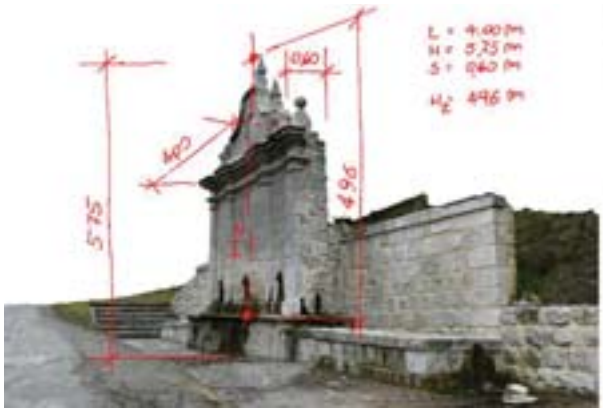


**Fig. 3:** Perspective of the polygonal model with the primary measurements.

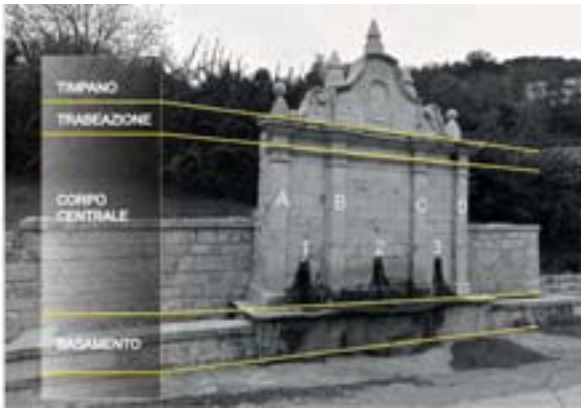


**Fig. 4:** Photograph of the fountain with the four horizontal bands that express the architectural image.

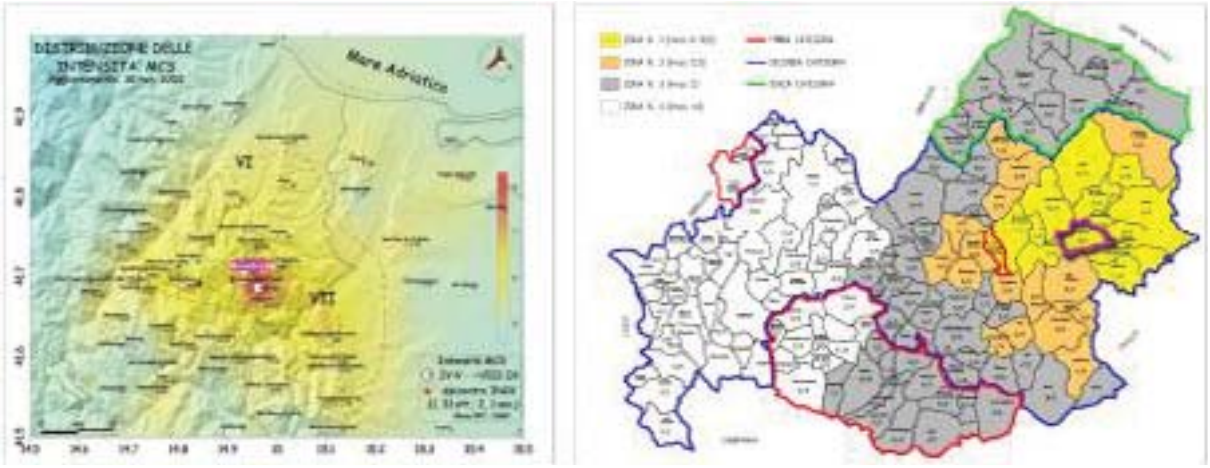


**Fig. 5a:** Map of the area affected by the 2002 earthquake; **5b:** Map of the Molise region, with red highlighting the areas most hit by the 2002 earthquake.

In this context of mending the damage inflicted by the earthquake, given the historical, architectural, landscape, and collective memory value expressed by the Fontana dei Ciechi, we encounter Alois Riegl (1858–1905), who said: 'for us, each historical event has an irreplaceable value' [17]. The design and operational activities in the field were monitored by the Soprintendenza Archeologica e per i Beni Ambientali Architettonici Artistici e Storici del Molise of Campobasso (SBAP Molise), to guarantee its reconstruction following the guidelines in the Venice Charter of 1964 and the 'Carta italiana del restauro' [Italian Restoration Charter] of 1972. These operational principles rest on the reflections on 'philological restoration', first developed by Camillo Boito (1836–1914) and then Gustavo Giovannoni (1873–1947) [18], to recall two scholars among the first in Europe to face the problem of restoring historical buildings seriously and conscientiously. Although the restoration returned the Fontana dei Ciechi to its state before the earthquake, we cannot help but note striking dissonances in the architectural apparatus which leave us perplexed. We refer to the excessive thickness of the mortar beds with which the wall facing of the fountain was reconstructed and the failure to recover the moulding that encloses the masonry at the top.

**Fig. 6:** Base of the central pinnacle with the date of the architectural and functional recovery of the Fontana dei Ciechi

**Fig. 7:** Photo of part of the top of the Fontana dei Chechi; part of the missing moulding is shown in the foreground.

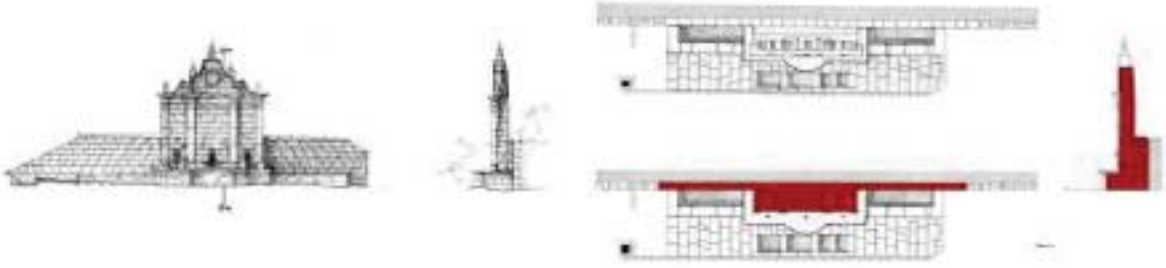

**Fig. 8:** Diagrams from the 1992 survey housed in the archives of the Soprintendenza Archeologica e per i Beni Ambientali Architettonici Artistici e Storici del Molise of Campobasso (SBAP Molise).

In our understanding of the restoration of an architectural good for conservation, such solutions adopted in the field lack any logic. In particular, the failure to recover the original design of the cornice of the top is illogical, given that the philological method was adopted for the other elements damaged by the earthquake. In other words, the original architectural design was recovered using new elements made of local stone, the same stone used to build the fountain, respecting the colours, but adopting a new surface finish different from the original to allow scholars and attentive, cultured visitors to distinguish the reconstructed elements. The solution adopted to rebuild the cornice is therefore incomprehensible. This is true not only due to the failure to recover the original architectural design, but also because the element needing replacement - with a stylized copy - was of a modest size which in no way would have influenced the reconstruction times or costs, while the absence of this detail today is not only noted, but disrupts the view of people observing the structure, especially when the play of light and shadows is most evident (Fig. 7).

## 2. Survey and modelling

For more than 15 years, means of 3D digital scanning with active sensors, such as terrestrial laser scanning (TLS), and passive sensors, such as digital structure from motion (SfM) photogrammetry, have been fundamental in surveying. Over time, the workflow relating to the two methods, as well as their means of integration, have been the object of research and experimentation, adoption, and codification. But it is methods relating to image reconstruction that, due to software refinements, have allowed for substantial improvement in the reliability of the models in recent years.
However, these scanning methods, especially if aimed at modelling architectural elements of a certain height, do not allow for complete reconstructions with a uniform definition without relying on tools that allow for observation points at height. Overlooking the use of yardsticks or auxiliary scaffolding, which are often unavailable, the spread of UAS (unmanned aircraft systems) equipped with digital imaging devices has certainly contributed to providing, within the regulatory limits of flight, effective assistance in this field for suitable high-definition photogrammetry.

### 2.1 Data Acquisition and Processing

The digital model of the fountain in Bonefro was constructed using the 3D Zephir software, integrating the results of two different set of photos. One consisted of 270 images with a resolution of 6192 x 4128 taken from the ground using a Nikon D850 digital camera with a 58-mm objective lens, CMOS sensor in FX format, 35.9 mm x 23.9 mm, of 45.7 MP. The second set consisted of 200 images with a 4000 x 2250 resolution taken in flight on a DJI mini 2 drone fitted with a digital camera with 24-mm objective lens, 1/2.3" CMOS sensor of 12 MP. For the entire set of images, the metric reliability and referencing was tested by collimating 10 celerimetric points (GCP) acquired using a Leica TCR 703 total station (TS). As mentioned, photos of the entire base were taken with a Nikon camera calibrated on 3Df Lapyx, a wizard in the 3D Zephir software. Snapshots were taken at a distance of 2–3 metres with a fixed 1/125 exposure with ISO 200, ensuring a superposition between photographs of 60%. The area of the cornice and surface of the top were instead photographed using a drone with a fixed distance of 1–2 metres, with exposure values automatically set by the device based on ISO 200 and a fixed aperture of F 2.8.
With respect to data processing using the SfM software, two different 3D models were developed, one for the ground and one for the air, using 5 photogrammetric points of reference for each section as control points to regulate the reconstruction. Of the 10 total points, five with the lowest error were used as limits for the union of the two models, using the remaining five as control points. Once combined in the final project, the maximum projection error of the images was 0.8326 cm with a final average residual alignment error (RMF) calculated using the control points after regulating the band, equal to 0.0580334 cm, while the main root mean square of orientation (RMSE) was 0.0695047 cm. The entire resulting photogrammetric point cloud consisted of about 9.8 million points. The SfM process to define the final dense cloud lasted about 30 minutes (Fig. 9).

### 2.2 Development of the Polygonal Model

Once the dense photogrammetric cloud was defined, the mesh of the entire structure was developed. The process was started after applying the octree-based decimation filter, keeping the values suggested by the software. The resulting model consisted of about 2,179,000 points and 4,355,000 triangles. Once the polygonal model was defined, the textures were generated, giving different weights to the images depending on their quality in terms of clarity and light. The visual analysis of the quality made on the final model in the virtual environment allowed for an assessment of the effective opportunities offered by developing a high-density 3D model, both overall and in detail.
A comparison between the model developed using SfM and one developed using a TLS model would have allowed us to validate the quality and reliability of the results, considering the reduced dimensions and metric reliability substantiated using the topographical control points, the visual result of the texturized model, and the reduced time necessary to define the entire process between the scan and post-processing.

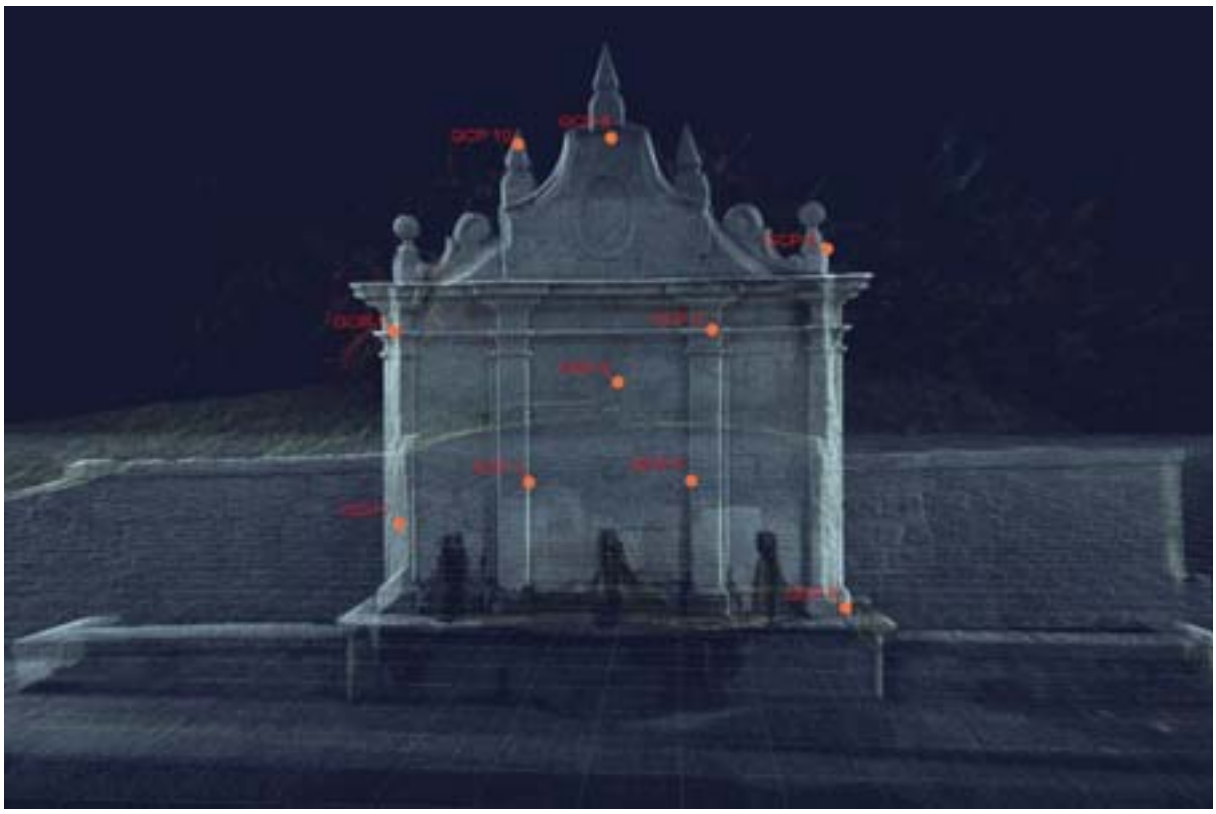

**Fig. 9:** Image of the dense cloud of the fountain; the control points used as a reference to define the model are shown in red.

**Fig. 10:** Image of the polygonal mesh of the fountain with textures.

It is therefore maintained, at least in cases with comparable dimensions and complexity, that the results are effective and reliable for later use in terms of graphical representation aimed at both analysis and the graphical definition of details (Fig. 10).

## 3. Graphical/metric analysis

Based on the metric-scale reconstructions made in the CAD environment by processing the data deriving from the acquisitions, the study focused on identifying a system of measurement that could have plausibly been adopted to build the structure, also considering the absence of metric studies dedicated to this building. The 4.00 m width of the fountain – without the drinking troughs made later – oriented our study towards the metric system. Following this route of investigation we found as a probable proportional module the meter and its submultiples. The architectural rhythm marked by the pilasters is in fact 1.00 m, 2.00 m, 1.00 m, the thickness of the pilasters is slightly wider than 25 cm, while the overhang of these architectural elements compared to the plane of the wall facing on average is 10 cm. About geometric proportional analysis, we realized that it is possible to inscribe the shape of the artifact without the base, in 2 golden rectangles (fig. 11).

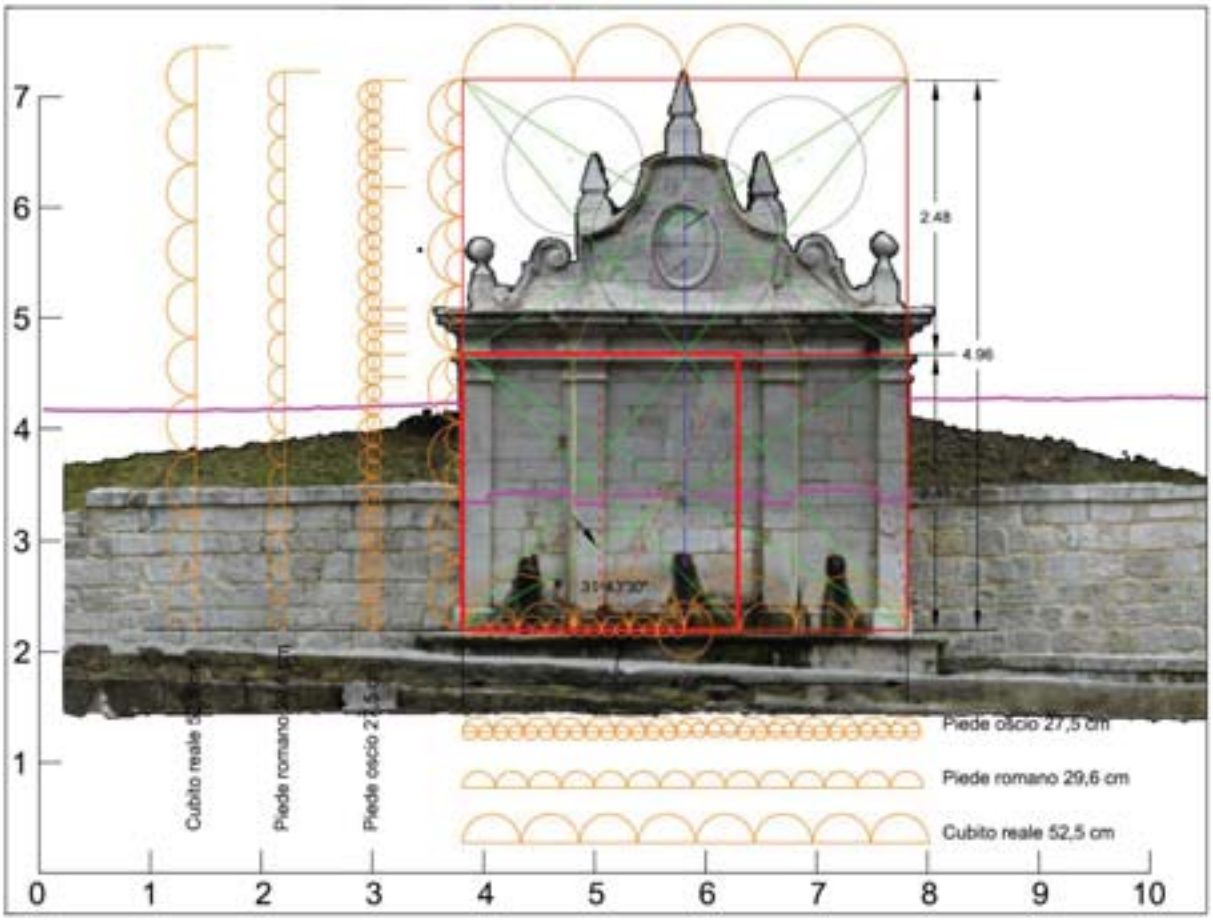


**Fig. 11:** Graphical/metric analysis of the Fontana dei Ciechi at Bonefro. The golden rectangle used as a proportional guide and the metric ratios referring to the Oscan foot, the royal cubit and the Roman foot used in the cognitive investigation are highlighted.

From the metric evidence, in fact, it is clear that the width of the fountain is in golden ratio with the distance between the base of the same and the impost line of the entablature corresponding to 2.48 m. As much as the metric unit of measure revealed a certain dimensional reliability especially for horizontal measurements, it was nevertheless verified the level of reliability addressed the possibility the topic relates to the metric analysis of the Oscan foot, used in the Samnite territories, also implausible, as implausible as the metrological analysis experienced with the royal cubit and the Roman foot, dimensional modules used in southern Italy before the General Conference of Weights and Measures (CGPM) held in Paris in 1889 when the then young Kingdom of Italy adhered to the International system of measurement.

In metrological terms, the results of the study lead us to advance the hypothesis that the Bonefro fountain was designed with the metric system insofar as the vertical measurements do not joint the rigor of the horizontal ones, Among the possible causes we could, for example, attribute the less rigorous metric correspondence, as we had the opportunity to point out earlier, to the post-earthquake reconstruction, This would also explain the non-full correspondence between the artifact and the geometric proportional ratios assumed.

## 4. Conclusion

The Fontana dei Ciechi in Bonefro offers a point for reflection on the relationship between citizens and the architectural heritage, the noble component of the landscape. In fact, the landscape is strongly connected with the tangible and intangible cultural heritage. This is full of the tangible physical traces of transformations on the Earth's surface produced by historical events over the centuries, but also the intangible traces of human culture, as historians, geographers, and anthropologists have long highlighted. Not only that, the landscape is also the object of social perception as philosophers and historians reiterate [19].

All of these landscape aspects help us understand that there is also room for this topic in the National Recovery and Resilience Plan (NRRP). In fact, the NRRP aims to give a new layout to Italy and with it, we also hope, a new appearance to inhabited places, promoting projects aimed at protecting and enhancing architecture, and thus historical and rural landscapes, given that this national programme also promotes activities to boost the national economy with respect to tourism/culture and therefore traditions and local cultures. This is the course of action along which we are moving with our joint disciplinary action, whose combined point of research activity is the hamlets of Molise.

The research aims to transmit to younger generations the cultural traces of this part of Central Italy, which is little known to the greater public, and we do so by studying prestigious architectural constructions, which, as evidence of human know-how, hold civil value. In fact, an architectural construction is a three-dimensional object that contains the marks of time that have shaped it with the addition and removal of material. Its historical dimension consists in the fact that it may be analysed by tracing back the steps marked by the succession of events.

Each construction has a living body and a surface, its 'skin', as Daniele Manacorda [20] calls it, with which we come into contact with our senses and we analyse the construction both directly and indirectly, through archival documentation and standing in the place to measure it. In the case we bring to the scientific community, in addition to the desire to document the structure after the restoration and functional recovery made necessary of the earthquake of 2002, there was also a desire to use digital photogrammetry for new documentation, making use of digital tools such as cameras and unmanned aerial vehicles (UAV).

This means of investigation allowed us to quickly scan all the elements of the fountain in the field and then, in the studio, create an extremely precise 3D digital model consisting of a point cloud, with which we have all the metric and colour data regarding the construction in real time. This system of architectural surveying has been known for some time, but the shift to digital in recent decades has given it new life, which is also due to the latest high-performance software, making surveying options quick and precise. We also intend to use these methods in the near future to document and study constructions that are more complex than the Fontana dei Ciechi in Bonefro, as well as extensively test its application potential.

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# The measurement of decorum as a practice of knowledge in the expanding Naples of the early twentieth century: some examples

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## Abstract
Adopting the goals of the Forum and with the intention of preserving the assets that history has given us, this paper proposes a path of analysis aimed at the knowledge and enhancement of some Art Nouveau architectures built in the expanding Naples of the first half of the 20th century, where the architectural sign of the full-field decorations creates a cultural relationship between man, architecture, and the environment. In order for these assets to become a collective resource, it is vital to promote increasingly in-depth knowledge analysis, also thanks to the most recent digital survey technologies, and greater dissemination to develop new strategies for a sustainable future of the city in defence of the urban environment.
The analysis of building facades leads to identifying the features of an urban environment that can be recognized as identifying a place and as a cultural attraction in the context of a development strategy.
Therefore, it is necessary to spread and consolidate the imperative of dwelling on earth with respect to history, projecting into the future the assets we inherited to defend our cultural identity and for sustainable development.
Three buildings were chosen as case studies: Palazzina Rocco in Chiaia, Villa Loreley in Vomero, and Villa Pappone in Posillipo, investigated with the aim of "measuring" decorum as a practice of knowledge of a rich architectural heritage, an authentic attraction that can be used in the cultural and tourist chain of Naples.

**Keywords:** Liberty decorations in Naples, Palazzo Rocco, Villa Loreley, Villa Pappone, integrated survey.

## 1. Introduction
In the urban fabric of the city of Naples are numerous architectural works built in the Liberty/Floral style of the early 20th century, which finds expression in many Italian cities and several European countries, with differences specific to their places of origin [1]. The less speculative nature of the homes built during this period, especially in the hilly areas of new expansion, made it possible to create low-density apartment buildings and villas, where there was a greater opportunity to experiment with new architectural and decorative forms.
The Liberty style in Naples is the signature of famous architects, who also operate nationally, including Adolfo Avena, Giulio Ulisse Arata, and Gregorio Botta, and who spread the new language in the building practice, which still has traces in an urban fabric that has since developed chaotically [2]. Examples include Villa Margherita on Via Francesco De Mura 4 in Vomero, the Liberty villa on two levels in Via Crispi 76 in Chiaia, and the Floral villa in Via Marechiaro 40, which, even though they are not among the most representative and emblematic buildings of the new style, show a skilful integration of the old and the modern, with the use of decorative elements.
Dynamic, undulating, and asymmetric ornamental lines with a strong reference to natural forms characterise each element of Liberty architecture. Based on the selected case studies, this paper considers decoration as the main character of architecture, an element that "captures the eye," creates

emotions, and imprints identity onto the surface on which it develops. However, the decoration was banned by Adolf Loos in his work "Ornament and Crime" of 1908, in which the author proposed eliminating ornamentation in the design phase, laying the foundation for a new way of thinking and doing architecture [3].
Recalling this essay, this contribution, which develops within a research on the features and expressive varieties of the new Liberty architectural language in Naples, aims, like Loos, to eliminate ornament from the Liberty architecture façades -after having surveyed and drawn them- to measure the impact that decorum exerts on them and to decode the language that decorum expresses.
Based on these premises, the main façades of three Liberty architecture buildings are analysed and compared in this study, namely Palazzina Rocco, Villa Loreley, and Villa Pappone, which were already partially investigated in previous studies using Image Based Modelling techniques.

## 2. The case studies

The case studies are located in three different hilly areas of the city of Naples: Palazzina Rocco was built in 1909 by Emanuele Rocco in Chiaia in via del Parco Margherita; Villa Loreley, designed by Adolfo Avena in 1912, is located in Vomero in via Gioacchino Toma; and finally, Villa Pappone, designed by Gregorio Botta in 1912 on behalf of Francesco Pappone, was built in Posillipo in via Salita del Casale.
The choice of these buildings is because each is located in a different area of new urbanisation of the city and expresses a different compositional character that the new liberty style acquires in Naples. For example, Palazzina Rocco stands out for its volumetric variety with a mixtilinear façade profile decorated with light floral motifs, phytomorphic designs and classical stuccoes independent of stylistic reminiscences which recalls the façade of the Hotel Paris in Prague in via U Obecniho domu 1; Villa Loreley, on the other hand, expresses a transition phase between the eclecticism of the late nineteenth century and the neo-eclecticism of the early twentieth of the XX century with decorations towards the monumental that recall the Art Nouveau palaces across the Alps, such as Casa di Muse by Otto Wagner in Vienna in via Kostlergasse 1 [4]; finally, Villa Pappone, in Posillipo, is closer to the European trends of Art Nouveau; its entrance canopy recalls, for example, the barrel-vaulted iron and glass one of the building in 1090 U Prasné Brany Staré Mesto street in Prague, but also the numerous cast iron and glass entrance shelters to the Paris metro by Hector Guimard [5] (Fig.1).
The study only focuses on the façades facing the main street, for decorative expression finds its highest manifestation where there is greater visibility. This choice coincides with the main façade for Palazzina Rocco and Villa Pappone. In the case of Villa Loreley, however, all façades were considered primary since the building is located on a hairpin bend.

**Fig. 1:** Examples of Art Nouveau architecture in Naples, from the top, left: villa Margherita in via Francesco De Mura 4 in Vomero, two levels liberty villa in via Crispi 76 in Chiaia, floral villa in via Marechiaro 40. In sequence on the right: villa Pappone-Prague building, Villa Loreley-Vienna building and Palazzina Rocco-Hotel Paris in Prague.

The most evident issue is Palazzina Rocco, where on the South side, not visible from via del Parco Margherita, only the openings on the top level are decorated.

## 3. From image-based modelling to drawing

The processing of metric data, previously obtained through image-based modelling techniques, allowed the two-dimensional representation of the façades of the buildings in their entirety, the interpretation of the distribution patterns of the façades and the detailed drawing of the decorative elements. Based on this work, we studied the buildings' main compositional, formal and geometric elements. The following paragraphs describe the main phases of the photogrammetric survey of the buildings and their graphic representation.

### 3.1 Architectural survey of the façades

Applying direct and indirect methods, we used an integrated methodology to investigate the façades of the case studies to understand, acquire and represent information about each building at an appropriate scale [6].

From an operative point of view, there is a temporal succession of survey, processing and drawing operations due not only to logistical requirements connected to the accessibility of the sites but also to the fact that this research has emerged as a comparative study of three emblematic examples of Neapolitan Liberty previously investigated. In the preliminary phase of the work, we analysed the morphological and environmental features of each survey site, each with different peculiarities, to correctly plan the operational steps of the survey campaigns through the choice of instruments, the elaboration of eidotypes, the planning of photogrammetric surveys and drone flight stations.

In the case of Palazzina Rocco, which stands on an irregularly shaped lot enclosed on three sides by fences and terraces, two acquisition campaigns were necessary to complete the survey operations. For the first one, we used Unmanned Air Vehicle (UAV) systems to capture photographic images from all sides of the building. The drone was a DJI Mavic mini 2 Fly with an integrated camera and a 1/2.3" CMOS sensor, 35mm lens and 4k video, a model that enables flight operations in VLOS (Visual Line of Sight). For the second survey, we used a Nikon D7200 SLR camera with a 23.5 x 15.6 mm CMOS sensor with an 18-105 mm lens attached.

In the case of Villa Loreley, located in the bend of the slope via Toma, photogrammetric images could be taken with a Nikon D5200 SLR camera, APS-C sensor 23.6 x 15.7 mm, which mounts a Nikkor AF - S DX lens 18-55 mm, freely rotating the building and using the slopes and adjacent terraces to avoid effects of perspective distortion in the images. The same camera was also employed for the photogrammetric survey of the main façade of Villa Pappone. In particular, considering the complex and articulated nature of the rich entrance canopy with semi-transparent white and green glass, we decided to operate in overcast skies to avoid light reflections incompatible with the difficulties of the photo modelling software in processing images with transparent objects, mirrored or reflective surfaces. In contrast to the acquisition phase, the data processing phase for the three buildings followed a standard process in which the images were first processed in photo modelling software such as Matashape and 3DF Zephyr Aerial with ultra-high accuracy first to obtain a sparse cloud, and then a dense cloud. Since the product of the photogrammetric process has no dimensional correspondence with the actual object, it was necessary to scale the numerical models, on the base of external metric values acquired directly on-site. From the dense photogrammetric clouds, appropriately scaled and cleaned of spurious data, the mesh surfaces were elaborated, to which the photographic texture was then applied. The orthophotos were extracted from the models thus obtained and then used to create the survey drawings [7].

At the same time, a series of significant images for the study of the decorative elements were processed with the digital photo-rectification software RDF Didattica, performing projective transformations with the geometric method based on the direct measurements made (Fig. 2).

**Fig. 2:** Architectural survey of the decoration. Positioning of control points (Ground Control Point) on the facade of Palazzina Rocco for frame measurements with 3DF Zephyr Aerial software.

### 3.2 The drawings of the façades

Based on the orthophotos performed through the SfM software and appropriately scaled according to the measurements taken with the direct method, as well as with the help of digital and geometric photo rectification applications, it was possible to carry out the drawings of the façades not only in the functional and structural elements but also in the decorative apparatus. For these operations, it was also helpful to have the support of synthetical contemporary architectural blueprints of the second level of the buildings examined [8], updated based on the measurements taken.

For better graphic clarity, in addition to the traditional representations in orthogonal projections, the design of the façades was also carried out in its entire development, considering a sequence of projection planes parallel to each side facing the street.

Each façade was drawn in all its elements contributing to understanding the morphology of the compositional and architectural-decorative structure: from the base to the elevated part of the roof. For the rendering, we chose a scale ratio of 1:10 to allow a true-to-scale reproduction of the drawing with a greater reduction factor without compromising the representation of the details.

The drawing of the main façades of the case studies made it possible to assess the intensity of the expressive power of the ornament in the Art Nouveau style, which contributed to enhancing proportions and new architectural solutions. The drawings show an abundance of ornaments that characterise this architectural style, reaching an extraordinary semantic range, different for each building. The decoration of a window, a door, a base, is not repeated from building to building but always represents a unicum that can only be found in the facades of the same construction.

The themes of the decoration are typical of Art Nouveau and are presented in solutions that stand out in terms of shape and colour.

In Palazzina Rocco (Fig. 3), for example, the mixtilinear façade is marked by horizontal compositional elements: the string course frames, finely decorated with motifs that vary at each level following the broken profile of the façade without interruption, bending at the corners and also following the shape of the front section where the entrance portal opens.

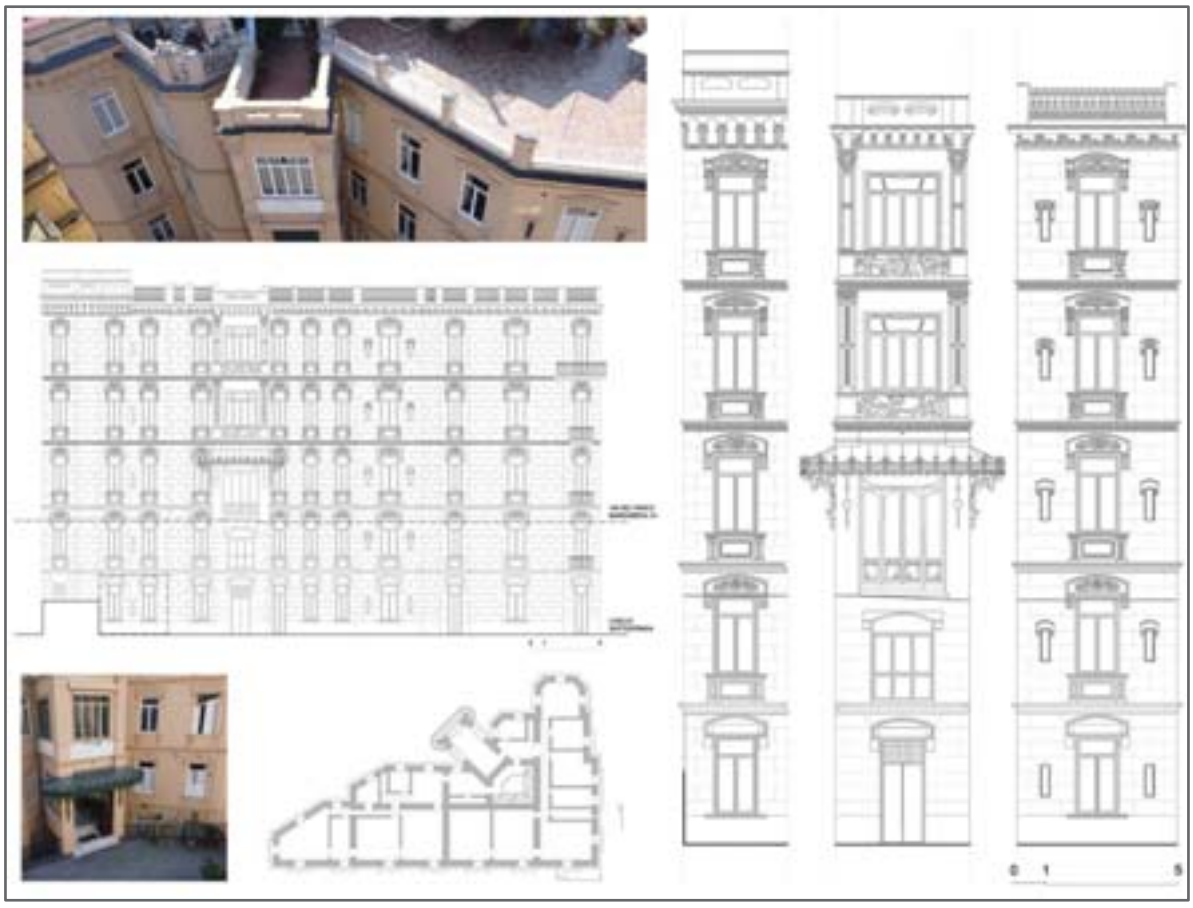

**Fig. 3:** Palazzina Rocco. Views of the last level and the entrance area using a drone. raphic representation in orthogonal projection of the façade on Via del Parco Margherita. Floor plan of the typical floor. Architectural details of the façade.

The sandy colour accompanies the flat surfaces of the façade and the decorated reliefs, except for the bas-reliefs under the windows of the avant-corps of the entrance, which are entirely white. The surface forming the backdrop of the façade is treated with a delicate pattern of moulded stone slabs, a faux ashlar that can be seen only at close range and crosses the space between the individual bars.
The decoration of the windows, which is different for each level of the building, is immediately readable thanks to the axiality of the openings and develops as tympanum and subwindow.
The volume of the square porch, which fits into a fold in the façade, expresses an essential compositional value for the entire front of the building, both because it contains an elegant canopy of glass and iron and because it has bas-reliefs with putti and floral bands that cover the underside of the large windows, which open on three sides with curved wooden frames that bear the same motif of curved lines as the entrance portal.
Another compositional element that characterises the morphology of the façade is a tower with rounded corners that, in continuity with the overall design of the façade, closes the corner that spans the side of the building.
The façade is not visible entirely, but only on the last three floors from the portal, below which two other floors are exposed to the road and detached from it. It should be remembered that the entire building develops on a slope of Chiaia hill. On the façade is a bar holder used during the occupation of the building by fascist officers [9].
On the other hand, Villa Loreley (Fig.4) is visible from all sides, as it is located in a hairpin bend that overcomes the steep slant on the southern slope of Vomero hill. On the garden side, the façade has four levels, three outside the hairpin curve and two at the beginning of the street. From the evolution of the elevation of the entire villa, it is easy to understand the alternation of linear and curved surfaces that compose the entire façade.


**Fig. 4:** Villa Loreley. Image of the building seen from via Palizzi with the loggia. Graphic representation in orthogonal projection of the façades on the bend of via Gioacchino Toma and on the private garden. Floor plan of the typical level. Architectural details of the façade.

On the rear level of the façade are the windows and the windows/balconies, most of which have architraves and are decorated with massive geometric motifs reminiscent of elements of Catalan architecture, with vegetal decorations introduced only on the top level. The axiality of the windows reveals precise vertical bands of decoration that appear seamlessly between the second and third levels. It is noticeable that, in contrast with Palazzina Rocco, the decoration of the windows tends to decrease as the height of the façade increases.
An arched loggia of classical scale, opening on the uppermost level, marks the corner of the building towards the hill, while the façade towards the valley has a front part on which a curved balcony opens, accessible from two rooms with two windows, side by side in a mullioned frame enclosed by a single lowered arched cornice. A thin frame with polystyle columns at the base, typical of Catalan architecture, marks the entrance portal, which opens into a curved surface that follows the path of the hairpin curve and is surmounted by a "multi-light" window [2] characterised by four rounded and two half-rounded corner pillars. This short sequence of decorative elements ends with a semi-dome with majolica roof tiles, typical of the Neapolitan tradition [8]. The building's crowning element is a prominent cornice onto which the decorations of the windows and balconies below are grafted.
Finally, the façade of Villa Pappone (Fig. 5) facing Salita del Casale di Posillipo, an emblematic example of Neapolitan floral decoration, is punctuated by horizontal elements consisting, in this case, of the wrought-iron balustrades of the balconies arranged both on the last two levels and the crowning of the building, as well as by majolica bands that develop on the lower floor between the interspaces of the windows/door windows, marking the crowning and the base of the windows on the ground floor only. Different floral motifs for each floor are reproduced in the square tower with rounded corners that closes the façade on the left side. Above a simple base with horizontal bands, the decoration of the three levels is enclosed by a slightly thick frame, interrupted at the windows/ door windows of the first and third floors. The entrance to the building is marked by an elegant canopy of iron and two-tone white and green glass, supported upwards by bronze gryphons and downwards by a rich wrought-iron framework running in large volutes like a railing to the shell-shaped marble steps below.

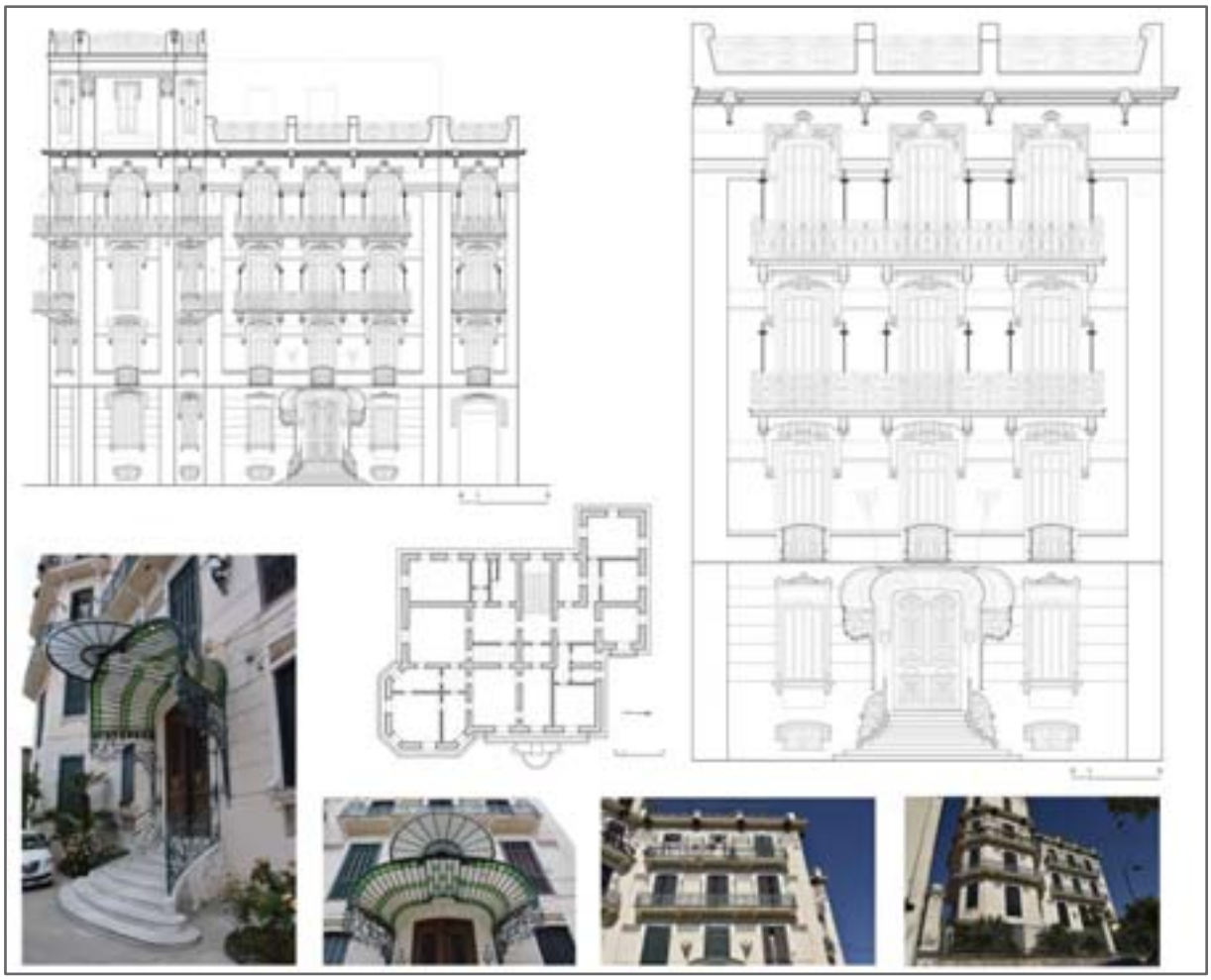

**Fig. 5:** Villa Pappone. Graphic representation in orthogonal projection of the façade. Floor plan of the typical level. Detail of the main front with the entrance. Images of the entrance canopy and the building seen from Salita del Casale. Graphic representation in orthogonal projection of the façade. Floor plan of the typical level.

The building is crowned by a protruding cornice supported by large iron leaves corbels that bend to support the overhang. Along the balconies are additional iron support elements, alternating on the balustrade. Crucial to the design of the façade of Villa Pappone are the decorations of the windows/door windows, which present different floral and geometric ornaments on each level, enriched by particular darkening elements and by wooden window frames that follow the shape of the lowered arch of the openings. The colour of the shutters and railings, jointly with the shiny colours of the majolica contrasting with the ivory backdrop, make the façade polychrome, with shades tending towards green.

## 4. The measurement of decorum

From the surveys and renderings of the façades (Figs. 6-7-8) of the case studies, it can be seen that the main decorated elements on the façades are as follows: windows, balconies, entrance portals with their respective finishing details, which are also subject to decoration, such as fixtures, grilles, shading elements and canopies over the entrances; followed by loggias, stringcourses, the background surface of the upper floors, the base or plinth, cornices, upper moulding, roofing elements and the corners.

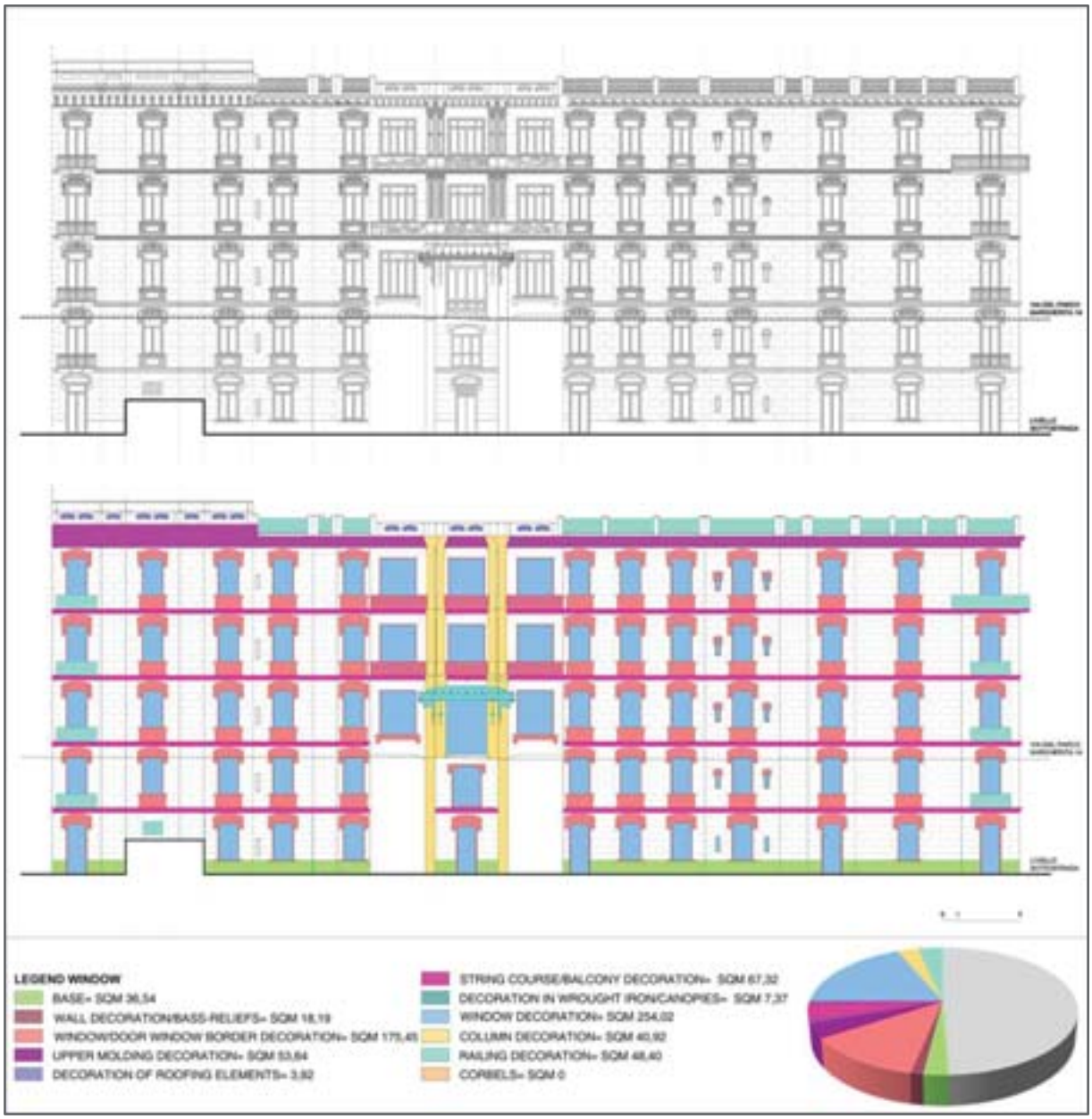


**Fig. 6:** Palazzina Rocco. Comparative analysis between the development of the facade on via del Parco Margherita with architectural details and the synthesis scheme of the decorated surfaces. Histogram representing the incidence of decoration in relation to the facade area represented.

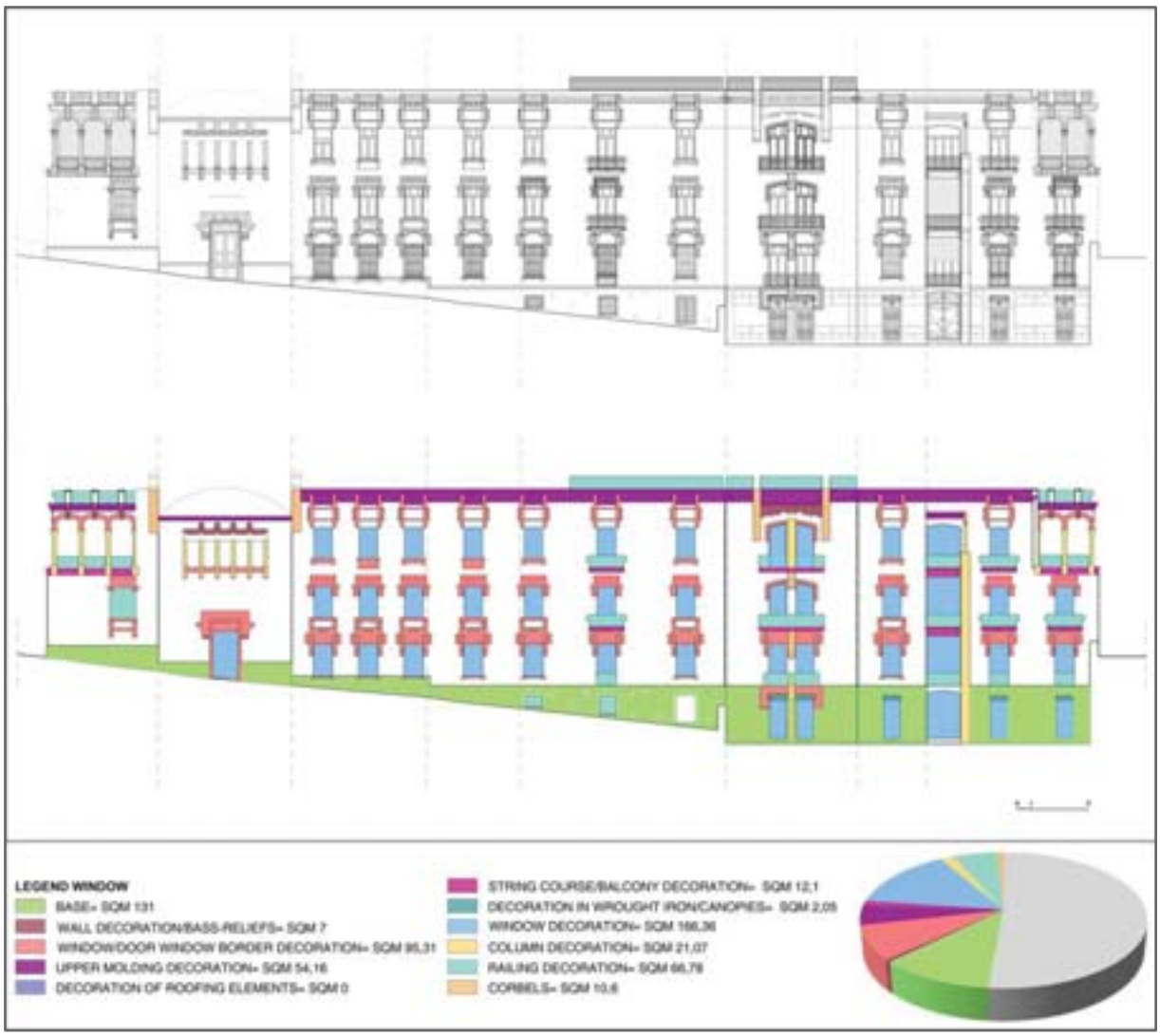


**Fig. 7:** Villa Loreley. Comparative analysis between the development of the facade on via Gioacchino Toma with architectural details and synthesis scheme of the decorated surfaces. Histogram representing the incidence of the decoration in relation to the area represented.

Finally, other parts that become decorative objects overlay the façade: mascarons, brackets, pole-holders, and railing stops. The analysis shows that the most commonly used materials are glass, iron, majolica, plaster, stucco, wood and cast iron, which, with their colours, element by element, have a significant impact on the visual perception of the entire building and influence its interpretation. The different articulation of the colours in the analysed buildings leads to different perceptual outcomes.
In Palazzina Rocco, for example, the decorative elements of the façade have the same colour as the background, resulting in a monochrome effect that seems to diminish the presence of the decoration on the façade and does not immediately enhance its value; in the case of Villa Lorelay, a strong chiaroscuro effect is perceived through the use of different shades of the same colour; finally, in Villa Pappone, the decorative elements are made more prominent through the combination of intensely coloured elements that contrast with the light background of the façade.
For the measurement of decoration on the façade of each analysed edifice, the development of the entire frontage was used, in which each portion of the façade was projected onto a plane parallel to it. Subsequently, the decorative surfaces were selected with different coloured hatching, based on the types of elements identified.
The comparison between the two facades, the first being a descriptive representation of the decoration and the second a synthesis, highlights the amount of ornament on the façade, which already at first glance, and confirmed then by critical data reading through the elaboration of a histogram, covers a significant percentage of the surface area compared to the entire façade.
The histogram drawn up for each façade of the examined buildings completes the analysis of the quantitative data of the realised decoration, confirming the significant role of ornamentation in the Liberty style and contributing to decoding the architectural language.


**Fig. 8:** Villa Pappone**.** Comparative analysis between the development of the facade on via Salita del Casale with architectural details and synthesis scheme of the decorated surfaces. Histogram representing the incidence of the decoration in relation to the area represented.

To compare the three investigated buildings, a single histogram is presented below as a synoptic overview of the decorative designs of the main facade elements as previously identified, which gathers the data for each case study of the recurring defined typologies (Fig. 9).

## 5. Conclusions

The operation of "measuring" the decoration and its impact on the design of the entire façade (Fig. 10), carried out on the buildings studied, has contributed to deciphering an artistic and architectural language of great importance in the definition of a building, namely the Neapolitan Liberty, by identifying some of the most commonly used decorative elements. For example, it was found that the decoration of the window/door window frame, together with the decoration of the fixtures, is present in a percentage ranging from 8.5% to 12.5% for the former and from 18.3% to 14.3% for the latter, varying slightly in the case studies. On the other hand, the corbels, absent in Palazzina Rocco and scarcely present in Villa Pappone, reach 0.9% in Villa Loreley.

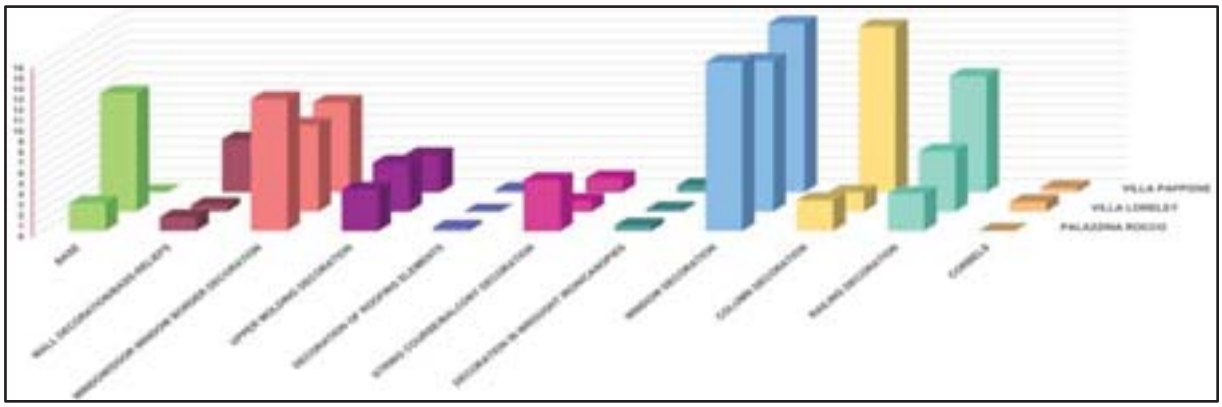

**Fig. 9:** Summary histograms relating to the percentage incidence of decoration in relation to the total area represented for the three buildings examined, divided by typology.

| ELEMENT | VILLA PAPPONE | IMPACT OF DECORUM | PALAZZINA ROCCO | IMPACT OF DECORUM | VILLA LORELEY | IMPACT OF DECORUM |
|---|---|---|---|---|---|---|
| | sqm | % | sqm | % | sqm | % |
| BASE | 0,00 | 0,0 | 36,54 | 2,6 | 131,01 | 11,2 |
| WALL DECORATION/BASS-RELIEFS | 41,88 | 5,0 | 18,19 | 1,3 | 7,01 | 0,6 |
| WINDOW/DOOR WINDOW BORDER DECORATION | 71,79 | 8,5 | 173,45 | 12,5 | 95,31 | 8,2 |
| UPPER MOLDING DECORATION | 29,84 | 3,5 | 53,64 | 3,9 | 54,16 | 4,6 |
| DECORATION OF ROOFING ELEMENTS | 1,68 | 0,2 | 3,92 | 0,3 | 0,00 | 0,0 |
| STRING COURSE/BALCONY DECORATION | 10,66 | 1,3 | 67,32 | 4,8 | 12,10 | 1,0 |
| DECORATION IN WROUGHT IRON/CANOPIES | 4,66 | 0,6 | 7,37 | 0,5 | 2,06 | 0,2 |
| WINDOW DECORATION | 138,19 | 16,4 | 254,02 | 18,3 | 166,36 | 14,3 |
| COLUMN DECORATION | 132,66 | 15,7 | 40,92 | 2,9 | 21,07 | 1,8 |
| RAILING DECORATION | 92,64 | 11,0 | 48,40 | 3,5 | 66,78 | 5,7 |
| CORBELS | 3,75 | 0,4 | 0,00 | 0,0 | 10,60 | 0,9 |
| TOTAL SURFACE DECORATED | 527,75 | 62,7 | 703,76 | 50,6 | 566,47 | 48,5 |
| TOTAL SURFACE NOT DECORATED | 314,60 | 37,3 | 686,35 | 49,4 | 600,42 | 51,5 |
| TOTAL SURFACE REPRESENTED | 842,35 | 100,0 | 1.390,11 | 100,0 | 1166,89 | 100,0 |

**Fig. 10:** A synoptic panel of the decoration measures and relative percentage incidence in relation to the total area represented of the three buildings examined.

This comparison of the buildings made it clear which decorative elements are most frequently used in a façade. This comparison of the buildings clarified which decorative elements are most frequently used in a façade. On the one hand, it was possible to explore the individual architectural detail without removing it from its structural context. On the other hand, by measuring the decoration, it was possible to quantify its power to draw the eye of those viewing highly decorated architecture. These are architectures in which the decoration strongly impacts the overall surface of the façade: 50.6% in Palazzina Rocco, 48.5% in Villa Loreley and no less than 62.7% in Villa Pappone.

## Acknowledgements

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# Vanished landscapes. New scenarios for dwelling on earth with the awareness of the past for a sustainable future. The ancient Vallis regia, now Lake Barrea

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## Abstract
This contribution will document the transformations that have taken place in a territory which, after man's intervention, has been flooded with water, changing its configuration from a valley to a lake. The objective is to disseminate and defend the history of a territory as a common asset and resource for sustainable development. The case in question is the ancient Vallis regia in the province of L'Aquila, close to the town of Barrea. In 1951, when a dam was built across the River Sangro, the valley was flooded with the river's waters, turning it into an artificial basin used as both a reservoir and to produce electricity.
There are many, incisive interventions of this kind on our planet; they have not only redesigned a territory, but also changed the way indigenous populations dwell on earth. The aim of the contribution is to find evidence of this vanished landscape and document how such a radical environmental transformation has not only influenced the life of the inhabitants, their culture, and traditions, but also created new scenarios. In fact, we believe that understanding the history of a territory is the key tool we need to safeguard it; a precious resource to be transmitted to future generations in order to achieve economic, environmental and above all cultural sustainability.

**Keywords:** vanished landscapes, Vallis regia, Lake Barrea, territorial information systems

## 1. Introduction
The landscape has, for many decades, been considered as representing the identity and sensitivity of a territory whose cultural values consolidate and stratify over a period of time, thus confirming its dynamic nature based on a dialectical debate between conservation to protect the past and social and environmental transformations. This is why an analysis of these processes - visible in the layout of the landscape everywhere - is considered a tool well-suited to understanding not only the way in which man has inhabited the earth, but also to what extent these transformations and environment, social and cultural changes have helped draft new sustainable development strategies [1]. The landscape is a crucial historical document, the unitary expression of transformations and evolutions.
A critical review and documentation of the landscape helps recover the memory of a relationship that over the years man has successfully established with his territory. We can therefore talk of cultural landscapes that make up the identity heritage of a place. Based on these premises, this contribution proposes to establish the historical and cultural identity of the current landscape of the higher reaches of the Sangro river where hydraulic engineering has modified the natural and built environment. In order to encourage an integrated territorial enhancement, the study examined the artificial Lake Barrea and its ancient valley, considering it as a single environmentally-enriching territorial asset [2], and proposing an integrated study model based on multiscalar documentation which will be summarised and disseminated as part of territorial informative systems.
All forms of representation are thus believed to not only play a fundamental role in the iconographic documentation of a site, but also input into the dissemination of knowledge as a first step towards the

protection and safeguard of what still remains of the former valley as a common territorial asset. For this paper a Geographic Information System has been designed, the results of which will hopefully be implemented in the future; the project gathered local and web data regarding basic information concerning the territory of the higher reaches of the Sangro river, and then enriched it with historical data taken from bibliographical and archival sources. Using the territorial database of the Abruzzo region (DBTR) and the digital elevation models published on the web [3] it was possible to develop a territorial elevation model (DTM) of the area of the Vallis regia and Lake Barrea, both before and after the creation of the artificial lake.

## 2. Historical-territorial framework of the Vallis regia

The territory of the old Vallis regia [4] corresponds geographically to the upper reaches of the Sangro river, between the towns of Opi and Barrea, surrounded by the Meta mountains and Mount Greco, and urbanised by small mountain hamlets including Villetta Barrea and Civitella Alfedena. The name Vallis regia (valley of the king) appears for the first time in the "Dialogues of the miracles of St. Benedict" written by Pope Victor II, abbot of Montecassino between 1076 and 1079; the king is refers to is probably King Ludwig II who passed through this area during that period [5]. In 1951 the layout of the valley changed radically when an artificial lake was built, flooding the valley and turning the mountain landscape of the hamlets of Barrea, Villetta Barrea and Civitella Alfedena into water landscapes. The lake had an enormous impact on the local economy; it caused the loss of fertile land and production facilities as well as traditional agricultural and pasture activities; it did however encourage the development of the tourist industry on which the local economy is still based.

Before the Barrea valley was turned into a lake it was crossed by the paths taken by transhumance herds of livestock who were moved during the winter to pastures in Apulia; they started from Opi and Civitella Alfedena at a higher level compared to the bottom of the Sangro valley, passed along the stretch from Pescasseroli to Candela and then continued down through the Colle della Croce towards Alfedena and then on to the Molise region and finally to Apulia. Vice versa, as reported by Terentius Varro in De Rustica, in the summer the livestock headed back to the fresh pastures of the Abruzzi. We know that for many centuries the tratturi, the old rough 'wool' roads, i.e., grassy paths used for the transhumance of livestock, especially sheep, were the main paths/roads in lower Abruzzo.

The territory of the Vallis regia was inhabited as far back as the prehistoric era by hunters of the Upper Paleolithic period who used grottoes and rocky outcrops as places where they could find shelter; during the Neolithic period these caves were later occupied by shepherds and farmers. We know this thanks to the archaeological remains found in the Graziani grotto close to Villetta Barrea [6]. As the Apennine civilisation began to emerge (1400 – 1300 BCE) sheep farming developed and, as a result, transhumance; the latter was initially "vertical", between valley pastures and mountain pastures, but in the same area; it then became "horizontal", characterised by longer journeys which, following the natural lie of the land and ancient prehistoric paths, spread from the internal area of the Apennines to areas closer to the sea [7]. During the Imperial period the economy based on transhumance (towards what is now known as Apulia) became consolidated in the Vallis regia while during the feudal era the sheep farming industry became the leading source of income in the valley. Under the Aragonese, transhumance was reorganised and managed directly by the State; there was an increase in the production of wool and the establishment of the Customs of sheep affairs in Apulia, active till the early 19th century (1447-1806) (Figs. 1 and 2).

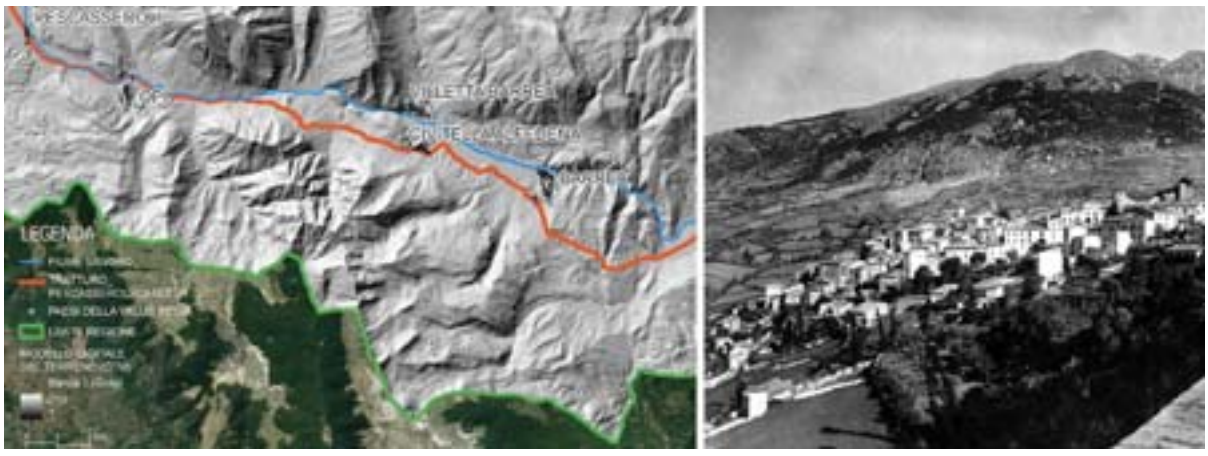


**Fig. 1**: Digital model of the terrain corresponding to the area of the ancient Vallis regia. Photo of Barrea, before the lake was created [14].


**Fig. 2**: Digital model of the terrain corresponding to the area of Lake Barrea. Photograph of Barrea today.

The sheep industry was an important economic activity in central and southern Italy; it allowed for the exploitation of less productive lands such as the Tavoliere delle Puglie, coastal areas, and the Abruzzi mountains; this sparked a strong process of territorialisation that led to the Abruzzi region being identified with pastoralism. Sheep farming in the Abruzzi also had an international market until it was replaced by other productions such as wool from Castiglia and later from non-European countries [8].
After the abolition of the Customs of sheep affairs in Apulia and the perpetual lease concessions regarding the lands on the Tavoliere, there was a gradual decline in the sheep farming industry; this prompted the economic decadence of the mountainous Abruzzo region and sparked waves of migration towards other areas in Italy and abroad.
The end of sheep farming and the damage caused by World War II reinforced the decision of some local inhabitants to rebuild what was now a 'destroyed' economy, starting with local resources. If, on the one hand, the creation of the lake radically transformed the area without ensuring immediate environmental stability, on the other it was considered as an opportunity, a real springboard to achieve sustainable development.

## 3. The Barrea valley: from a mountain landscape to a water landscape. The Barrea Lake

Barrea was artificially created in 1951 after a dam was built across the Sangro river near the Barrea gorge; it represents a humid area which in 1976 was inserted in the list of areas envisaged by the Ramsar Convention; its management is the responsibility of the Ente Autonomo Parco Nazionale d'Abruzzo, Lazio e Molise, with offices in Pescasseroli (L'Aquila).
The Barrea municipality, as well as the municipalities of Civitella Alfedena and Villetta Barrea all overlook the lake (Figs. 3 and 4). In 1922 a project was initially proposed to build two artificial basins in order to exploit the hydroelectric energy of the plains of Opi and Barrea [9].


**Fig. 3**: Transformation of the landscape of the upper reaches of the River Sangro. The towns in the valley before [14] and after the lake was created. Views from Barrea.


**Fig. 4**: Transformation of the landscape of the upper reaches of the River Sangro. Views from the valley towards Barrea, before [14] and after the lake was created.

The citizens and local administrators were instead very much against this project; they defended the integrity of the area and numerous technical and sanitary reports emphasised that the project would deface the landscape and could possibility cause malaria to become endemic, thus damaging the local economy which during that period was still based on agriculture and transhumance sheep farming. The projects were therefore suspended; only the project involving the Barrea Lake was revived immediately after the war.

From 1949 to 1951, after initial concerns regarding its environmental impact were overcome, work began to dam the Sangro river in the Barrea gorge, thus creating an artificial lake. Contemporary publications reveal that the inhabitants welcomed the construction of this big infrastructure; they believed that the lake would enrich the natural beauty of the Vallis regia,[5], a territory with huge areas of woodland, chiefly beech trees, and countless species of flora and fauna, i.e., a very important national ecosystem [10].

The construction of the dam unfortunately involved the demolition of ancient infrastructures, for example the one-arch stone bridge across the deep gorges of the Sangro river near the hamlet of Barrea. Parts of the base are still visible and several old photographs portray its imposing structure (Fig. 5).

**Fig. 5**: Ancient bridge with a single ogival arch [14]. Right: spillway of the dam.

## 4. Enhancement of the landscape: the *tratturi* path along Lake Barrea

A stretch of the old tratturo path from Pescasseroli to Candela is still visible along the south shore of the lake; it used to cross Civitella Alfedena and continue along the valley to Barrea. This small dirt track winds its way through beech woods and grassy fields and is still used as a walking/hiking path; it also connects several local properties (Fig. 6).

We know that these tratturi were not real roads, since they have no road surface, nor did they have any well-defined borders; however, they represented paths that were more than visible in the territory since they were created by the hoofs of the sheep passing along them. They followed the ridges of the mountains or riverbeds and ended along either the Adriatic or Tyrrhenian coast.

Sanctuaries or sacella were located along these ancient paths; they were places where people could meet and where fairs and markets were often held under the auspices of the gods. Farmhouses have also been found along the path, small stone buildings only a few square meters in size that were used by shepherds as shelters. Some of these farmhouses are now used by walkers and hikers or as tourist infrastructures. The Campitelli Refuge in Alfedena is one example.

Bearing in mind the orography of the land and the numerous prehistoric remains found in the territory, scholars were able to recreate the road network of the tratturi connecting the Apennine mountains with the plains in Apulia and Lazio – a crucially important economic path for the territories involved. [7] On the website of the Abruzzo region there is a map showing the restricted areas (AW), i.e., parts of the territory for which protection is already provided by State and EU regulations [11].

Issuance of Law 746 of 1908 established the conservation of four important tratturi in the Abruzzi: the L'Aquila – Foggia Tratturo, the Celano – Foggia Tratturo, the Pescasseroli – Candela Tratturo, and the Castel di Sangro – Lucera Tratturo. They have been assigned equal status to national and state-owned roads (Ministry of Agriculture and Forests).

**Fig. 6**: Path along the southern shore of the lake, corresponding to the old *tratturo*.

## 5. Conclusions

Like all other localities, the Vallis regia and its lake is unique, because the reasons for its existence cannot be generalized or likened to other sites. In fact, every place has its own history, one which creates its recognisable cultural identity [12]. We know that the term “place” does not refer to spatial dimensions when its special identity traits are described, analyzed and interpreted. We believe this is the starting point with which to emphasise how important it is to protect and enhance cultural landscapes in order to dwell on earth while ensuring environmental, social and economic sustainability.

The currently perceived image of the Vallis regia provides us (albeit with great difficulty) with ‘snapshots’ of history, based on a critical documentation of the sites; they are acknowledged to be surviving fragments that should be protected and safeguarded due to the fact they testify to a history that should be known and preserved [13]. For example, our knowledge and understanding of the paths of the tratturi allows us to go back in time, to an age when dwelling on earth was based on relationships between man and the environment, between man and society. The different conditions that have emerged over the years are signs bearing witness to the presence of a civilisation that developed down through the centuries.

The environment of this territory has been radically changed; it has led to the configuration of new scenarios as well as uncharacteristic landscapes, e.g., the presence of trees with their roots in water during several months of the year (Fig. 7). Moreover, the possibility to swim near the shores of the lake (even if regulated by law) has determined an increase in the competitiveness of a territory already full of extraordinary flora and fauna that make this territory unique.

As a result, we must increase our knowledge of its cultural values and disseminate and communicate them by using survey campaigns and critical territorial, urban and architectural documentation, well aware that local identity is first and foremost a potential asset, an added value, a resource for sustainable development that will allow us to design our near future.

**Fig. 7**: Lake Barrea. Trees with their roots immersed in water during the late Spring season.

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# Landscape and history in the tip of the leaf. Preservation and enhancement of the historical olive grove of the Grottoes of Catullus.

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## Abstract
On the promontory at the tip of the peninsula of Sirmione there are the monumental remains of a Roman Imperial villa, known as Grottoes of Catullus, that dates back to the end of the 1st century B.C. They stand in awesome panoramic position surrounded by the water of Lake Garda and immersed in a large and ancient olive grove. The grove covers 7 ha and today it represents a plant archaeological layer which is inextricable from the ruins. The centuries-old olive trees are living testament of the usage of the area from the abandonment of the villa to the first agricultural utilization during the Middle Age and until the 20th century, olive growing becoming a part of the social context sustaining the local communities. What is today an international archaeological site, until a few decades ago was the vegetable garden of the Sirmione's citizens who cultivated native varieties of plants passed down from one generation to another.
The particular microclimate has allowed the development of crops and spontaneous flora different from the typical one of the Po Valley. The promontory of Sirmione is partially isolated limiting the movements of plant and animal populations. The reduced genetic exchange has given rise to a peculiar ecological niche of environmental importance from both an agricultural and a floristic point of view.
The preservation and the enhancement of this cultural and agricultural heritage are the keywords for a new telling of the history and the agriculture of the area.

**Keywords:** Archaeological ruins, olive grove, agricultural heritage.

## 1. The Grotte di Catullo
Grotte di Catullo (Grottoes of Catullus) are the remains of a monumental Roman Imperial villa that dates back to the end of the 1st century B.C. [1] [2]. They stand at the tip of the Sirmione peninsula in an awesome panoramic position, surrounded on three sides by the water of Lake Garda and immersed in a large and ancient olive grove.
The site belongs to the Italian State and it is part of the Direzione regionale Musei Lombardia as one of the thirteen museums managed by the regional museum office of the Italian Ministry of Culture. The aim of this paper is to discuss how, while preserving and conserving the archaeological remains, the Direction of the site is dealing with the maintenance of the historical olive grove.
Lake Garda is the biggest Italian lake and it is a crucial junction point between the Alpine area and the flatland of the Po Valley. From an administrative point of view, there are three Regions involved as the western shore belongs to the province of Brescia, the eastern to the province of Verona, while a short lakeshore in the North belongs to the province of Trento.
The Sirmione peninsula is located in the middle of the Southern part of Lake Garda, where the lake is larger, and it belongs to the Regione Lombardia.

**Fig. 1**: Aerial view of the Western side of the Grotte di Catullo.

### 1.1 From the construction to the abandonment

The archaeological site of Grotte di Catullo occupies completely the far end of the peninsula overlooking the lake in its widest point. It is one of the best-preserved buildings of its kind and it is a model for the understanding of similar central Italian villas.

Built based on a single, strictly symmetrical design, the villa spanned a surface area of 20.000 $m^2$ and was laid out on three levels: the top floor hosted the living quarters; the middle floor was perhaps a service area and the bottom floor supported the entire building. In fact, during construction, considerable work was required to adapt it to a terrain that was anything but level. To offset the slope of the rocky bank on which it sits, sub-structural compartments were created to support the floors above. On the two long side of the top floor were two walkways set alongside one another: one internal, which was covered, and another uncovered external one. The ones in the east lay on the rocky bank, whereas a closed colonnade, the *cryptoporticus*, supported the western ones.

In the original villa, there was a continuous passage between open or semi-open spaces and covered spaces, open and semi opens spaces occupying more than eighty percent of the whole surface. The open spaces along the perimeter of the building, walks, had the surrounding lake environment becoming an integral part of the villa. The loggias, on the three sides of the lake and the terrace are elements that permit to enjoy the natural environment with a broad view over the horizon. The link between water, landscape and the building should have been very much similar to the one described by Pliny the Younger in the letter to his friend Gallus. Here Pliny portrays the beauty of his Laurentine estate that is a villa with an "extensive view of the sea-coast" ("*litoris spatium*") [3]. "From the middle of […] porticoes you pass into a bright pleasant inner court, and out of that into a handsome hall running out towards the sea-shore […]. On every side of this hall there are either folding-doors or windows equally large, by which means you have a view from the front and the two sides of three different seas, as it were: from the back you see the middle court, the portico, and the area; and from another point you look through the portico into the courtyard, and out upon the woods and distant mountains beyond" ("*Est contra medias cavaedium hilare, mox triclinium satis pulchrum, quod in litus excurrit* […] *Undique valvas aut fenestras non minores valvis habet atque ita a lateribus a fronte quasi tria maria prospectat; a tergo cavaedium porticum aream porticum rursus, mox atrium silvas et longinquos respicit montes*.) [3].

Although some modifications occurred to the thermal sector between the end of the 1st and the beginning of the 2nd century, the villa did not undergo any major reconstruction until its early abandonment during the 3rd century. This could be linked to a traumatic event of which traces can be read in the collapse mode and in traces of fire clearly detected during the 19th century excavations [1], whether a seismic event of considerable power or several raids by the Alemannic that caused pillaging and destruction in central and northern Italy in 259-260 and 270.

The crisis and the deconstruction of the villa took place when the function of the building ceases without any restoration or renovation of the complex. Some of the architectural elements of the villa has been removed to be used in the new large building that was under construction in the central part of the peninsula.

The vestiges of the magnificent roman villa remained visible since then.

### 1.2 Reuses, early mentions and representations

The massive substructions during the 5th century developed into the first fortification walls of the peninsula and the remains of the villa became a military stronghold (proved by some high-grade military bronze buckles found in the tombs excavated inside the site [2]).
Some rooms on the residential floor that still retained parts of the elevated structures could have been used with the addition of wooden parts (shown by holes for posts cutting the floor [1]), but more likely must have been used the numerous sub-structural rooms on the lower levels, especially in the southern part where they still retained the roofing. Since coins and numerous pottery sherds from the 4th to the 6th century have been found in old excavations.
Several tombs located within layers of collapse or on floors that had already been removed or were in a state of serious decay were found in early excavations during the 19th century. By the time the necropolis is settled the main building is already in ruins, but also long since abandoned and despoiled. First tombs date back to mid-4th century, after then the necropolis expanded until the early 5th century and then with sporadic occurrences until the 7th century. The frequentation of the site must have been uninterrupted from the late Roman age until the early Middle Ages. To the Lombard age belong some fragments of common and decorated “a stralucido” pottery from old excavations of unknown context, yet important as a document of the frequentation of the area during the Lombard period [1].
An early record of the site is in a document from Archivio di Stato di Milano reporting a trade of land between Giovanni, prior in the church of San Vito di Medole and Almerico of Brescia, that has been notarized on June 10, 1155 in “grottis de Sermion” [1] [4]. Mentions increase from the mid-15th century and the very first descriptions of the Roman villa date back to the Renaissance and were provided by travellers writing accounts of their itineraries with a particular focus on the remains of the classical world. By then, the name “Grottoes of Catullus” assigned to the ancient Roman villa had become its given name.
While the first known representation of the site can be found in a map of the Veronese territory (*Map of the territory of Verona*, Archivio di Stato di Venezia, *Miscellanea mappe*, dis. 1438), many depictions of the Grotte di Catullo date back to the 19th century when the ruins became a recurring theme among the paintings of the Garda area.
The oldest scientific survey of the ruins dates from 1801 [5], during the second Napoleonic campaign, when the General La Combe-Saint-Michel, commander of the siege artillery of the Italian army, stationed in Peschiera, wanted to carry out some excavations so as to better define the less visible remains. In mid-19th century, Giovanni Girolamo Orti Manara carried out the most extensive and best-documented investigations. The results of his excavations, with a new floor plan of the building, some detailed plants and perspectives of the most significant parts, and some drawings of the found materials, were published in 1856 in a volume dedicated to the history of the Sirmione peninsula [6].

### 1.3 State acquisition

The first measures aimed at safeguarding the remains date back to the beginning of the 20th century. They also tried to create a buffer zone around the villa with the prohibition of any construction. It was only between 1947 and 1949 that was carried out the public acquisition of the whole area (78.000 $m^2$). This allowed the full protection of the ancient remains and the surrounding natural environment, consisting of a vast olive grove and the lakeshore.

## 2. Olive groves in Sirmione

### 2.1 Early records

The Garda territory was a privileged area for its location, close to important communication routes, both by land and by water. Its landscape must have been characterized by valuable intensive cultivation on sunny slopes alternating with areas of meadow or forest. The presence of the lake, then as today, helped to maintain a constant temperature, resulting in a much milder sub-Mediterranean climate than in the rest of the Cisalpine region. Important resource for the economy of the area, already in Roman era, must have been agriculture with specialized cultivation of vines and olives. Grapevines are well documented by botanical remains, dating to the 5th century, found at the villa of Desenzano del Garda, while olive trees were more widespread by the upper lake.
While it is possible, proven by the rests of a post-classical machinery for oil processing found in Sirmione, that the Roman cultivated olive trees around Lake Garda, the first record of olive trees cultivation in Sirmione dates back to the Lombard period, in a document of 771. In a deed of exchange of property between the Canon Andrea and Anselperga, abbess of the monastery of Santa Giulia in Brescia, among other goods exchanged, there was a 480 *tabulas* plot of land containing six olive trees inside the Sirmione *castrum* (“[…] *et t(er)rola illa intra castro Sarmionensi tabulas quadragenta octo, arboris olive numero sex* […]) [7].

Four centuries later a deed dated 28 February 1193, listing the property owned in Sirmione by the monastery of Santa Giulia, registers few parcels of land with olive trees in close proximity to the *castrum* ("[…] *peciam unam terre cum olivis […] a mane murus castri […] a Biunda terram cum olivis, unam peciam terre cum olivis et vines* […] *apud Sanctum Salvatorem* […] *terram cum olivis in loco Cortine* [...]") [8].

**2.2 Modern mentions**

Closer to our days, the olive groves in Sirmione and near the archaeological remains, are recorded in traveller's books, in letters, in poems.

In 1802 the catholic priest and writers John Chestwode Eustace toured Italy with three companions, studying antiquities. He described the landscape of Sirmione: "The promontory spreads behind the town, and rises into a hill entirely covered with olives; this hill may be said to have two summits; as there is a gentle descent between them. On the nearest is a church and hermitage, plundered by the French, and now uninhabited and neglected. On the farthest, in the midst of an olive grove, stand the walls of an old building, said to be a Roman bath, and near it is a vault, called the grotto of Catullus" [9]. Among the numerous mentions of olive groves in the peninsula by 19th authors, the Italian politician Faustino Sanseverino described the route to the Grotte as such: "[…] the street leading to Catullus's palace opens up in the middle of an olive grove, which covers almost the entire town […]" ([…] la *via che conduce al palazzo di Catullo si apre in mezzo a un bosco di ulivi, che copre quasi tutto il paese* […]) [10]. Alfred Tennyson wrote of the olive groves of Sirmione in his poem *Frater Ave Atque Vale*: "Row us out from Desenzano, to your Sirmione row! / So they row'd, and there we landed — 'O venusta Sirmio!' / There to me thro' all the groves of olive in the summer glow, / There beneath the Roman ruin where the purple flowers grow, / Came that 'Ave atque Vale' of the Poet's hopeless woe, / Tenderest of Roman poets nineteen-hundred years ago, / 'Frater Ave atque Vale'—as we wander'd to and fro / Gazing at the Lydian laughter of the Garda Lake below / Sweet Catullus's all-but-island, olive-silvery Sirmio!" [11]. And more recently in 1917 the poet Ezra Pound sang the olive trees of Sirmione: "Our olive Sirmio / Lies in its burnished mirror, and the Mounts Balde and Riva / Are alive with song, and all the leaves are full of voices." [12].

The persistence of the agricultural landscape until mid-19th century is also well illustrated by numerous painting, drawing ad photographs.

During a project carried out by the Direzione regionale Musei Lombardia with students from local high schools (*A macchia d'olio*, progetto educativo di Alternanza Scuola Lavoro per l'a.s. 2019-2020 in collaboration with Liceo di Stato G. Bagatta di Desenzano d/G, I.I.S. V. Dandolo di Lonato d/G, I.P.S.E.O.A. C. De Medici di Desenzano d/G, involving 15 students) have been recorded some oral history told from local people born in the 1930s. This is the testimony of Mrs Alba: "The Grotte in 1945 were free, there was a mountain and the road that came from the village led directly to the highest plateau. When my brother and I were children, we played among the olive trees of the Grotte and inside some sort of galleries.

My father owned many olive trees in the area […]; they were all plants that already had many years and had been inherited. The land belonged to everyone, while the plants were divided among many families, not all of them from Sirmione. When the harvest was done, the olives were brought with boats to Malcesine, Toscolano or Fasano, where the mills were. One day the mountain of the Grotte was fenced and excavations began, the tunnels where I used to go play as a child disappeared and so did the olive grove crop, in fact the plants and the land were expropriated".

**Fig. 2:** WETZEL, Johan Jacob, *Les grottes de Catulle, in Voyage pittoresque au lac de Garda ou Benaco*. Zurigo: Orell, Füssli & Co., 1824.

**Fig. 3:** Lago di Garda, *Sirmione, grotte di Catullo bambini con capre*. Archivio Negri, 1915.

The expropriation of the site and of the olive trees put an end at the common use of the land and the agricultural exploitation that had been carried out for centuries, yet it preserved the rural landscape along with the archaeological site. First the creation of a buffer zone, dating back at the beginning of the 20th century, and then the acquisition of the entire tip of the peninsula, between 1947 and 1950, prevented the urban growth and the land consuming that has affected the rest of the territory.

## 3. Agricultural landscape

Under the current national law, the protection of landscape finds its fundamental references in the Codice dei Beni Culturali (D. Lgs 42/2004) and, at continental level, in the European Landscape Convention (signed by the Italian State in Florence on 20 October 2000 and ratified with L. 14/2006). A form of protection of rural landscapes has led to the establishment by the Ministry of Agricultural Food and Forestry Policies (D.M. 17070/2012) of the 'National Observatory of Rural Landscapes, Agricultural Practices and Traditional Knowledge', which, for the first time on an institutional level, recognizes the importance of the cultural value of rural landscapes. This constitutes the culmination of a long research process about the transformations of the rural landscape and it establish the possibility of rural landscape assuming the value of historical and cultural heritage.

Traditional rural landscapes - i.e. all those portions of territory in which the cultivation systems are characterized by a long historical persistence and strong links with the local social and economic systems that produced them – can constitute a cultural heritage of great value, as a formal expression of regional resources and orography, of ancient knowledge, and a testament to the articulations of society in the past. Moreover, these landscapes play an important role in land management, in their maintenance function of protection against degradation, fire, and hydro-geological instability, in their proactive ecological function of maintaining biodiversity, and in their social function of maintaining the specific cultural identities of places.

With the awareness that the highest level of protection is related to the archaeological context, and then to the landscape context, we tried to build a best practice for the management of the agricultural heritage to ensure that the local communities recognize the rural landscape of historical interest, as an important component of Italy's cultural heritage that plays a fundamental role in preserving its cultural and social identity which is linked to a not too distant time, but with centuries-old roots.

## 4. The historical olive grove of the Grotte di Catullo

The Park can ideally be decomposed into a set of interconnected layers: the archaeological layer made up of the ruins of the villa and the Archaeological Museum, the agricultural layer made up of olive trees previously cultivated by the local inhabitants and preserved by the State after the expropriation and the first excavation works of the 1940s, and the landscape layer made up of natural elements, above all the lake, its coasts, the mountains that crown Lake Garda and the strip of vegetation that surrounds the promontory extending towards the centre of the lake.

In 2018, after the transfer of management of the archaeological site of the Grotte di Catullo with its historical olive grove to the Polo Museale Regionale della Lombardia (now Direzione regionale Musei Lombardia) an overview of the entire Park took shape, with the different constituent layers that intersect each other, strengthening and enhancing itself synergistically as an ecological, historical and cultural network that holds together the components of the Park that have been interconnected in almost 2000 years of history. Therefore, the enhancement of a single layer could not be separated from the enhancement of the other two as well.

**Fig. 4:** Olive trees and ruins in the Grotte di Catullo.

### 4.1 The agronomical project and intervention

In 2018 a forward-looking and visionary project took shape thanks to which specific public funds were allocated for the redevelopment and enhancement of the park's olive-growing heritage. From January 2019, a slow agronomic intervention began on the 1470 olive trees registered in 2018.

The intervention proceeded in a centrifugal manner, starting from the plants in the central area of the Park where the attendance of tourists is greater, gradually moving towards the plants in the peripheral areas up to today in the areas outside the Park, where restoration and redevelopment interventions are underway.

These vegetated areas that surround the remains of the villa, although not accessible by tourists, are still clearly visible from the lake and from the beaches that surround the promontory of Sirmione, and frame the archaeological remains enhancing them.

As a first intervention, it was necessary to proceed with a reform of the canopy on most of the plants. Over the years the canopy had been left free to develop and vigorous pruning had only occasionally been carried out, also affecting the supporting structures of the plant, such as main branches or even trunks. Probably these interventions had been implemented following important damages caused to the plants such as those caused by the frost of January 1985. At the beginning of the work, the canopy appeared globular, very bundled up, with the inside of the canopy aged and dried out and the very intricate outer parts that shaded each other. Many olive trees had bulky crowns which invaded each other or which were penetrated by the crowns of other spontaneous pioneer plants such as the numerous hackberry (*Celtis australis L.*) and laurel (*Laurus nobilis L.*) which over the years had grown spontaneously among the plants of olive tree.

These conformations of the canopy brought numerous problems: i) from an agronomic point of view, the plants were not very productive given that the strip of fresh vegetation capable of producing olives was small, badly ventilated and poorly lit; ii) from a physiological point of view, the plants were undergoing deterioration and aging which, if continued for a long time, would have reduced the life expectancy of the plants themselves; iii) from a landscape point of view, the thick and untidy canopy formed a green barrier which blocked the view of the surrounding landscape and at the same time hid the villa from the eyes of beach goers or tourists on boats and ferries passing in front of the promontory.

A second intervention was to eliminate the ivy that was suffocating many plants, especially those outside the Park fence. The central part of the canopy was completely covered by ivy and cords of ivy with diameters of several centimetres were wrapped around the trunks, for which it was necessary to use a chainsaw to remove them. The negative effects of ivy are numerous: it takes away water and nutrients from the plants, it limits the circulation of air inside the canopy, thus favouring the establishment of bacterial and fungal diseases, it shades the leaves of the olive trees, reducing their photosynthetic activity and finally it blocks the view of the landscape, forming a very dense vegetal backdrop in all season.

Over the years the invasive flora within the lawn areas has been contained by the numerous and regular grass mowing interventions. Unfortunately, some hackberry and laurel plants have had the opportunity to grow undisturbed next to the olive tree trunks for many years, invading both the root zone of the olive trees, thus subtracting water and nutrients, and the aerial part of the canopy, reducing the recycling of air and sun exposure. All these factors have contributed to an early aging of the olive trees.

From time to time in the past years these invasive plants have been cut at the base, leaving however alive the stumps which promptly restarted, reforming in a short time other disordered vegetation which, in addition to debilitating the olive trees, gave the Park a sense of disorder and neglect. Since 2020

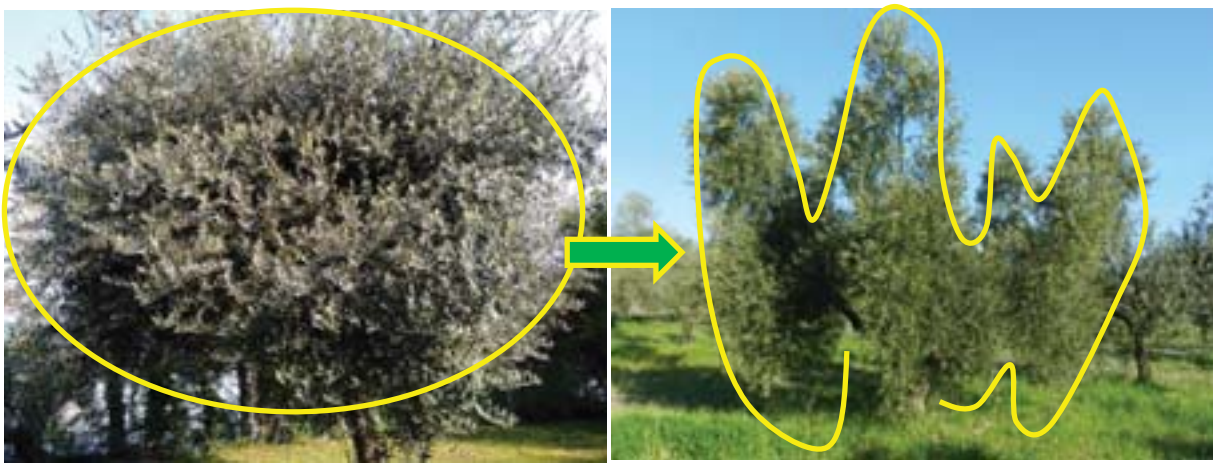

**Fig. 5:** Crown reform pruning.

**Fig. 6:** View of the large pylon before and after the 2020 interventions.

these stumps have been devitalized through continuous elimination of the shoots and fracturing of the stumps, in order to weaken the invasive plant until it dies. Today only a few specimens survive, growing next to and on top of Roman-era walls, and therefore their elimination is complex due to the possibility of damaging the archaeological remains.
After defining the spaces occupied by the individual plants, it was necessary to support the growth of the new vegetation by supplying the plants with the nutrients necessary to build the new plant structure with young tissues more resistant to diseases and environmental factors.
After having carried out the soil analysis, a fertilisation plan was defined in order to compensating for the nutritional deficiencies of the soil (in particular phosphorus) and supporting a balanced development of the plants, stimulating the vegetation and favouring maturation of new shoots. Both soil and foliar fertilizer were applied, above all for those plants which, growing inside the ruins of the villa, have a reduced volume of soil available.
Boron-based foliar fertilizers have been used which are able to favour the setting of small olive fruits after flowering and other bio-stimulants extracted from algae to strengthen and nourish the foliage of the plants to make them more vigorous and resistant to attacks by pathogens or extreme abiotic factors such as extreme temperatures or dryness. All this was done with the intention of bringing the plants to a condition where they can deal with stress, thus reducing interventions to treat any pathologies.
Furthermore, the fertilizers supplied have led to a better development of the foliage which has longer and more vigorous shoots and with larger leaves and more intense colours, both factors which have given a more pleasant appearance to the plants, and therefore to the entire Park.
In order to reduce the environmental impact and improve the ecological performance of the site, a more sustainable management of pruning residues was opted for: the residues obtained from summer and winter pruning, instead of being disposed of in a dump, were chipped and distributed on the grass and under the plants in the Park according a circular economy perspective.

**Fig. 7:** View of the lake from the western side of the promontory before and after the thinning of the foliage and the elimination of invasive flora.

In a first step, during 2020-21, a test was conducted in an area closed to the public in order to verify the aesthetic impact that this wood chip would have had on the grass and under the olive trees.
It was observed that after just a few weeks, this wood chip was sufficiently shredded and covered by the meadow to be almost invisible, except from close and detailed observation.
With this management it has therefore been possible to reduce work times, allocating manpower to other interventions, saving on dump transport costs, but above all recovering an agronomical important resource such as the nutrients contained in plant residues which, thanks to the soil fungi and bacteria can be returned to the crop, thus reducing the inputs of fertilizers.
Furthermore, the organic matter brought into the soil has improved its structure, fertility and the capacity to retain water which can be exploited during the summer.
In the Park there are different varieties of olive trees, among which the main one is Casaliva, a native variety of Northern Italy and in particular of the Garda area. This variety has peculiar characteristics both in terms of its ability to adapt to a climate that is not strictly Mediterranean, and in terms of the organoleptic profile of the oil obtained from its olives. However, Casaliva has a high sensitivity to olive knot disease caused by the bacterium *Pseusomonas savastanoi*. This bacterium infects the wounds, causing the formation of galls or knots which absorb nutrients from the plant and reduce the lymphatic flow, weakening the plant, and in some cases leading to its death. Furthermore, the presence of these knots disfigures the foliage, penalizing the ornamental aesthetic aspect of the plant. The disease is neither curable nor eradicable: it is necessary to provide to the plants the necessary resources required to guarantee balanced growth, and to remove the environmental factors that favour bacterial infection.
After a trial conducted on 5 plants in 2019, at the end of winter 2020 many of the plants infected with olive knots, and debilitated by years of diseases, were vigorously pruned to remove the branches affected by the bacterium, with the aim of rebuilding a young and vigorous canopy able to coexist with the parasite, but which at the same time can fulfil the productive and ornamental purposes of the plants. After topping the plants, we proceeded with a disinfection of the wounds with copper salts and we applied an enriching fertilizer capable of supporting the formation of the new foliage. In the following years, the most suitable shoots were selected to reform the scaffolding of the plant canopy which, after three years, took on a more pleasant and tidy appearance capable of having relevance also from a production point of view.
The interventions carried out on the plant canopy must have sufficient time to allow the plant to achieve the result obtained. For the olive trees this time has been estimated at five years and therefore in 2023 we are seeing the completion of the interventions carried out in 2019 in the first central areas of the Park. Other interventions on the more peripheral areas or outside the Park, carried out in the following years, need other years to be able to show the expected result. The work carried out in recent years has been able to give a more balanced and orderly appearance to the plant layer, giving the visitor the opportunity to immerse themselves in a unique site of its kind, making them live an immersive experience between history, agriculture, nature and landscape.
The restoration work of the olive grove, and more generally of the plant component of the Park, is now almost complete. Over the next five years, the management's objective is to maintain what has been done in the first five years and work to further enhance the plant heritage through various types of initiatives and interventions.

### 4.2 Involving the local communities

To raise awareness and focus to this very specific resource while strengthening the link with the heritage community we developed some participatory activities with the local communities.
Since 2019, themed visits on the olive tree and olive cultivation on Garda area have been organized every year. Furthermore, annually is organized a festival about olive oil with the guidance of the agronomist who has planned and followed up on the interventions on the olive grove in recent years. Training and dissemination activities were carried out with local schools (high schools, hotel management institutes, agricultural institutes) and with teachers to raise awareness and appreciate the immense cultural heritage that has characterized the tip of the Sirmione’s peninsula for over 1500 years. Furthermore, relations have been established with bodies present in the area that deal with olive growing, such as for example the University of Milan and Verona, the Garda DOP Consortium, associations for the enhancement of the landscape, to ensure that the synergy of the various bodies can make tourists and the local population aware of the potential and value of this site and of the olive tree in the Lake Garda landscape.

### 4.3 Future developments

Several applications for funding have been presented for projects aimed at improving the usability of the site and the dissemination of environmental and cultural awareness.
Among the various objectives proposed for the coming years is that of preparing a varietal field of olive trees typical of Northern Italy in the sector that is currently not accessible to tourists, in order to show

visitors, the biodiversity that characterizes olive growing in Northern Italy. There are also exhibition spaces where to tell the story of olive growing from the Roman Empire to the present day, showing reproductions of tools and machines used for the cultivation of the olive tree and the production of oil.
Alongside the olive trees, collections of plants typical of the Roman period can also be planted, so as to reconstruct a glimpse of what the countryside could have been like during the Imperial age. In this way it will be possible to have an open-air museum that can tell the story of the last 2000 years of the site's life.
Another project concerns the characterization of the olive trees present in the Park. The expropriation of 1947 crystallized the genetic pool of the cultivars present, preventing them from being lost due to the progressive elimination of the native varieties which have been replaced by more productive and profitable varieties, as it has happened in the last 70 years in the rest of the Garda area. A genetic study of the olive plants could reveal the presence of accessions handed down by the various families who have cultivated olive trees on the Sirmione's peninsula for centuries. The discovery of a new variety would make a further contribution to enhancing the site, as well as enriching the already long list of Italian olive tree varieties.
Furthermore, a request was made for the registration of some olive trees in the register of monumental plants as recommended by L. 10/2013 (Regulations for the development of urban green spaces). If the procedure will be successful, we could have in the Park the northernmost monumental olive trees in the world.

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# From waste to resource for a sustainable future

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## Abstract
Every day we produce waste that constitutes an environmental and economic problem.
A quantity of this waste is recycled, reused or composted and a quantity is sent to landfills.
How can we produce less waste and using waste as a resource?
Reducing waste is one of the objectives of the circular economy and their recycle asks us to rethink production and consumption models, this implies that design is a strategic element.
In fact, in recent years design played a key role in the transition from a linear to a circular economy with a design based on the efficient use of materials, the reduction of the amount of waste generated, intervening on durability, repairability, the possibility of updating and recyclability of the products themselves.
This article will analyse the contributions of design from processes optimization to waste prevention strategies, up to process circularity. The sector of stone materials and recycled materials born from processing/production or consumption waste and reintegrated into the biological cycle will be considered. The aim of this article is to show the connection of contemporary design with the environment, products and materials and to show that wastes will be a problem or a resource depending on their management.

**Keywords:** Zero Waste, Circular Economy, Sustainability

## 1. Introduction
Our society is producing more and more waste, surpassing the resilience of the earth [1]. Europe produces considerable volumes of waste: food and garden waste, construction and demolition waste, industrial waste, sludge, paper, sanitary waste, old furniture, plastic bags, etc.
In 2018, the total waste generated in the 27 Member States of the European Union (EU) was over 23 million tonnes [2]. Furthermore, waste generation is predicted to increase by 70% by 2050 [3] .
The ecosystems, like the marine, can be damaged by poor management of waste, or by littering.
Waste impacts nature indirectly as well.
Everything is not recycled or recuperated from waste signifies a loss of raw material and other inputs used in the chain. Eco-friendly impacts in the life-cycle chain are larger than those in the waste management phases alone.
Directly or indirectly, waste touches our health and well-being in various modes: methane gases contribute to climate change, freshwater sources are contaminated, etc. Therefore, a reduction of this waste is now needed. Waste is not only an environmental problem, but also an economic loss. How can we change the way we produce and consume to produce less and less waste, while using all waste as a resource?
EU legislation has already set determinated targets
The legislation in this area is the Waste Framework Directive (UE, Directive 2008/98/CE - WFD)
It outlines a waste management hierarchy: beginning with prevention, followed by re-use, recycling, recovery and ending with disposal. It is aimed to preclude waste production as much as possible, to use waste that is produced as a resource and to minimise the quantity of waste directed to landfill.

Anyway, the amount of waste we generate is closely linked to our consumption and production patterns as well.
What if we could use waste as a resource and thereby scale down the demand for extraction of new resources?
Extracting fewer materials and using existing resources would help avoid some of the impacts created along the chain.
Today one approach to reduce waste is to imagine a transition from a linear economy to a circular economy. The circular economy described by its goal to regularly decouple economic activity from the consumption of finite resources and to strategy waste out of systems has become a central concept used in production, and in policy [4]

## 2. From linear to circular economy

To leave a linear economy the designers must go beyond recycling and focus on systems-level to passage to a circular economy. The circular economy is a mode to solve this by dissociating economic growth from the consumption of resources. It's about redesigning products, services and the mode businesses work to shift the economy from one waste system to one that eliminates waste, circulates products and materials, and regenerates nature.
Designers must beyond rethink how they make individual products and consider the entire system that surrounds them. However, to drive action forward, it is crucial that we focus upstream to prevent waste before it is created.
To change the system, and this means redesigning the way we make and use products and food. This modification will give us the control to not only reduce waste, pollution and greenhouse, but also to grow opulence, occupations and resilience
The designer is crucial to this transformation. In the field of design this implies a reflection on the aspects of the profession to understand how design can contribute to restoring value to what production evaluates as waste. The transition from material of value to waste takes the form of a shift in typology.
This is even more important in the case of stone materials both for their characteristics and qualities presented by the single block, and because they are non-renewable resources. How is it possible to present the inclinations of the waste stone materials from production? There is a range of objectives ranging from the optimization of processes to waste prevention strategies up to the circularity of production processes.
In stone materials, the actions for closing the cycles are complicated precisely because of the uniqueness that characterizes the material; instead, it is easier to identify examples in which the material offers ideas for waste prevention.
It is in this case that the ability of designers to give value to what is considered waste depends, as well as to find a new identity in these waste or semi-finished products, or rather, an identity born from the shape of the piece itself.
In this study we want to report on waste that has a defined formal configuration and not on the reuse of residual dust and sludge from stone processing
What is rejected from a process can be considered of value in areas even distant from those for which the stone material was originally selected.
This transversal use of waste and this ability to regain value (material, commercial, etc.) are precursory aspects of the Circular Economy, in which the figure of design emerges which sometimes manages to recognize a value even when others see it as waste.

## 3. From waste to resource

In the stone materials production sector, the contribution that the designer can offer for waste and waste prevention can be traced back to three choices: the optimization of production processes (from cutting to the final product); the use of waste elements re-evaluating their formal characteristics; the exploitation of powders for the production of new materials. In this study we focus our attention on the re-evaluation of the formal characteristics of waste and on the influence that some fundamentals of product design can have on the correct approach to the relationship between waste and value or from elements abandoned by a process or production.
Furthermore, stone materials also offer further opportunities when the reuse of residual dust and sludge from stone processing find a use within other productions (from paper mills to construction and road paving, etc.) and in the production of new materials.
Here the geometries can be redefined with the use of new machinery and processes much as with the thermoplastic material made up of marble dust and resins by Carmine Deganello and Pietrasanta Industries in 2015. It is therefore interesting to confirm that there are numerous viable paths and solutions. The theme of the productive revaluation of dust and sludge opens up another area of intervention, but as already mentioned here we continue with the potential of those residues that present a morphological-structural characterization and, in particular, of scrap slabs.

In this context the work of Paolo Ulian is admirable because the cutting processes and the recomposition of the elements allow to give three-dimensionality, without waste, to the material in slabs as in some of his projects
Paolo Ulian aim at creating beautiful and functional objects and possessing an ethical and social value. The key words ethics, respect the material, good form, observe behaviours, enable us to venture into his creative universe which is, first of all, design vision and view of the world. Because of this personal vision of things, his concern to avoid waste, by recycling and retrieving, is central to his personal approach to a material such as marble, characterized by large amounts of waste in the manufacturing process.
Paolo Ulian's obiects are produced of the use of waterjet technology and observation of manufacturing discards.
In his approach he has tried to eliminate the difference between usable pieces and discards. He tries to give the same practical value to both. An example that expresses this concept is the Without Waste table (Fig.1). In this work a series of cuts made in a marble slab provided all the pieces needed for the three-dimensional support of the glass top. Then the skeleton of the hollowed slab, apart from representing using all the worked marble, becomes the natural base of the table.

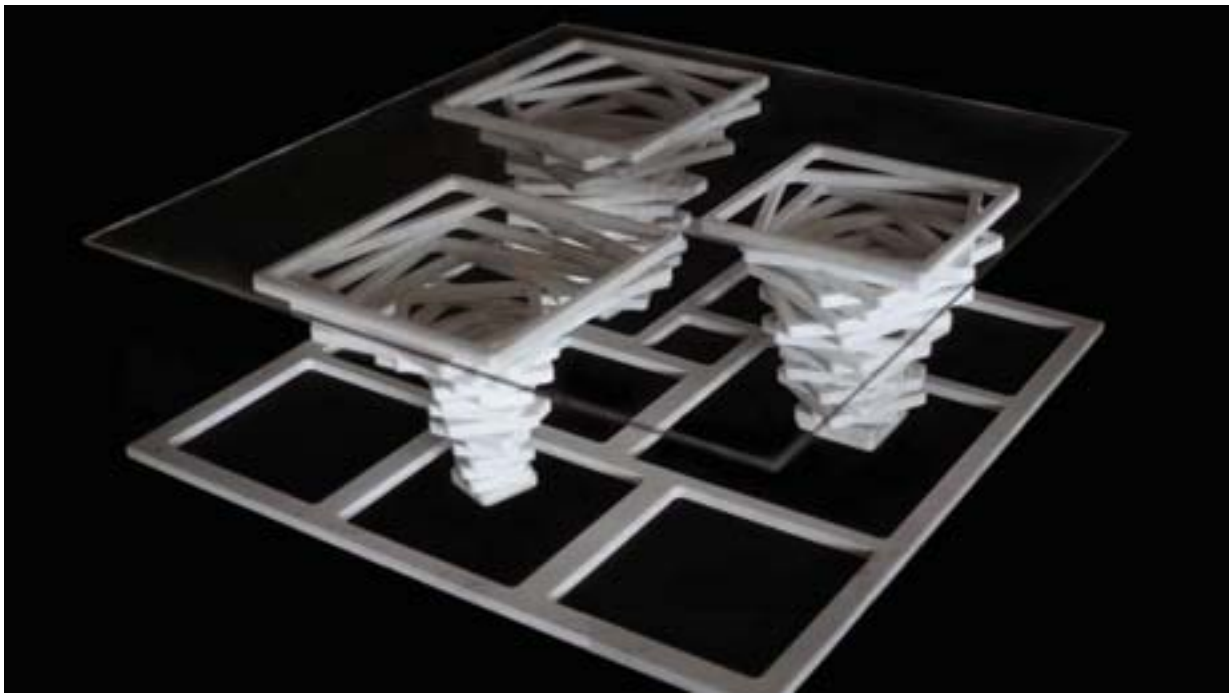

Fig.1: Without wate table  Photo © Bufalini Archives © Davide Calafà

Instead with the Vase Vago (Fig.2), Ulian has make a big vase without producing large amounts of waste.
So, he started from the two- dimensionality of three slabs of marble measuring 60x60 x 2 centimeters and he cut them out to produce a number of concentric ring of marble
He then superimposed them, so they overlapped to form a vase 50 centimeters tall.
In addition, he has also made other projects marble bookcase and tables
The bookcases used marble tiles salvaged from the odd lots in warehouses transformed by simple processes into modular units
Numerica, modular bookcase in White Carrara marble. Starting from marble pieces in current production, mainly wall tiles, the designer combined four different modules in a compositional pattern alluding to Roman numerals I to IV
In the tables he tried to develop his research into designing with waste where the decorative holes piercing the tops were necessary in order to extract the small round pieces stacked on top of each other that form the legs
Autarchico, tables of Bardiglio marble. Each tabletop is made by assembling three slim staggered marble slabs pierced using waterjet cutting technology to form abstract designs. The pieces left over from drilling the tops, usually discarded are here stacked to create the table legs
Concentrico, modular coffee table is made of White Carrara marble. Waterjet cutting technology is used to turn production tiles into hollow square shapes. The definition of the form derives the optimization of the concentric cut in the square surface of the tile in order to avoid wasting the material.

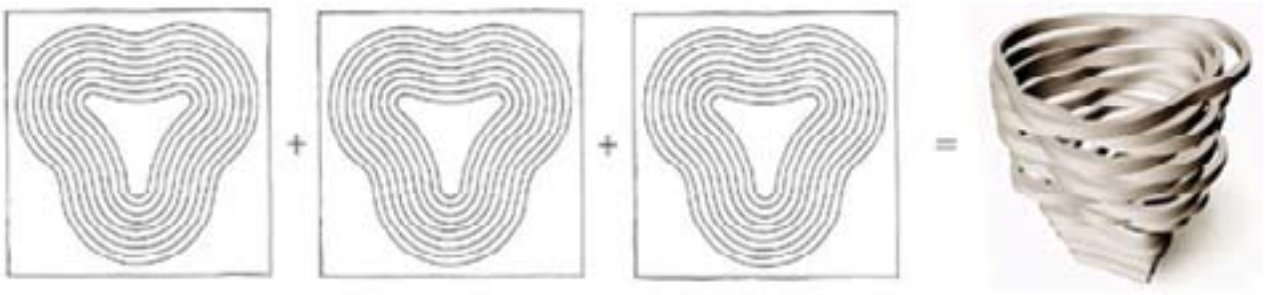

Fig.2 : Vase Vago  production UP Group

With his projects Paolo Ulian tells his relationship with marble through the attention to reuse and the optimization in the construction phase. His projects reflect a vision that brings out aspects related to the social context, ethics and environmental issues, combining digital technologies and craftsmanship.
As we have seen, the previous projects show the designer's skills with the formal characteristics of the products. These skills will be useful in a circular economy perspective

## 4.Conclusions

The examples cited above show how waste becomes a resource and how it is the designer's responsibility to rethink marble starting from a basic premise: consume the minimum amount of material and that every marble waste becomes an opportunity not to be wasted.
This experience on marble can become a potential laboratory for experimentation to be applied to any other material because too often we do not consider that for each piece produced there is a quantity of waste which can contribute to its creation. It is from this approach that some rules can be established in order to rethink the ethical dimension of good design, where waste becomes matter of conscious design that engages the designer and companies in a production method that also has positive effects from an economic and social point of view for a fair and sustainable future.

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# The Greener Europe. Ecosystem Services and Green Infrastructure for Resilient Cities.

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## Abstract

Rethinking smart cities with fewer impacts and without gas emissions by 2050 is part of the European Green Deal. Using a more resilient green is one of the elements on which to invest in the process of urban transformation. Undoubtedly, the landscape project in the past has always interpreted the needs of the society to which it belongs, proposed a cultural model to be followed and put into practice scientific innovations. Cities are evolving into intelligent super-organism and seal become capable of searching for opportunities of co-evolution within Urbansphere. The contribution of landscape architecture has become a necessity in solving the problems of contemporary society.
In the solution of various environmental problems the use of a set of green solutions, resilient and at different spatial scales from the city, the neighborhood, the block and the single building has become a necessity.
The objective of this paper is to present some highlights strengths and weaknesses of green infrastructure projects in European cities, which are based on the key concepts of sustainability, multifunctionality, adoption of Nature Based Solutions, increased ecosystem services and multiscale.
The main strategies will be exemplified through the analysis of case studies at different scales. In terms of planning and some specific interventions such as sustainable parks, rain gardens, drainage trenches, green roofs, green facades and systems for the collection of water in European cities.

**Keywords:** urbansphere, sustainability, multi-functionality, nature based solutions

## 1. Preface

Rethinking smart cities with fewer impacts is part of the Green Deal, an action plan established by the EU for modern, resource-efficient and competitive economic growth, without net greenhouse gas emissions by 2050. Using a more resilient green is one of the elements on which to invest in the process of urban transformation. Undoubtedly, the landscape project in the past has always interpreted the needs of the society to which it belongs, proposed a cultural model to be followed and put into practice scientific innovations. Examples can be found from the Agora synonymous with Hellenic democracy, to the forums meeting places of the Res Publica, to the irregular squares of the fortified or designed cities of the Renaissance, Mannerist and Baroque ones up to the public park of the nineteenth-century city, which is a mirror of contemporary society. Today, environmental problems characterize contemporary society. Cities are evolving into intelligent super-organism and seal become capable of searching for opportunities of co-evolution within Urbansphere. The contribution of landscape architecture has become a necessity in solving the problems of contemporary society. It is

no coincidence that world-renowned architects such as MVRDV and AMO/Koolhaas have based their research on green tech in order to use it in architectural projects.
The research work The Green Dip by The Why Factory Workshop represents a programmatic study on the diffusion of greenery in urban spaces, buildings and urban environments to restore livability to cities. The new projects by MVRDV, whose founding partner Winy Maas is also the creator of The Why Factory, point to the green component as a key element of the architectural design process.
In the solution of various environmental problems the use of a set of green solutions, resilient and at different spatial scales from the city, the neighborhood, the block and the single building has become a necessity.
The objective of this paper is to present some highlights strengths and weaknesses of green infrastructure projects in European cities, in progress or completed, which are based on the key concepts of sustainability, multifunctionality, adoption of Nature Based Solutions, increased ecosystem services and multiscale.

## 2. Methodology Through Case Studies

The main strategies will be exemplified through the analysis of case studies at different scales.

### 2.1 Cases Study in Italy

In terms of planning in Italy, the Action Plan for Urban Forestry in Prato (Florence). In this case it was established that the main causes of the rise in local temperatures were buildings, paved roads or sealed surfaces without trees. The main strategies are implemented with the creation of green infrastructures to bring great benefits to the urban environment, including energy saving, reduction of pollution, improvement of air quality, increase in biodiversity, reduction of runoff. All this, in addition to the environmental benefits, increases the real estate value of that part of the city interested in the intervention. The action plan of urban forestation, through 6 strategies (Fluvial and Gore park, Green infrastructure mitigation, Capillary green, Peri-urban agricultural gulfs and large parks, Urban demineralization and Belt agricultural park) aims to increase the wooded surfaces of the city and the processes of urban renaturalization. A single system made up of existing and future parks, agricultural areas and private green spaces is nothing new for Italy.

**Fig. 1:** Forests and boulevards for a greener Declassata: https://www.cittadiprato.it/en/Sezioni/691/Urban-forestry/

**Fig. 2:** Nenni area - The park-forest: 215 trees: https://www.cittadiprato.it/en/Sezioni/691/Urban-forestry/

Already in 2007, Studio Land together with the Associazione Interessi Metropolitani (AIM) presented the 'Raggi Verdi' project, also promoted by the Municipality of Milan, in view of Expo 2015. The ‘Raggi Verdi’ are the idea of a green belt made up of parks and avenues, which, starting from the city center, join radially to the peri-urban parks. In the layouts of the city of Milan the 'Blue' is the other sign that is re-emerging next to the Green. *Mediolanum*, the name of the ancient city of Milan founded by the Romans, etymologically means place between waterways and highlights the past importance of the water element within this city. The 'water' has always been understood as part of a project that accompanied the seasons of mercantile and industrial growth of this city, which only in the twentieth century gave way to more efficient networks, also belonging to the radial design, of the railway and the 'Tangenziale'. The waterways are now part of a sustainable transformation project for the city, in which part of the canals will be brought to light and uncovered. These will accompany the new soft mobility network and enrich the meeting points for collective life. With a view to reopening the system of Milan's waterways, the recently redeveloped barycentric area of the Darsena deserves special mention among the blue infrastructures.

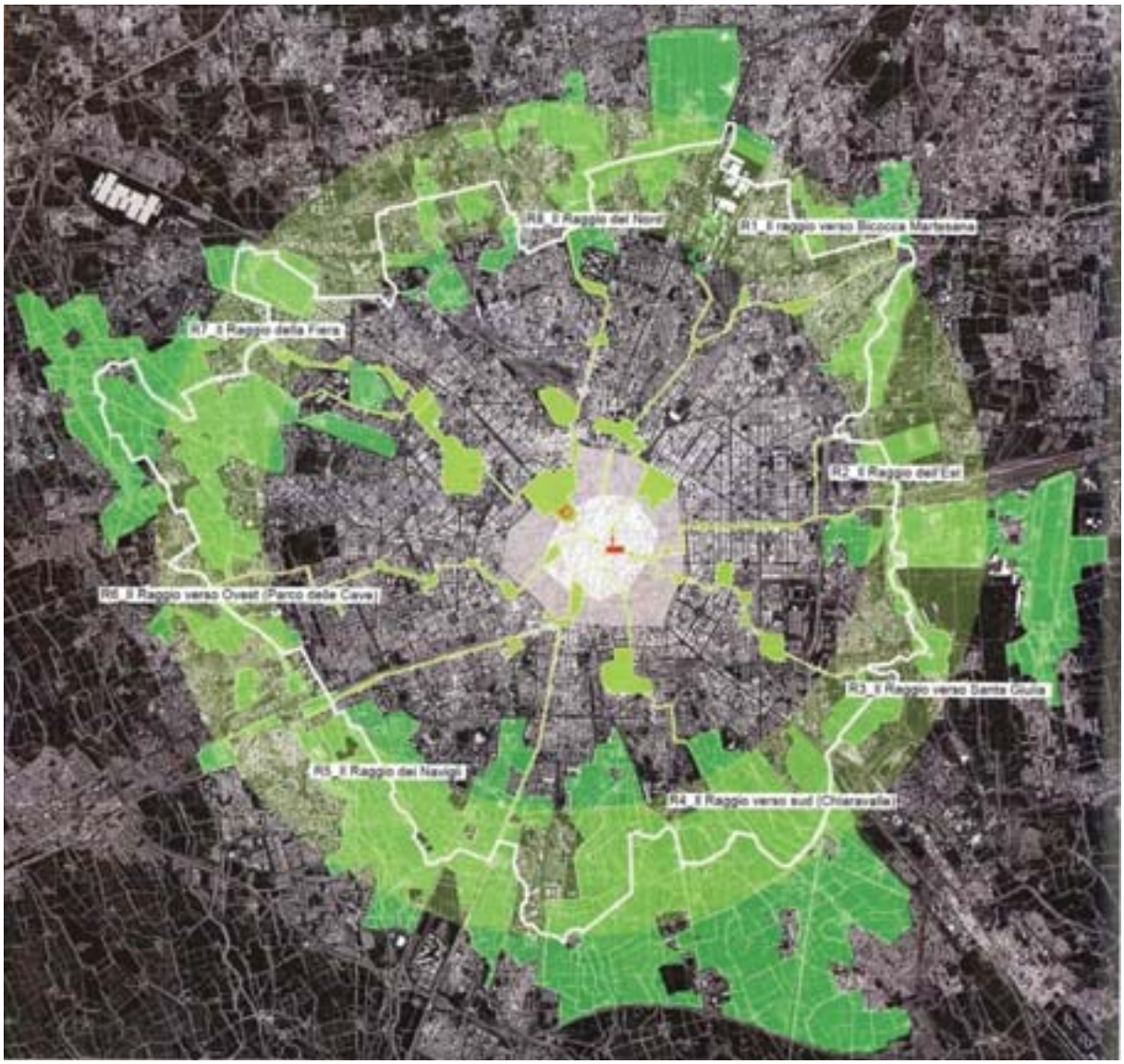


**Fig. 3:** The ‘Raggi Verdi’ project, linking urban centre and periphery of Milan: https://www.landsrl.com/08 mailand

Cascina Merlata represents the conclusion of the Italian case studies.This is a new sustainable neighborhood built in the North-West area of Milan between the location of Expo 2015, the M1 metro line and the Rho-Pero exhibition center. A self-sufficient district, a city within a city that is perfectly connected both to the center and to the periphery. This new district is equipped with all the primary functions, recreational, cultural, sporting, residential, productive and tertiary: a new-concept, smart and sustainable metropolitan habitat. In the past this was an agricultural area, but soon it will be a metropolitan center with a predominance of greenery. That is characterized by the recovery and regeneration of the thick system of canals that cross the 25 hectares of park, in memory of the historical landscape. In 2008 Caputo Partnerships, Antonio Citterio and Mario Cucinella created a first master plan of Cascina Merlata and in 2019 the second phase of the project was launched. In total, eleven new high-rise residential blocks, many of which are social housing, border a sustainable linear park, while the old farmhouse, redeveloped as a contemporary meeting place, is the new South Gate of the entire area. The cycle-pedestrian connection with the EXPO area is currently provided through the motorway and railway overpass.

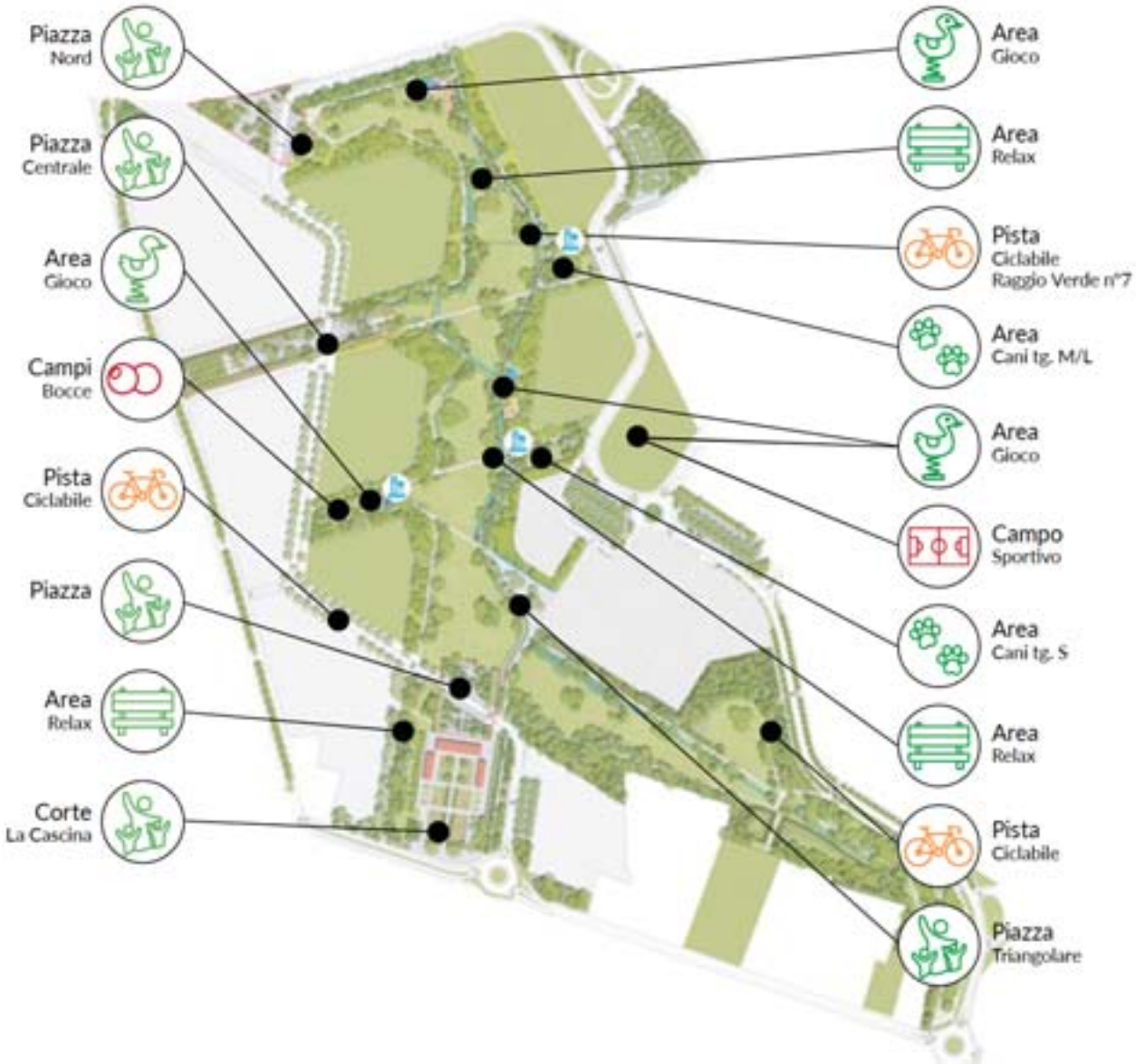


**Fig. 4:** The Park of Cascina Merlata (Milan) https://www.cascina-merlata.net/alla-scoperta-del-nostro-masterplan/

**Fig. 5:** The Fontanile in Cascina Merlata (Milan) https://www.cascina-merlata.net/alla-scoperta-del-nostro-

**Fig. 6:** The Creek in Cascina Merlata (Milan) https://www.cascina-merlata.net/alla-scoperta-del-nostro-masterplan/

## 2.2 Cases Study in the Netherlands

A new water management to mitigate the increasingly frequent floods and to improve urban livability/ sustainability is the contemporary trend within European cities. Long-term planning to make cities and territories more resilient to climate change is one of the most important and imminent concerns of the Netherlands, a European region about a quarter of which is below sea level. In this nation, all urban centers have been invited to conduct climate stress tests to see how they adapt to erratic rainfall patterns, heat waves and periods of high river flows. An excellent example on an urban scale is represented by the new district of Nørrebro, in the municipality of Copenhagen, which has been designed according to very innovative objectives. Not only was a rainwater utilization system used to purify the neighboring lake basins, but also participatory urban planning was an important element involving the local inhabitants in the planning; last but not least, there has been a lot of focus on a general increase in biodiversity….The three complementary cycles, hydrological, biological and social, on which the whole project of the new neighborhood is based, which includes Hans Tavsen Park and Korsgade, generate a functioning ecosystem with a resilient effect with respect to possible influences and alterations from external systems. The hydrological cycle has the ambitious goal of reusing rainwater throughout the city of Copenhagen. From small to large scale, rain water is seen as a resource where the water is collected, purified and reused.The hydrological cycle optimizes Copenhagen resource consumption, climate-secures the area surrounding Hans Tavsens Park and Korsgade, purifies the water in the lakes and makes Copenhagen even greener. Nature's biological cycles are revitalizing, dynamic and constantly evolving. Hans Tavsens Park will become the birthplace of a biological diversity and variety that will spread to the rest of Nørrebro and Copenhagen. The biological cycle will ensure a diverse, adaptable and unique city nature and natural experiences in the center of the capital. The social cycle is expected to increase well-being in Nørrebro, the most diverse area of Copenhagen, by promoting large and small communities through various social resources. In Nørrebro, the sense of community and tolerance must be preserved as they are the hallmarks of the neighborhood.
Always staying in the Netherlands in Arnhem, where 39°C was reached in 2019, a much higher temperature than the local seasonal average with serious drought problems, it was planned to replace at least 10% of the paved roads with greenery and trees and citizens are being encouraged to increase greenery within their properties.

**Fig. 7:** The Master Plan of Nørrebro (Copenhagen): http://landezine.com/nature-based-climate-adaptation-wins-scandinavias-biggest-architecture-award/masterplan/

### 2.3 Cases Study in Spain

In other more precise interventions, the tendency is to mitigate the effects, both qualitative and quantitative, of soil sealing and the connection of rainwater in urban areas and at the same time improve urban landscapes. Nature Based Solutions reduce the impact of urban growth on the water cycle. The Sustainable Drainage Systems, SuDS, combine a series of important functions in a single solution: the reduction of run-off and the creation of multifunctional green spaces, the permeability of soils and infiltration, the improvement of the microclimate, the reduction of pollutants, they collaborate in the improvement of the activity of urban soils, increasing their widespread humidity. All these functions make it possible to significantly reduce the quantity of water delivered to the sewer and to increase the amount reintroduced into the hydrological cycle.A brilliant example of the application of SuDS is found in Barcelona. In the Spanish city, 7 'Superillas' were built, a Catalan term that indicates purely pedestrian and green areas, where only authorized vehicles have access and these can reach a maximum speed of 10 km/h. A new 'super-superblock' is currently planned for the Eixample district, where an 80% increase in tree-lined avenues has been foreseen and the permeable surface will be increased by 20% compared to the current situation.Moreover, half of the latter will have to be 'green' to allow the soil to absorb rainwater and improve resistance to flooding.

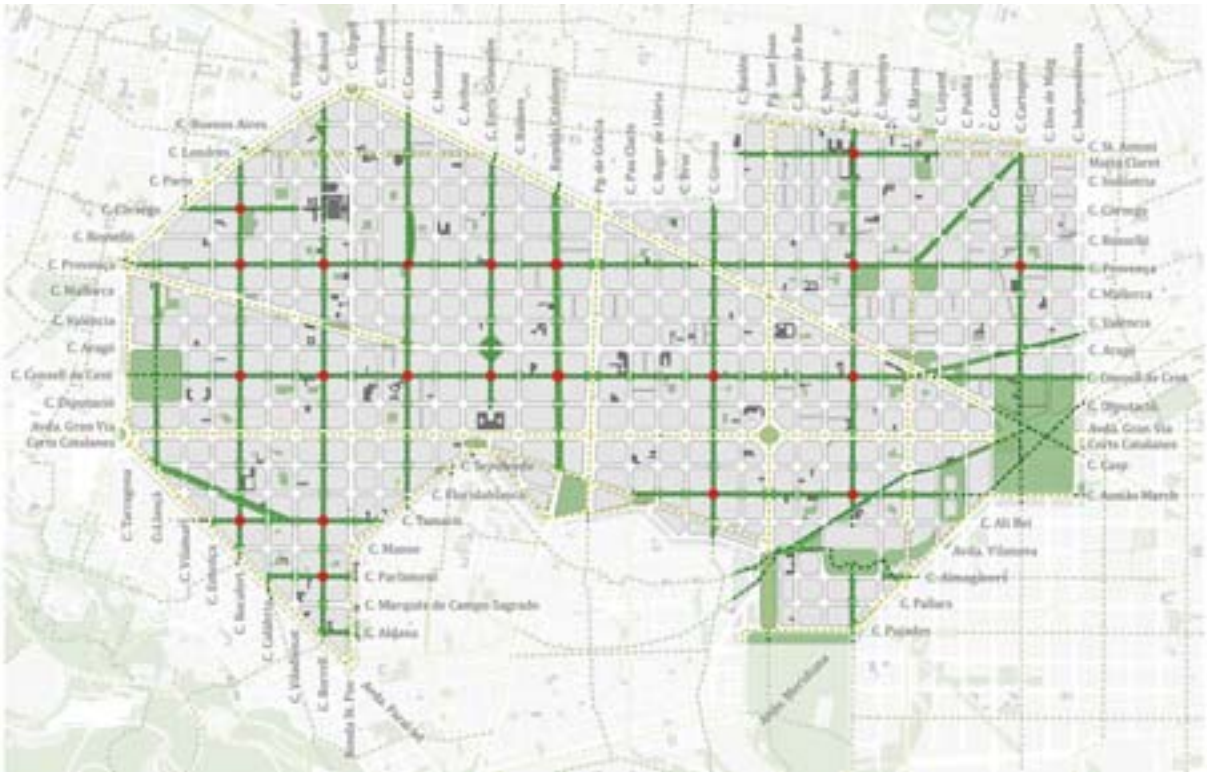

**Fig. 8:** Eixample district (Barcelona): https://ajuntament.barcelona.cat/superilles/en/superilla/eixample

## 2.4 Cases Study in France

France, which has always had a particular focus on public green spaces, is now focusing on intelligent water management. An example is the Billancourt Park in the hinterland of Paris, created by the transformation of a former industrial area near the Seine.The concept is to reconnect the inhabited center with the water through a series of islands connected to each other by a series of water paths of variable dimensions depending on the level of the river. The park is a hydraulic system, a huge reservoir that filters water and uses it to irrigate the plantations. The ponds and filtering gardens welcome a wide range of fauna and flora.

**Fig. 9:** Billancourt Park (Paris): https://landezine-award.com/boulogne-park/

**Fig. 10:** Billancourt Park (Paris): https://landezine-award.com/boulogne-park/

### 2.5 Cases Study in England

To conclude, one of the main exponents of sustainable interventions in England is Nigel Dunnet, who has already introduced many rain gardens for some time, as punctual interventions, but important in the total balance within the city. The rain gardens are light depressions in the soil that are vegetated, capable of retaining and infiltrating the flow of rainwater coming mainly from the roofs of the buildings, from the roadways and from the large paved areas. The rain gardens, in addition to filtering, contribute to the purification of the water collected, thanks to the vegetation. The rain garden is designed to dry up (in whole or in part) within a few days after the rain has stopped, making it accessible and usable again. Rain gardens can vary widely in size and can be designed to keep one part always moist, or to dry out completely.

## 3. Conclusions

The analysis of different types of intervention in progress or in anticipation in different European locations has highlighted numerous critical issues related to climate change, heat islands in urban centers, the imbalance in the management and use of water. At different scales and in different ways, each European state has adopted strategies to overcome these problems, however at present it is still too early to take stock of the success of the new and innovative methodologies adopted.

**Fig. 11:** Nigel Dunnet (England) https://www.abitare.it/it/habitat/landascape-design/2021/10/15/nigel-dunnett-racconta-i-suoi-nuovi-progetti/

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# Old Construction and New Technologies. An Experiment for the "Borgata" of Syracuse

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## Abstract
Attention to existing assets is a contemporary imperative. The architectural project on the identity of the historical building needs to confront the contents of technological innovation, providing a contemporary vision of the old/new relationship.
Through the use of natural materials, you can make an important contribution to the theme, also to rethink and build in an ecological key because these are fields that affect the environment. They affect resources and energy consumption. The choice to use natural materials, recyclable and easily available, such as clays suitable for the technique of raw earth, can represent a virtuous response. The raw earth technique is now a tool of innovation through 3D printing, able to optimize the production process.
The proposed experimentation concerns a part of the urban fabric of Syracuse, the Borgata, nineteenth-century expansion of the historic center. The urban scheme is a closed block. In particular the study focuses on incomplete corner lots because they lack the second floor. The research involves the study of the identity characters of nineteenth-century buildings and the completion of dwellings, according to the principles of bioclimatic architecture, using prefabricated elements in raw earth. It is a process that enhances the existing building and offers a traditional technology in a contemporary and historical context.

**Keywords:** Existing buildings, Retrofit, Natural Materials, KETs

## 1. Introduction
Historically, man and nature are in direct relationship and for a long time they have evolved in continuity. Nature changes spontaneously and endlessly, man transforms nature by changing matter according to his needs. Despite this link, the continuous change that defines the environment is subject to change the balance that binds the two entities: environment and nature represent fundamental resources to the survival of living species, simultaneously expressing different concepts according to the functions they perform:

- environment, in the sense of habitat, is the place where the activities of men, plants, animals develop; in this place man exploits natural resources in an almost irreversible way;
- environment, understood as nature, is the complex of natural events that contribute to the transformation of the planet (rains, winds, etc.), and the set of natural resources necessary for the survival of man (air, water, food, natural materials, etc.).

The instability of human activity is a direct cause of the change of the nature-environment system so that each change follows a change in the natural equilibrium; the effect of this action, large or small, depends on the response of the environment: An excessive impact makes the system unable to restore initial conditions; conversely, a weak impact follows the possibility of restoration of previous conditions [1].

Ecological Footprint accounts document that humanity overuses our planet by at least 75%, the equivalent to living off 1.75 Earths. This overshoot erodes the planet's health and, with it, humanity's prospects. […] Varying levels of Ecological Footprint are due to different lifestyles and consumption patterns, including the quantity of food, goods and services residents consume, the natural resources they use, and the $CO_2$ emitted to provide these goods and services. For example, Built-up land footprint measures the demand for biologically productive areas covered by infrastructure, including roads, housing and industrial structures [2].
The activities of recovery of the existing building heritage propose an interpretation of the building based on saving resources and safeguarding embodied energy. This refers to the amount of total energy used to produce a good, starting from the phase of production of building materials and components; it also refers to the amount consumed (energy value):

- during transport from the quarry to the construction site,
- during the construction,
- in the life of the building;
- the possible demolition or disposal of materials.

Factors contributing to energy consumption include vehicles, machinery and tools used in the construction phase.
The definition of embodied energy concerns both direct energies, necessary for the construction of the building (extraction, construction, maintenance, renovation, demolition), and indirect energy, used to provide products and services in construction operations. The building sector is one of the largest contributors to greenhouse gas emission in urban areas. Quantitative assessment of the carbon footprint of urban buildings is needed to advance research and policy debates on building carbon emission reduction and sustainable architectural planning. […] The carbon emissions from building material production and building energy use contributed 45% and 40% of building carbon footprint respectively. With the implementation of low-carbon strategies in building sector, such as increased energy efficiency design for new buildings and energy-saving retrofit for existing buildings, there would be a significant influence on carbon emission reduction [3].
Promoting the development and use of the low embodied carbon building material and services, the energy efficiency of construction machines, as well as the renewable energy use are identified as three main pivotal opportunities to reduce the carbon emissions of the construction sector [4].
The 2021 Global Status Report For Buildings And Construction highlighted that building emissions will need to be reduced along their lifecycle through a triple strategy, namely a combination of reducing energy demand (behaviour change and energy efficiency), decarbonizing the power supply (e.g., electrification through renewable sources and increased use of other zero-carbon heating technologies) and addressing embodied carbon stored in building materials. Through the first two measures, it could be possible to nearly eliminate carbon emissions from building operations by 2050. Additionally, emissions from materials and construction processes must be urgently addressed, to ensure that the buildings being built today are optimized for lowcarbon solutions across the full life cycle. This involves maximizing the refurbishment of existing buildings, evaluating each design choice using a whole life-cycle approach and seeking to minimize upfront carbon impacts (e.g., lean construction, low-carbon materials and construction processes, etc.), as well as taking steps to avoid future embodied carbon during and at the end of life (e.g., maximize the potential for renovation, future adaptation, circularity, etc.) [5].
From these considerations research that wants to explore, in technological key, the relationship between traditional construction and entry of new parts.
This search applies to a block in the district of Borgata Santa Lucia in Syracuse.

## 2. The case study: Borgata, historicized suburb of Syracuse

Between 1870 and 1890 in Syracuse are demolished the sixteenth-century walls built by Charles V, motivating the intervention also for the serious conditions of sanitation in which the urban tissues of Ortigia. Here the type-morphological characteristics of asphyxiated and high urban blocks, due to the constriction of the city within the walls, did not favor direct sunlight and ventilation of inhabited environments, recording high levels of mortality, above average. After the demolition, the Ministry of War maintained easements on the site of the fortification system -for which a band of respect continued to exist, *not -aedificandi* at least until 1885.
The Borgata Santa Lucia, reachable by extending the straight axis northwards from the dock, through a utopian and debated bridge (never built until the second half of the twentieth century, now again demolished) becomes a place where to think of an expansion that embraces the pre-existence of the Sepulchre, a site very dear to the inhabitants and frequented for processions in the worship of the patron and for fairs. In the last decade of the nineteenth century there will be the demolition, with an iconoclastic fury, of the Ligny Gate, and the setting of an orthogonal mesh, still aligned with the hygienist matrices, but now far from the innovative structures shareable for a contemporary city.

The district of Borgata, was subjected from 1885 to 1925 to intense building activity, made by parceling and construction by private individuals. The Borgata Santa Lucia is a sort of second historical center of Syracuse, outside Ortigia and represents the late nineteenth-century expansion zone, near the Sepulchre of Saint Lucia, from which it takes its name.
The strategy of transforming Syracuse into a modern city began in the last decade of the nineteenth century with the birth:

- of Borgo Sant'Antonio, for production sites;
- of Borgata Santa Lucia, intended for popular residences;
- of the Umbertina area for residential purposes.

The housing estates of Saint Lucia, in spite of the popular aims for which they were intended, attracted the attention of the emerging bourgeoisie of the city [6] for their regular and extensive urban layout, healthier and more modern. The plotting of the "contrada" Saint Lucia were built on a vast agricultural area cultivated with vines, overlooking the sea with farms and warehouses and were divided into a system of regular lots, traced from the large square, different for building types and period of construction.
Today, the buildings almost always consist of closed blocks with little space for the voids (courtyards, cloisters), have variable height between the two and four elevations, with a high building density. This building density highlights lots for completion interventions.
We can identify:

- small buildings with two or three floors with uniform elevations and stone friezes, according to a lexicon, sometimes valuable, typically Art Nouveau;
- simple popular types without ornamental elements;
- poor Terranean houses for workers, farmers, sailors and small traders.

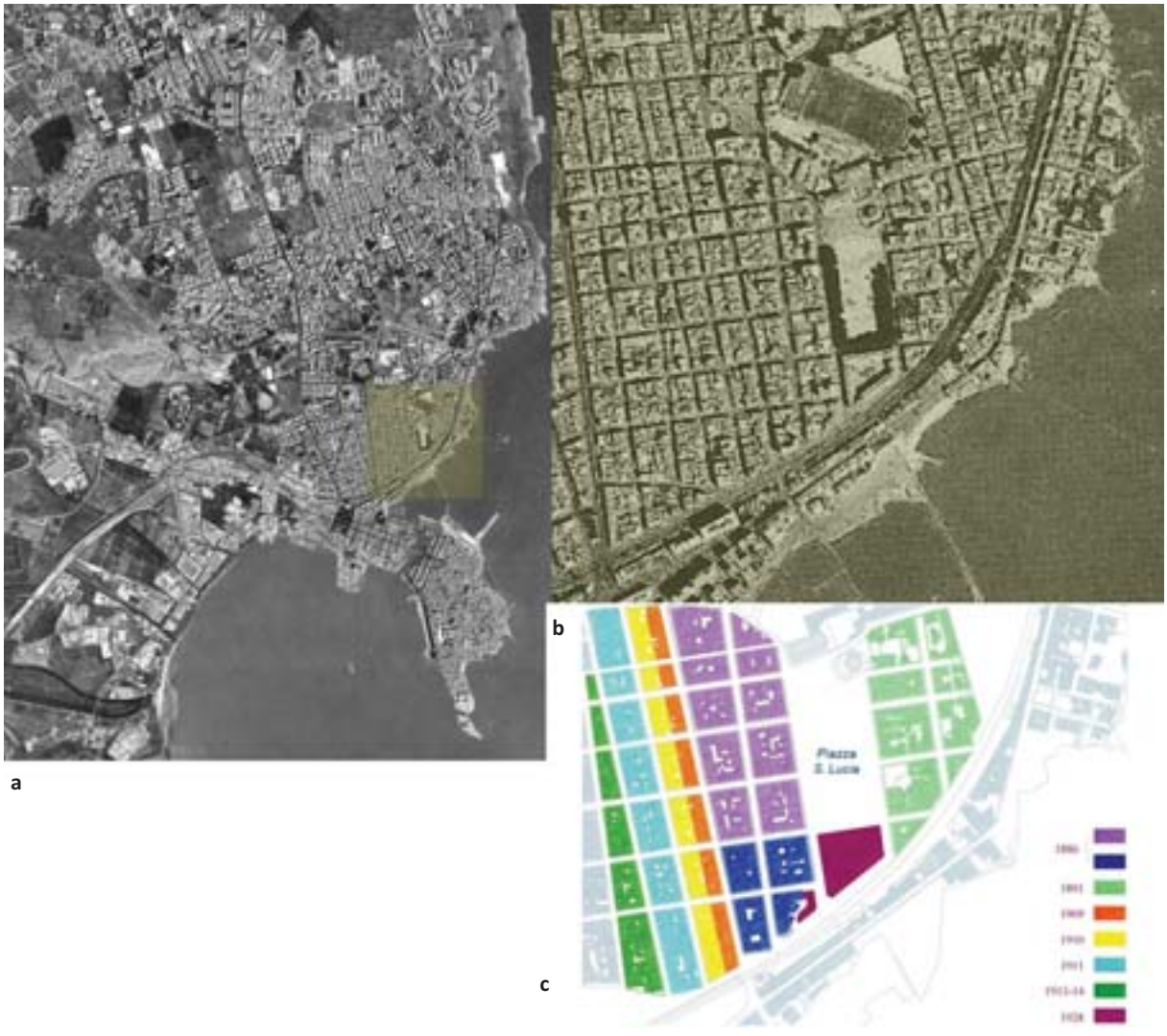


**Fig. 1: a)** aerial photo of Syracuse, **b**) Borgata district, **c)** plan of allotments

There are many houses "waiting", incomplete, with only the ground floor, frame and shelves for balconies that provided for the construction of an upper floor, never realized. Many scholars have highlighted the heterogeneous character of the buildings that represent different social needs, juxtaposed with each other. In the Borgata district there is an uneven and articulated social stratification, represented by the buildings, oriented downwards. The blocks were the mirror of the society, made by parts, by successive steps, by division, creating a play of voids and solids, of different heights, with different decorative elements [7]. Today, the village has different and discontinuous elements, identifiable both in the urban network and in the architectural features that distinguish buildings of the same block.

## 3. Research

The research starts from the concepts summarized in the introduction and intends to apply strategies for sustainability with particular attention to energy savings throughout the entire building process for recovery.
The trial was based on:

- the identification of the isolate characterised by incomplete building processes;
- the use of natural materials for building completion;
- material and construction compatibility in the addition process;
- Process innovations: advanced manifacturing solutions and additive manufactoring.

### 3.1 Identification of the isolate

The site located within the district of Borgata di S. Lucia, is defined between the roads of via Isonzo (west), via Agrigento (north), via Piave (east) and via Caltanissetta (south). The morphology of the block presents architectural model units in *Palazzetto*, with a state of mixed use. The visible qualitative characteristics of the block and the homogeneity of the stylistic decorations constitute a great qualitative potential, despite the transformations suffered by numerous interventions that have altered the state of the facades. The realization of fractions and additions of volumes, over time, has introduced elements related to different architectural and stylistic languages. The analysis of the district was organized on the basis of a thorough cognitive observation to identify the characteristics and recurrent elements. These elements, as a whole, define an urban area in which the building process, begun near the plots of the nineteenth century, has not exhausted the operational possibilities. The analysis showed batches consisting of buildings adjoined, with a different number of floors. Often the inner part of the isolated presence small courtyards and cloisters useful for ventilation of the rooms that do not face the streets; moreover, one of the most recurring aspects is the presence of stone corbels or overhanging slabs, placed at the first floor, indicating a construction program not completed. The volume of the block is usually characterized by building units with two or three elevations; however, the facades are often discontinuous in profile.

**Fig. 2:** discontinuity in the façades

These breaks are either placed in an intermediate position (type A) or occupy the angle of the lot (type B). In this context, the study element belongs to type B.
The construction of the *Palazzetto* has in fact been interrupted several times and this is demonstrated by the residues of recent interventions:

- the construction of the c.a. structure of the staircase connecting the first floor,
- the arrangement of the masonry to support the floor,
- incomplete internal partition walls.

On the elevations these interventions are legible through the presence of materials foreign to the original construction and in particular the position and development of the ramps of the staircase interferes with the geometry of the low arch holes defined by stone elements.

### 3.2 The use of natural materials for building completion

In the field of prefabrication, industrial production uses raw earth with increasing frequency; different elements, applicable with structural function, infill or filling, are widely developed and manufactured in Germany and South America in the form of straw-ground partition panels, lightweight infill blocks for insulation of walls and ceilings, or straw and earth panels used in roofing.
The CSEB - Compressed Stabilized Earth Blocks, developed since the fifties through the manual press Cinvaram, patented in Colombia, are composed of a mixture of:

- fine soil with low clay content,
- water (8-16%)
- sand and silt of different grain sizes (less than 5-6 mm).

They are formed by the use of a press - manual, hydraulic or pneumatic mechanical [8] which reduces the volume in half and increases the mechanical strength under compression. With this system the blocks become similar to the common solid baked bricks and can be used for the construction of internal and external load-bearing walls. The presses enhance the strength, compactness and heat storage capacity of the blocks, improve water resistance by adding small amounts of cement.
Industrial or semi-industrial tools increase the production of blocks directly on site: with two or three employees per press, average compaction pressure of 10 kg/cm2, in a common working day it is possible to produce from 300 to 1200 elements. As an alternative to the traditional production of raw bricks, the processing of adobe is mechanized with the help of transportable concrete mixers that allow to reduce the time by pouring the liquid dough directly into the shapes and pressing it manually or mechanically.
The industrial production of uncooked bricks, developed in principle in the United States, contributes to increasing the quantity of product and it serves to speed up the large-scale production process, producing more than 4000 per day. Extruded or drawn blocks are made using a drawing machine that produces bricks from 20 to 60 cm in length, between 3 and 10 cm thick with a mixture of raw earth with clay quantities of 14% in 22% silt, 62% sand and 2% gravel [9]. The characteristics of the final product allow to increase the living well-being by improving the internal microclimate because they contribute to regulate the thermo-hygrometric balance of the interior spaces. Such masonry performance helps save energy for air conditioning with a contribution between 75% and 97% less than a similar system made with traditional fired bricks [10].
Finally, the lightened blocks, as a variant of the straw-earth blocks and plant aggregates, are made from straw, sawdust, cellulose fibers, cork, perlite or expanded clay and are formed by a compression machinery, with higher production and commissioning speeds. The blocks, due to their small size, low density and light weight, are a sort of perforated brick but with a low specific weight (1200 kg/m3) [9].
The raw earth mixtures, for their easy shaping, linked to the plastic properties of clay, are a versatile material, capable of taking different shapes according to its components and being processed and used in many ways. The technique of raw earth is important in construction for its characteristics of availability, economy, workability and for the technical and insulating capabilities: acoustic, thermal, fireproof.
The proposed framework highlights the possibilities offered by contemporary production of using raw earth components to complete the building identified as a case study. In this way and on the executive level, a renewed interpretation of the old/new relationship can be experienced in a historical city context. Operating within the Borgata S. Lucia involves the conception of the project as a realization in a densely inhabited context, with a level of vehicular traffic sustained by the presence of numerous commercial activities. The limited size of the road sections makes it necessary to plan for a limited impact construction site and to use small equipment. In this sense, the use of prefabricated components to be assembled on site and the use, to a large extent, of "dry" systems allow a significant reduction in construction time.

### 3.3 Material and construction compatibility in the addition project

The technological investigation deals with defining the architectural quality of the pre-existing and the possibility of transforming and recovering through a performance assessment; it considers the building

a system on which it is not possible to intervene in a indistinct manner, but the intervention must respect technological compatibility and identity characteristics. The intended use of spaces also derives from the comparison between possible functions based on:

- contemporary living parameters;
- pre-existing quality of the building and evaluations of the usability of the environments;
- needs of the neighborhood and revitalization goals of this part of town.

From these premises, the analysis has taken into consideration several aspects of the recovery and addition project that refer to the different areas of compatibility: dimensional, mechanical, physical, chemical, energy and ecological.

The analysis set out the following operational objectives, based on the identification of:

- a construction system compatible with masonry;
- natural materials with low environmental impact;
- a low energy impact system;
- a site management system compatible with the characteristics of the urban area.

The incomplete configuration of the blocks shows a previous desire to achieve further elevations and therefore the existing masonry sections have mechanical characteristics suitable for the construction of an extra level. The research has identified and verified the suitability, among the natural materials, of elements in raw earth for vertical closures and vertical internal partitions and laminated wood for horizontal internal partitions.

### 3.4 Process innovations: Advanced Manufacturing Solutions and Additive Manufacturing

The use of KETS (Key Enabling Technologies) for the innovation of production processes is increasingly affecting the construction industry. The use of mobile robots that can be transferred from the field of Logistics to the construction site allows an optimization of the production phases and a reduction in production times.

In our case, the use of mechanized tools for the large-scale production of raw elements - bricks, blocks, panels - compensate for the loss of skilled labour and can contribute to a greater spread of construction techniques in raw earth in the building industry. The application and development of this construction technique allows a high quality of the product and, above all, to optimize the production, without waste and long construction processes, thus also controlling costs. In this way, the different traditional construction techniques - pisè, adobe, *terra-paglia* - have been standardized, passing from the manual processing phases to the use of mixers, compactors, extruders, etc. The production of compressed, extruded or 3D-printed blocks is now a technologically advanced and simplified process compared to the construction and prefabrication of components.

These systems allow the use of innovative formwork, non-rectilinear shapes and the introduction of more resistant materials - metal - and provide for production with electrical or pneumatic machinery for compaction used since the first half of the twentieth century in France, Germany, the United States and Austria with contributions from designers such as David Easton and Martin Rauch. The contribution of these experiments demonstrates the possibility of speeding up the production of the Pisè by about 10% at 2 h/m3 compared to traditional manual production [9].

The modernisation of the technique also consists in correcting the composition of the earth through the addition of cement (8-10%) which contributes to increasing the mechanical performance of the material and improving its responses to seismic stress [11].

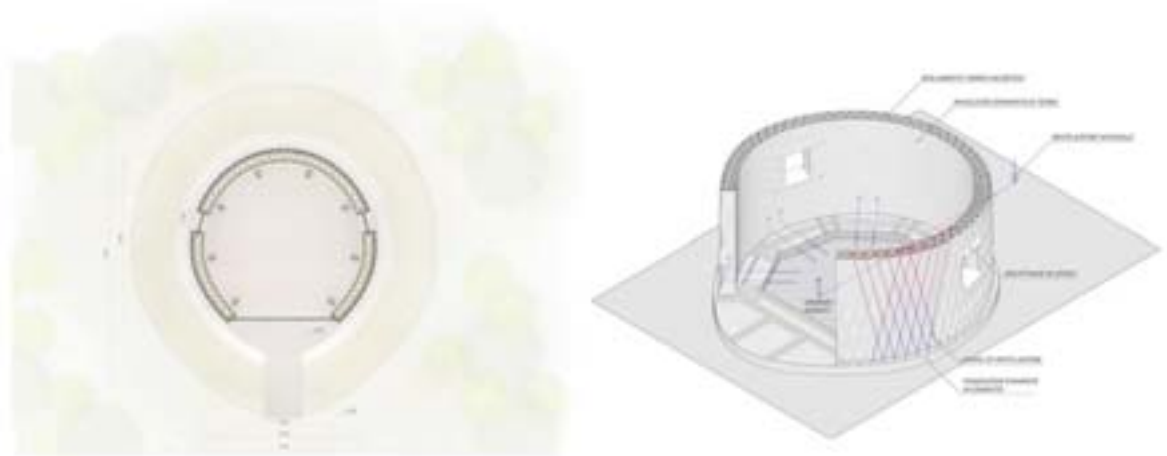

**Fig. 3:** Gaia: the first 3D printed house in raw earth.
Available on: https://www.3dwasp.com/casa-stampata-in-3d-gaia/

Today, extrusion 3D printing represents the latest construction technique with raw earth. It is part of Additive Manufacturing and allows to produce three-dimensional elements from earth filaments, a few centimetres high and arranged by overlapping layers. An anticipation of the printing process is Stranglehm, a technique of mechanical modelling of earth mixtures, developed in 1982 by the BRL, Building Research Laboratory. It is an advanced solution for the construction of raw earth that allows a rapid realization of the elements through a machine that produces wet earth profiles and is based on the extrusion process at a speed of 3 meters per minute, reaching a height of about 2 meters. In particular, the loose earth inserted in the machinery has a clay content of more than 15% that makes the dough malleable; to it are added finely chopped straw fibers and water to obtain a plastic mass, suitable for crushing and extrusion. The addition of natural products such as casein powder, whey, straw:

- facilitate and speed up the production of extruded elements;
- make the material hard;
- water resistance damage;
- confer a high capacity to contain withdrawal and thus the formation of surface fractures;
- limit the scaling of drying elements by between 3 and 5%.

Raw earth, when combined with the newly developed innovative printing equipment, can improve the productivity and sustainability of the construction industry. Among the traditional construction techniques with raw earth treated, the Pisé is the form of use closest to the 3D printing mode (by extrusion of the earth material).

Unlike the traditional pouring system of fluid material in formwork, 3D extrusion printing combines digital technology and dough design that can be used without media. It allows the construction of buildings with modular or monolithic elements whose implementation is based on the robotic construction process, automated with digital control. This system optimizes execution and assembly times. Moreover, the evolution of printing machinery allows both the production of prefabricated and assembled components on site and in-situ production.

## 4. Experimental project

The Information System for the achievement of the research objectives listed above (§3) defines the operational scope of the project and results in a system of collaborative solutions:

- the proposal for a residential model consistent with the concept of contemporary living;
- the use of natural materials with low environmental impact;
- the application of the principles of bioclimatic architecture in building renovation;
- the use of kets (Key Enabling Technologies): including Advanced Manufacturing Solutions and Additive Manufacturing.

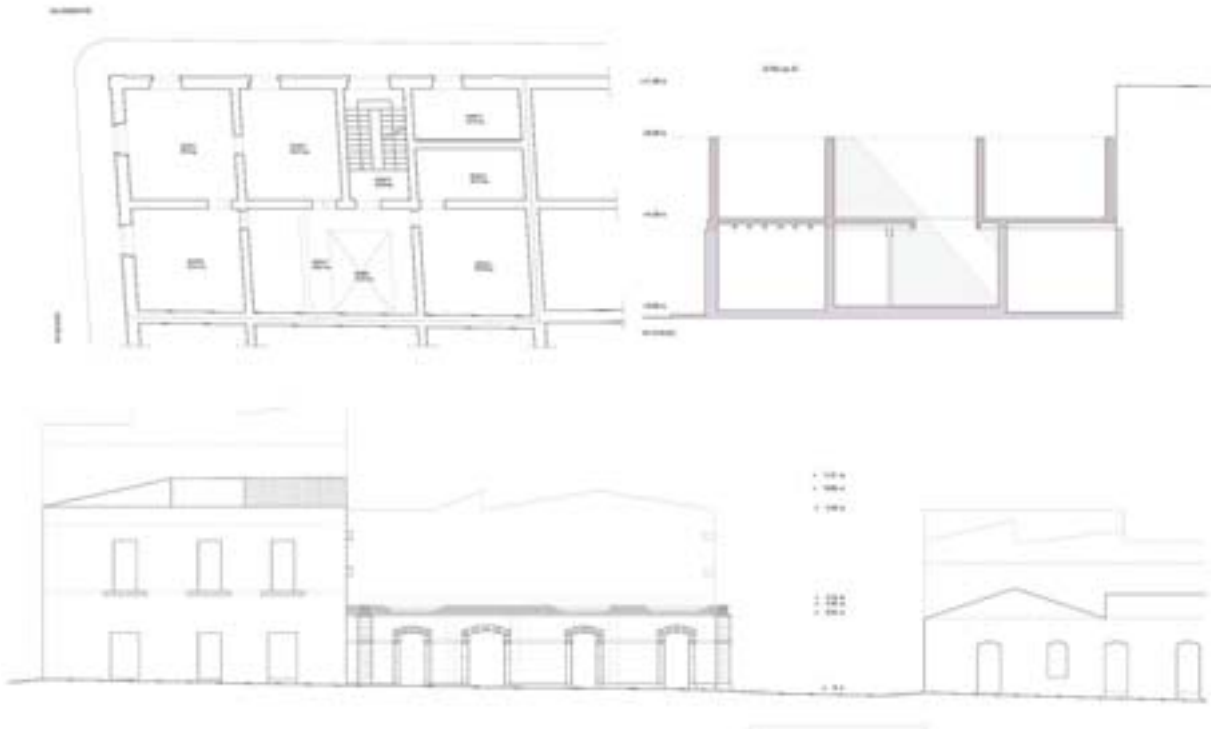

**Fig 4:** Survey

The redevelopment and completion of the building unit is consistent with the principles of bioclimatic architecture: the articulation of the interior space and the distribution of functions are based on the orientation of the lot, the internal cloister becomes a liveable space and a device for collecting solar radiation, but also for ventilation.
The project of the pitched roof was conceived as a composition of floors with different laying and involves the insertion of windows and skylights for the interior lighting of disadvantaged spaces. The displacement of the staircase makes the two levels independent and identifies two residential levels (ground floor and first floor) and one working (office/ studio) in a part of the ground floor.
The floors were designed in laminated wood and connected to the walls through wooden curbs; they were warped according to alternating layers in order to distribute the load on the different walls. The roof system includes trusses and inclined floors that create a non-pushing structure.

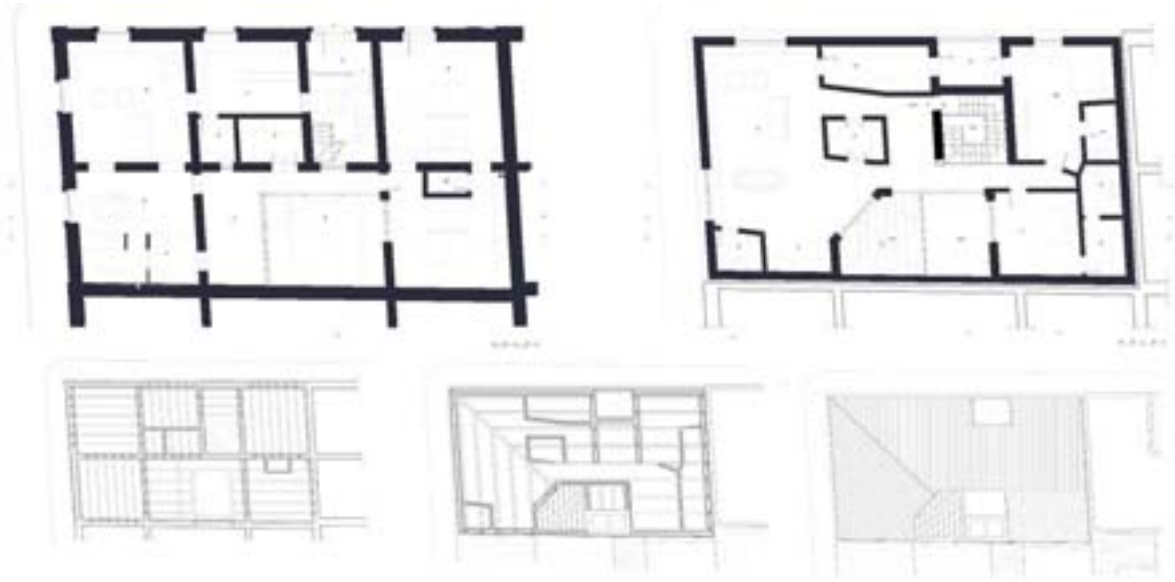

**Fig. 5:** Project

**Fig. 6:** Assembly phases of 3D printed elements on-site and off-site

The Vertical Opaque Closure consists of wall panels in raw earth moulded on site for subsequent stages. The cornice of the building, connecting the walls and the roof, is printed off-site, as well as the terminals of the internal partitions in contact with the main structure of the roof.In function of these choices the plan is equipped by a diagram of the phases of realization/assemblage of the members and from a georeferenced abacus of the same ones.

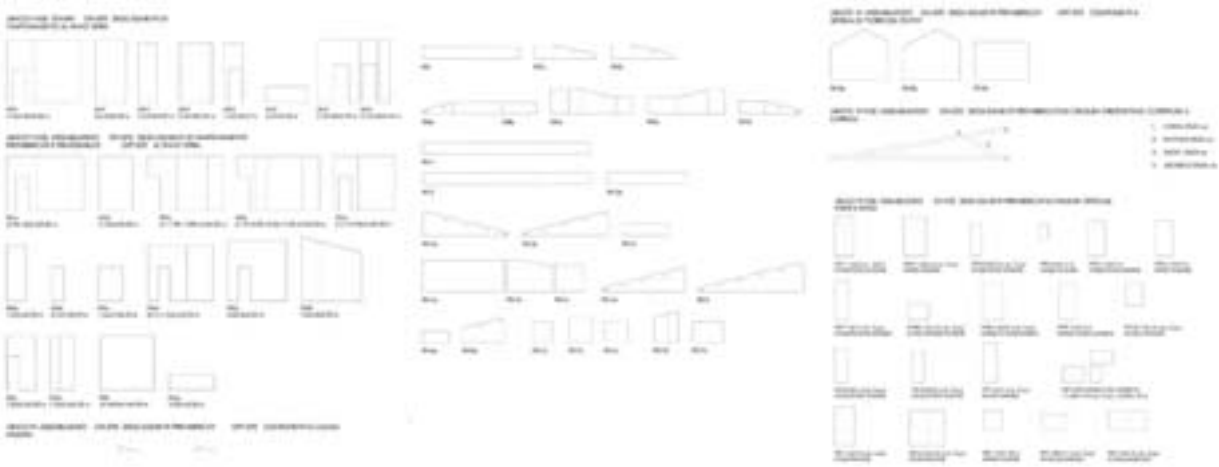

**Fig. 7:** Abacus of the building components

## 5. Conclusions

The 2023 Rebuild Observatory confirms the data emerged from the research of the Department of Culture of the Iuav University of Venice Project on investments in the field of energy upgrading of existing buildings. Both studies fill an operational gap on sustainable interventions on the existing building stock and identify actions for a very significant saving of energy consumed. The research project proposed here therefore has further and valid bases to refer to.

Moreover, as recalled by the United Nations in the Global Status Report for Buildings and Construction "the Renovation of buildings is one of the seven flagship recovery areas identified by the European Commission" [5]. In the current context, climate change requires rethinking and reorganization of production patterns and behavior. Therefore, the construction activities are at the center of attention and take an increasingly important role Key Enabling Technologies as a support for process innovation.

Although the Italian technical legislation has not yet considered the construction in raw earth contemporary construction systems, the experimentation conducted wants to offer an ulterior contribution to the research in existence from some decades in many Italian universities and founded on the wide diffusion of this technique on the national territory. In particular, the study focuses on the benefits of Wellness and Environmental Protection that can be significantly improved by using raw earth. In fact, the material is easily available, it is suitable for innovations and its disposal does not generate waste that is difficult to dispose of. The use of computerized production tools can help to innovate a traditional system.

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# Environmental recovery strategies for sustainable and resilient regeneration

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## Abstract
The physical degradation, the indiscriminate exploitation of non-renewable resources, socio-economic marginality, environmental fragility, the increase in climate-altering emissions and polluted sites, the effects of global warming, require, today, necessarily, a paradigm shift with a view to responding to major changes and crises, and enhancing resilience to future challenges. An interscalare and multidisciplinary approach hinged on new policies, procedures and tools, involving urban planning, landscape planning, technological-environmental design, design, promoting adaptation and mitigation actions to climate change, the twin transition, the enhancement of drosscapes, through the widespread use of innovative technologies for the environment, mobility, energy efficiency, waste recycling, human welfare and health. In this framework, the contribution, starting from the analysis of some best practices and a case study, proposes a reflection on the need to implement environmental recovery strategies capable of counteracting dissipative dynamics and activating a new urban metabolism, with the aim of prefiguring new spatial configurations, economic and energy cycles; restoring with natural solutions (nature-based solutions), biodiversity and the quality of environmental matrices (air, water and soil), for a sustainable and resilient regeneration.

**Keywords:** environmental recovery strategies, urban regeneration, urban metabolism, resilience

## 1. Govern the change. Between sustainability and resilience
The current political, socio-economic, health and environmental situation is drawing alarming trends and perspectives throughout the planet that undermine the world order. The strengthening of national sovereignty, the increasingly evident weakness of the principles of international cooperation as well as the demands of human and civil rights, the retreat of the policies of multiculturalism and environmentalism, the centralization of wealth in a few hands, the indiscriminate exploitation of environmental resources, the increase of urbanization processes, of climate-altering emissions, the commodification of labour, land and money [1] are having a major impact on the escalation of global climate change issues and the rise in inequalities and social, economic and spatial polarisation.
A clear sign of a system crisis, the replacement of liberal democracies by forms of populist authoritarianism [2], which rely on security rhetoric and incite racial hatred, marking spheres of influence between the east and west of the world, are at the root of the geopolitical crisis that resulted in the Russian invasion of Ukraine that in addition to causing death and destruction is having strong repercussions on rising inflation and energy markets forcing European countries dependent on Russian gas to deploy policies and strategies to diversify the supply of supply sources by accelerating energy transition processes [3].
In the three years that we leave behind the epidemiological emergency from Covid-19 has brought to its knees the economy and the labor market, causing profound changes, on the dynamics of aggregation and gravitation, on the ways of living, working and producing, defining new and unusual social questions that revolutionize the consolidated knowledge frameworks. At this time, while around 1.3 billion people in the world live below the poverty line, and 700 million suffer from hunger [4] [5], the wealth of the ten

richest men on the planet has doubled [6] and has grown at a steady pace, the economy, extraction of natural resources, population, greenhouse gases [7], biodiversity loss and soil consumption.
The environmental risks posed by *global worming* such as floods, deforestation, melting glaciers, heat waves, drought and pollution are undermining efforts to make cities and other human settlements inclusive, safe, resilient and sustainable [8]. According to the Intergovernmental Panel on Climate Change (IPCC), *global warming* by the end of the century could increase by 3° C above pre-industrial levels [9], while pollution-related diseases kill nine million people every year [10]. Many authoritative bodies predict that over the next 40 years the consumption of fossil fuels, metals and minerals will double [11], while by 2050 annual waste production will increase by 70% [12].
These are the concomitance of events and conditions that must necessarily find a shared solution at a global political, environmental, economic, social and cultural level so that their interaction does not irreversibly threaten the future of humanity. A paradigm shift, ambitious and coordinated action by governments, businesses and citizens, is needed to reverse the effects of the current crises [4] before «the window of opportunity to ensure a liveable and sustainable future for all» [13] don't shut down for good. In this context to respond to physical degradation, indiscriminate exploitation of non-renewable resources, socio-economic marginalisation [14], environmental fragility [15], increased disease [16] and migratory flows [17] and appropriate social policies, It is necessary to implement a unitary, integrated and inter-divisive strategy of public government [18] that takes on environmental regeneration and social and cultural valorisation, as key objectives of contemporary city government fostering resilience for future challenges [19]. The many obstacles that we face require concrete and immediate answers based on the new focus disciplinary of urban regeneration, smart cities, twin transition towards a climate neutral and fair economy, the decarbonisation of the energy system [20] [21] on the transition from a "production-consumption-waste" society to a carbon-free, environmentally sustainable, toxic-free and fully circular economy by 2050 [22].
New cognitive paradigms need to be implemented, such as Ecosystem Services (ES) [23] new design metaphors such as green and blue infrastructure [24] which can play a decisive role in the implementation of sustainable and resilient climate-proof planning through integration between urban planning and environmental policies, triggering a new urban metabolism [25] [26]. The pandemic highlighted the complex interrelationship between the material infrastructure of cities and human capital, highlighting the enormous potential of technologies and digital networks (*blockchain, distributed Ledger, 5G, cloud, edge computing, internet of things*, *etc*.) as a means of facilitating decision-making and resolving conflicts, enable new business models, regenerate economies and territories, promote smart, sustainable and inclusive growth [27]. New cognitive and design approaches which, supported by new digital technologies, innovative governance tools and funding channels [20] [28] and hinged on community-based activities, are able to contribute to the regeneration of fragile or fragile socio-economic contexts degraded by enhancing the cultural, economic and social potential and the axes structuring the places of identity.

## 2. The new paradigms of environmental regeneration

In the world, cities and territories preserve an immense cultural heritage, however, alongside what is recognized and protected there are spaces where the acceleration of the processes of fragmentation and settlement dispersion, often linked to the absence of planning, give rise to new categories of "urban voids" or "non-places aggregates" [29]. Urban suburbs, guardians of history and memory, abandoned and disused places «result of the exhaustion and lack of control of industrial, agricultural, commercial, real estate, mining cycles» [25], or consequence of the cycles of economic and demographic decline of cities (*shrinking*) [30], they question us on how to reactivate them.
In recent years the taxonomic effort has produced numerous definitions of degraded, polluted, abandoned or abandoned areas, landscapes and infrastructure networks [25] [31] outlining new paradigms of environmental regeneration and spatial reconfiguration of the contemporary city [25]. Decommissioning, abandonment and waste landscapes (*drosscapes*), landfills (*landscapes of obsolescence*), polluted sites (*brownfields*) [32] [33] [34], interstitial spaces between networks and infrastructure (*infrascapes*) [35] [36], aquatic or marine landscapes (*waterscapes*) [37] rural landscapes (*ruralscapes*) [38], related to the dissipative dynamics of material and energy flows, require integrated and multi-scale strategies and tools, capable of mitigating environmental, infrastructural and settlement criticalities, placing established communities and territory at the heart of environmental regeneration processes [39] [40].
Through the dynamic interaction between territorial, natural and anthropic infrastructures, it is possible to create new landscape networks integrated in the regeneration and recycling processes of the territory. An approach that marks the transition from a dissipative linear economy to a regenerative and sustainable circular [41] [21], «an opportunity to build resilient landscapes, alternative production chains and sustainable energy cycles within scenarios of ecological regeneration, reconfiguration of public spaces and social cohesion» [26].

### 1.2 The enhancement of waste dumps. Some best practices

In particular, the rethinking of waste dumps, now at the center of numerous design experiments carried out around the world, highlight how the creative approaches that arise from the multidisciplinary integration between urban planning, architecture, landscaping, technological and environmental design, design and the use of innovative technologies for the environment, energy, waste treatment and recycling, well-being and human health, are able to enhance these territories by giving them new life through compatible uses integrated in the context of new economic and productive cycles, circular and sustainable. This is demonstrated by some environmental recovery and regeneration projects, concerning landfills that have finished their life cycle, often placed in buffer areas between the settlement tissues and the areas with a strong naturalness, through their reuse for agricultural purposes, forestry, recreation, energy, ecological or multifunctional. Interventions related to both the safety, the remediation of polluted sites, and the restoration of the landscape and natural components, and the creation of cultural centers, multifunctional and inclusive spaces and services, forestry for energy purposes, ecological-environmental corridors, plants for the phytopurification of waste water and for the production of energy from biomass, waste and renewable sources.

Below is a brief review of best practices that are a huge wealth of experience to refer to for future projects. Fresh Kills Landfill was a 890 hectare landfill site located in Staten Island, NYC (USA) on an area originally consisting of tidal streams and coastal swamps [42]. Opened in 1948 as a temporary site, over the years it has become the largest landfill site in the world, receiving in the eighties a maximum of 29,000 tons of waste per day until its closure in 2001. In the same year, the New York Department of City Planning launched an international competition that won the company Field Operations. The Masterplan result of the collaboration between the Departement of City Planning and the study of the landscape architect James Corner of the Field Operation has led to the drafting of the final Masterplan that involves the transformation of the landfill into a green infrastructure in the arch 30-year-old.

The park, divided into five areas, is divided into project lines concerning the topographical reconfiguration of the site, the restoration of natural habitats, the prediction of recreational, artistic and sports activities, the development of landscape-use paths environmental, the prediction of plants for the production of energy from renewable sources and biomethane to be fed into the network to serve the park and the city of New York. Recreational activities such as kayaking, photography, hiking, horseback riding, mountain biking, birdwatching, group tours are provided. The progressive redevelopment project of Fresh Kills is made possible thanks to the involvement of local communities and all stakeholders, both because the ownership of the area and most of the funding for the transformation of the site are public.

The former Hiriya waste dump in Tel Aviv, Israel, active from 1952 to 1999, has been subject since 2001 to a redevelopment process promoted by the “Dan Municipal Sanitation Association” to convert the landfill into an urban park [43]. Through an international competition in 2004 was selected the project of Latz+Patner, the first step towards the construction of the “Ariel Sharon Park”. Extended for about 800 hectares, ex bad place, is today the largest green lung of the metropolitan area of Dane a privileged place for testing the theme of recycling. The waste is used to produce energy while storage systems, phytopurification and recycling of waste water from both the city and the landfill are reused for compatible uses. The project involves the construction of cycle-pedestrian paths, picnic areas, gardens and water mirrors that play an important aesthetic, perceptive and landscape function. The project is completed by the installation of specific site works considered symbols of the process of rebirth of the site.

The project to restore the site of Vall d’en Joan located in the Garraf Park [44], one of the twelve protected forest areas of Catalonia and promoted by the Àrea Metropolitana de Barcelona (AMB), is the outcome of the planning process that has engaged the multidisciplinary collective Batlle I Roig since 2002 in an intense cognitive and design activity to give shape and identity to a heavily degraded area that from 1974 to 2006 was used as an illegal landfill municipal waste. The regeneration project, which drew on expertise in landscape design, environmental engineering, agronomy and geology, was aimed at achieving the objectives of land reclamation and site security, landscape remodeling and waste gas recovery. The project is strongly characterized by a system of paths that zigzag across the entire area, resting on the terraces to resolve the steep slopes of the valley, as the key element to integrate the park with the landscape. The process of renaturalization of the site of about 60 hectares is based on the planting of plant species compatible, both with the new stratigraphy of the soil, and with the surrounding habitat to allow the spontaneous repopulation of the native fauna. The project also includes a drainage system that maximizes the collection of rainwater for summer irrigation and a power plant powered by biogas that produces electricity.

The redevelopment project of the former landfill of Ciliverghe in the municipality of Mazzano in the province of Brescia, the result of the collaboration of the Arcoplan study with the Universities of Padova and Brescia, aims to restore to the community a public park with a strong functional, landscape and environmental connotation, through the provision of a wide range of innovative measures, especially on the subject of renewable energy [45]. The site, which covers an area of 10 hectares, has been

redesigned since 2013, following design lines that include the construction of a public park, ponds for the accumulation of rainwater, the reshaping of the landscape thanks to a system of terraces intersected by zigzag paths, the planting of oil crops (rapeseed, sunflower and soybean for the production of biofuels) and lignocellulosic (for the production of biomass for energy purposes)the construction of a phytodepuration plant and a photovoltaic system to serve the park. In recent years the administration of Mazzano has presented in agreement with the municipalities of Nuvolera and Nuvolento an expression of interest to the Lombardy Region for the establishment of an “energy community” and the obtaining of funding to support the interventions for the production of renewable energy to be carried out on the site of the former landfill.

## 3. Rome: the Malagrotta landfill

The landfill of solid urban waste in Malagrotta is an emblematic case of the bad management of the waste cycle in the capital and in Lazio that crosses, both the legislative evolution in the field of construction and management of landfills, both the political andadministrative and judicial issues of recent years that have brought to light critical issues arising from choices made in the past and that today can be a heavy burden for the quality of the environment and the future of the city [46]. Located on the western outskirts about 13 kilometers from the city center on an area of 161 hectares previously used as a quarry of aggregates for construction, was active from 1974 to 2013 receiving up to 5,000 tons of waste per day for a total of 32,2 million cubic meters of waste, and for this reason considered the largest landfill of waste in Europe. The site, managed by the company E. Giovi Srl, is located within an urban-territorial context strongly characterized by the presence in the immediate vicinity, both of plants, services and equipment with a high environmental impact such as a hospital waste incinerator owned by AMA SpA (1), the Raffineria di Roma SpA (2), a warehouse for the processing and mixing of petroleum products (De.co. Scarl) (3) and some scrappers, both of low density urban fabrics often spontaneous or abusive, and, finally, of numerous quarries for the extraction of sand and gravel now abandoned or abandoned since the second world war have contributed to the rapid expansion of the city. Currently the landfill has three hydraulic containment systems set up by the property, two of which were built to meet the regulations in this field since the seventies. In addition to the basal part consisting of a thick blanket of Pliocene clays, in 1988, following the emanation of DPR 915/1982 [47], a containment diaphragm (polder) was built along the entire perimeter of the landfill of 5,423 meters and 161 hectares of surface cement-bentonite for a depth varying between 8 and 48 meters and a thickness between 80 and 100 cm, amortized to the gray-blue clays [48]. The third containment system designed from 2008, provides for the construction of the landfill cover (*capping*) by subdividing it into four areas with graduated interventions in relation to the condition of settling and the period of cultivation of the ten lots in which the landfill is divided. At the top of the site, a biogas emulation plant was built, consisting of 1,450 catchment wells connected to a treatment plant. The leachate present in the landfill is extracted, either by condensation following the cooling of the biogas, or by a drainage network placed on the bottom of the landfill. However, after 2007, leachate is stored in stainless steel tanks and delivered to treatment plants outside the site [46]. Over the years, in the south-west of the landfill, close to the refinery, the ditch of Rio Galeria and Via di Malagrotta, on an area of about 28 hectares were built some plants connected to the waste cycle managed by the Consorzio Laziale Rifiuti (Co.La.Ri). These are two plants for the biological mechanical treatment of waste (TMB) called Malagrotta 1 and Malagrotta 2, a gasifier for waste derived fuel (CDR) in addition to a plant complex consisting of generators and turbines that use biogas and syngas (derived from the gasification process), for their recovery for energy purposes. The aim of the promoters is to produce fuel from the dry fraction (paper, plastic, glass, inerts, etc.) produced by the two plants (TMB) through a high temperature gasification process with oxygen, to produce electricity from biogas and syngas, and to use part of the stabilized organic fraction (SOF) to cover the landfill (*capping*). Adjacent to the site in the north, outside the *polder*, finally, there is an area called “Head of dog” of a total of 25.8 hectares of which 13.8 used for the construction of an experimental plant, used for the treatment of SOF seized in 2012 for technical and administrative irregularities and for the presence of pollutants in the subsoil.

**Tab. 1**: Area of former landfill, waste cycle related facilities, and extension area

| *Ex-landfill area* | | | *Waste cycle plants and extension area* | | | Total |
|---|---|---|---|---|---|---|
| Basal area (*) | Capping area | Total (Polder 1988) | Waste cycle plants (**) | Area named “Head of dog” | Total | |
| ettari | ettari | ettari | ettari | ettari | | ettari |
| 47.0 | 114.0 | 161.0 | 23.2 | 25.8 | 49.0 | 210.0 |

(*) Area inside the polder. (**) Area outside the polder.

### 3.1 The impact of the landfill on the environment and local communities

Since 2004, the Malagrotta landfill has been the subject of intricate legal proceedings and, in 2016, the opening of a European pre-infringement procedure (Pilot 9068/2016/ENVI) for alleged violations of

Directive 1999/31/EC [49] in relation to the requirement for mechanical biological treatment (TMB) of waste prior to landfill. The dispute at the heart of the dispute concerned, among other issues, the verification of the impact on the environment and human health of the landfill with regard to the pollution of the site and the necessary remediation and safety measures. In this regard, the groundwater monitoring campaigns in the landfill area launched between 2003 and 2009 by the Regional Environmental Protection Agency (ARPA) Lazio, have detected a state of widespread contamination of groundwater, internal and external to the site for metals and organic pollutants, exceeding the limits set by Legislative Decree 152/2006 [50]. In 2013 a study promoted by the Eras Lazio program, extended to the south-west sector of the city including the landfill for a total area of 5,000 hectares and 85,000 residents, highlighted risks «for respiratory diseases, cardiovascular diseases and for some forms of cancer» [51]. In 2014 a special commission, including some teachers of the Polytechnic of Turin, charged by the Council of State to verify the environmental conditions of the site, has substantially confirmed the need to put in place all the necessary measures for the remediation of the site and the fight against pollutant emissions into the atmosphere. To these reliefs are added the vehement protests of the inhabitants and associations of citizens who have been fighting, for many years now, against the settlement in the area of new activities dangerous for man and the environment and the reclamation of the site of Malagrotta, highlighting how in the field already impact several industrial plants at risk of major accident partly subject to the discipline referred to in D. lgs 105/2015.

### 3.2 The government project

To address the complex issues related to the reclamation and security of the site of Malagrotta and not incur the sanctions of the European Union for which Italy has already paid from 2014 to 2019, about 275 million euros [52], in 2022, the Council of Ministers appointed a Government Commissioner with the task of carrying out all the necessary measures to adapt the site to current legislation. With Law 13/2023 were allocated 250 million euros from the Fund for Development and Cohesion programming period 2021-2027. The project, defined in recent months with special tenders prepared by the same Commissioner, is divided into two contracts integrated one of 150 and the other of 100 million euros, they provide for the implementation of the package of insulation cover (temporary *capping*) with installation of biogas and leachate emulation systems, the realization of the final cover (definitive *capping*) without the use of the stabilized organic waste fraction (SOF) the construction of a new plastic confinement diaphragm of the landfill (*polder*) with a length of 6.3 km and an average height of 35 metres, as well as the treatment of percolating liquids and biogas, with environmental monitoring of pollution sources. The government commissioner has guaranteed that the process of recovery and rehabilitation of the landfill will be timed by a precise timetable to reach the end of the work by 2025.
However, some issues relating to the application of the rule on prevention and remediation of environmental damage have already been highlighted [53] based on the «polluter pays» principle. In this specific case, it should be the ownership company, from 2018 in judicial administration, who should pay the reclamation, and not the community. In this regard, one of the possible solutions could be the one that provides for the acquisition of the landfill and the associated plants to the public heritage, opening up the complete re-use of the site for public and general purposes and, therefore, as is the case in the rest of the world, a process of ecological-environmental, social and economic regeneration of the area.

### 3.3 The Masterplan. Between best practice and experimentation

In this context of reference the project exercise planned in the Urban Planning Design Laboratory of the Faculty of Architecture of Rome (A.A. 2022-2023) held by the writer, develops for the entire territory of the City Hall XII of Rome Capital an integrated and multidisciplinary approach, iterative and interscalare, aimed at producing high levels of quality urban, environmental, energy efficiency and circularity of resources. In particular, the project developed by the group of students: Maria Francesca Perdum, Sofia Picone, Lucrezia Piervincenzi and Livia Pirau, provided an opportunity to concretely experience the disciplinary innovation with regard to the Malagrotta landfill regeneration project closely related to the promotion of an efficient, smart and green city.
In line with current legislation [50] [54] [55] and with the existing government project, the project proposal (Masterplan) focuses its attention on the start of an ecological regeneration process-environmental, social and economic aspects of the site considered in its close relationship with the surrounding area in which the former landfill could play an important role as a hinge between the abandoned quarries and the building to the east, the former refinery and the state nature reserve of the Roman coast to the west including the Site of Community Importance “Macchia Grande di Ponte Galeria”.
In this perspective, the first phase of the project involves actions aimed at the network construction of the environmental system with particular reference to the transformation of the former refinery into a productive, technological and playful park [31], the recovery of disused mining areas aimed at recreational use, the relocation of scrappers with the environmental restoration of the affected areas,

the recovery of farmhouses and pre-existing historical-documentaries, the creation of connection routes and landscape-environmental use, the construction of ecological-environmental corridors and, on the regulatory level, the extension of the ecological network of the Prg of Rome '08.
The second phase of the project involves the remodelling of the environmental landscape of the landfill aimed, partly for public use and, in part, the production of forms of energy from renewable sources linked to a circular economy that can also provide multiple ecosystem services improving local biodiversity. Drawing on some national and international experiences of recovery and redevelopment of landfills, the analysis of which is part of this contribution, the project hypothesis is divided into seven lines of action:

- the first concerns the prefiguration of a ring-shaped park at the base of the site, outside the capping areas of the landfill, consisting of green areas equipped with cycle paths, parking areas with charging stations and public services, for a total of about 54.4 hectares, a tree and shrub density respectively equal to 50 trees/hectare and 60 shrubs/hectare (plane tree, eucalyptus, elm, oak, broom, lavender, strawberry tree, etc.);
- the second concerns the prefiguration of a park located on the southern summit of the site adequately accessible by means of appropriate zigzag cycle paths capable of overcoming the slopes of the steps. The park will consist of life paths, stopping points , ponds with recreational function and accumulation of rainwater, meeting spaces for events, for a total of about 30.6 hectares, an arboreal and shrub density respectively equal to 40 trees/hectare and 50 shrubs/hectare (poplar, robinia, willow, broom, lavender, etc.);
- the third concerns the provision of two areas for new Short Rotation Forestry (SRF) productive and energy plants, using fast-growing forest species and the absence of chemical treatments [56] [57]. The first includes the planting of annual oil crops (soya, rapeseed and sunflower), which can also characterize the landscape during the flowering period, for a total of about 44.6 hectares and a density of up to 10,000 plants/hectare. The second involves the planting of ligno-cellulosic crops (poplar, robinia, willow, etc.) for a total of about 38.6 hectares and a density of up 700 trees/hectare. The choice of tree and shrub essences to be planted, especially for the second and third line of intervention, took into account some characteristics such as belonging to native species, resistance to water stress, the surface root system and the ability to intercept and absorb the pollutants present in the soil;
- the fourth the prediction, in the area called "Head of dog", after remediation and removal of pollutants, of a plant for the phytopurification of leachate in situin that can also reduce the environmental risks related to transport, and the costs for its disposal at authorised centres, totalling 13.3 hectares;
- the fifth foresees, the realization the construction of two systems agrivoltaici. The first of 1.0 MWp power, at the service of local communities (about 300 families), takes advantage of the facilities offered for the development of "renewable energy communities" [58]. The second concerns the installation of a plant serving the site of power equal to 2.6 MWp. Both plants will be installed on the northern summit of the former landfill for a total area of about 6.0 hectares;
- the sixth concerns the physical-functional reconfiguration of the area now occupied by the plants related to the waste cycle along the road to Malagrotta. In this regard, the project is part of a waste management strategy that includes increasing separate collection, improving recycling, energy recovery and reducing landfills. A process that should gradually lead to the final closure of the TBM plants and the gasifier (defined by the same unreliable property and malfunction), returning part of the area, public services and uses related to material recycling (with particular reference to the practices of "digital business transformation" [59]) for an area of 15.1 hectares, and for the remaining part, equal to 13.4 hectares, the construction of plants for the treatment and treatment of biogas and biomass produced by SRF in energy and biomethane. A solution, the latter, that could include the construction of a co-trigeneration plant powered by biogas capable of producing energy (electric, thermal, refrigerator, as well as biomethane) to serve neighboring settlements. In particular, the adaptation of biogas to biomethane is, in the current geopolitical crisis that requires an acceleration of the processes of diversification of energy sources, a technology of great interest because, it allows the introduction of biofuels into the gas network [60];
- the seventh, finally, provides for the crossing of the landfill through the construction of a road connection between Via del Casale Lumbroso and Via di Malagrotta designed primarily as an element of landscape perception of the site.

A project, therefore, which, starting from the government guidelines, broadens its scope and content with the aim of making local communities participate and main beneficiaries of the regeneration process creating the conditions for the former landfill site of abandonment, environmental and landscape degradation, become a symbol of rebirth for the territory and for the entire city. As a result of the Masterplan Roma Capital will count on a heritage of areas for park and public services equal to 85.0 hectares with the planting of almost 31,000 trees (including ligno-cellulosic energy crops) and 4,800 shrubs in addition to about 446,000 oil plants. However, it is not a traditional park. The presence almost everywhere of plants for the capture of biogas and leachate, energy crops, agrovoltaic plants,

phytodepuration swamps, along with the continuous settling of the hills of waste, draw a unique landscape, it will need to be monitored to assess its impacts for several decades.

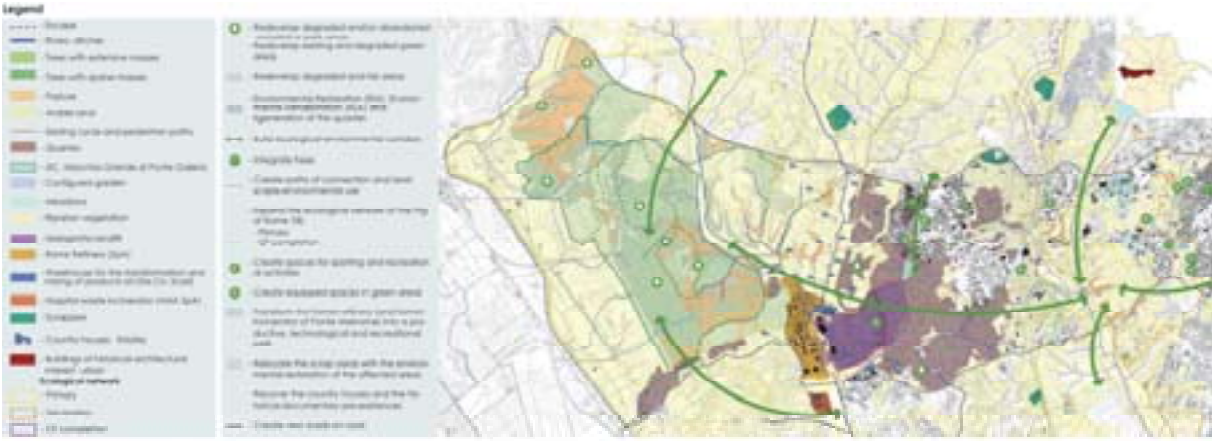

**Fig. 1:** Rome, City Hall XII (part). Environmental system: Map of objectives (Elaboration by Maria Francesca Perdum, Sofia Picone, Lucrezia Piervincenzi and Livia Pirau).

**Tab. 2:** Masterplan of the former landfill of Malagrotta. Surfaces by functional distribution

| *Short Rotation Forestry (SRF)* | | *Park areas and public services* | | *Waste cycle plants* | | Agrivoltaic plant | Phytopurification plant | Total (**) |
|---|---|---|---|---|---|---|---|---|
| Ligno-cellulosic | Oil crops (*) | Annular park | Summit park | Area for recycling of materials | Area treatment biogas and biomass | | | |
| ha | ha | ha | ha | ha | ha | ha | ha | ha |
| 38.6 | 44.6 | 54.4 | 30.6 | 15.1 | 13.4 | 6.0 | 13.3 | 210.0 |

(*) Cultivated area including the part at the base of the agrivoltaic plant. (**) Area does not include the agrivoltaic plant.

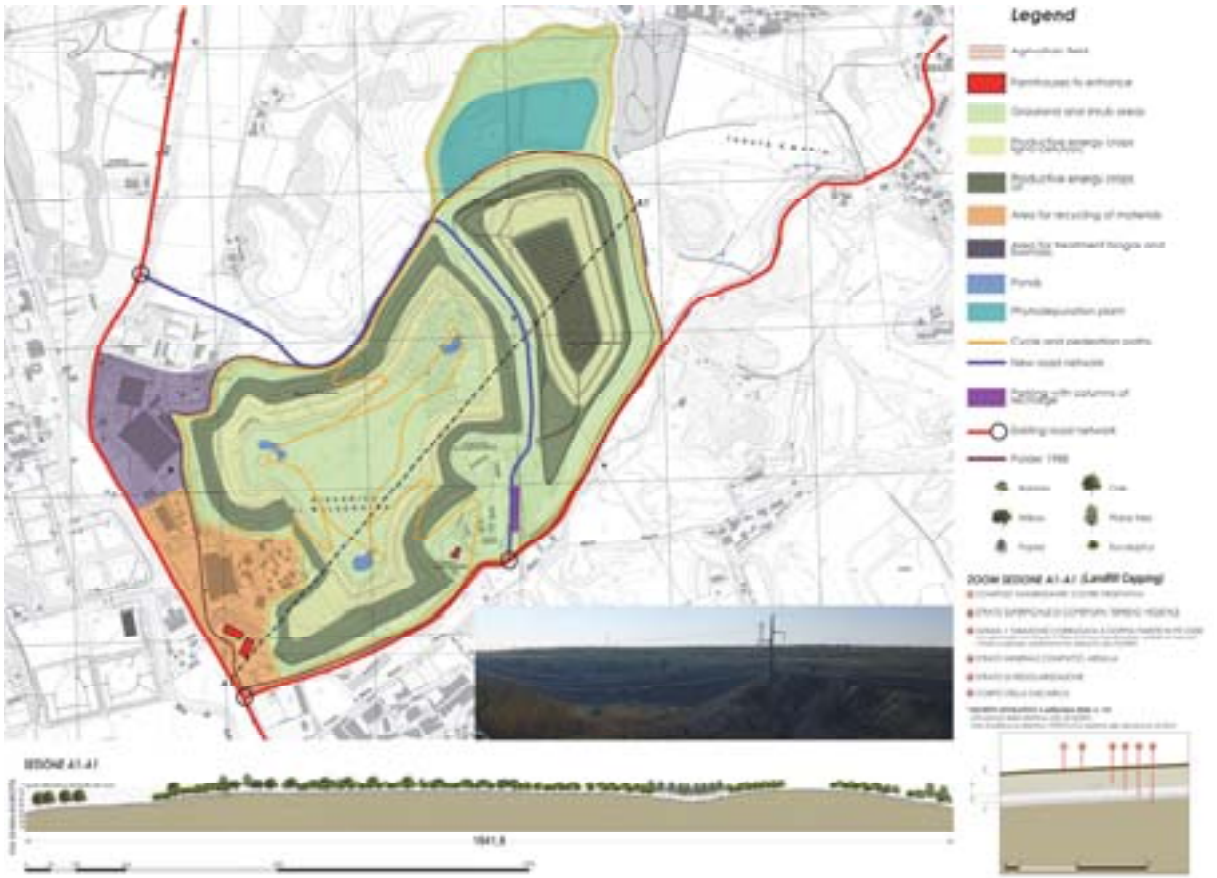


**Fig. 2:** Masterplan of the former landfill of Malagrotta (Elaboration by Maria Francesca Perdum, Sofia Picone, Lucrezia Piervincenzi and Livia Pirau) (Photo by Francesco Crupi).


**Fig. 3:** Masterplan of the former landfill of Malagrotta. The landscape design (Elaboration by Maria Francesca Perdum, Sofia Picone, Lucrezia Piervincenzi and Livia Pirau).

## 4. Concluding remarks

Although not exhaustive of the complexity of the issues that the theme of recovery and regeneration of abandoned landscapes, or polluted, raises in the current public and theoretical-disciplinary debate, the reflections carried out, the analyses and the proposed project experimentation outline a very framework complex, rich and articulated from which it emerges strongly the overcoming of the objectives of the only restoration and the environmental restoration - essential and priority operations to ensure respect for the environment and human health - towards regenerative processes of collective reappropriation able to configure new landscape projects, to counteract the dissipative dynamics in place, to prefigure new spatial configurations, economic and energy cycles, restoring with nature-based solutions (Nbs), biodiversity and the quality of fundamental resources.

In particular, the *Masterplan* for the environmental and socio-economic regeneration of the site of Malagrotta shows how the implementation of sustainable and resilient strategies that aim to reconnect communities and territories while keeping development together, environment, innovation and social inclusion, can strengthen the sense of belonging of the communities established in the territory, trigger growth processes and have effects on the health and well-being of citizens, finally bringing the entire urban sector out of an ancient condition of degradation, marginalization and isolation. Approaches that also attach great importance to the active participation of citizens, communication and promotion of creative companies able to implement practices for the use of alternative energy, environmental education and awareness-raising programmes on circular and green economy issues for the right to a desirable future against any risk of *greenwashing* [61].

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## Notes

(1) The special hospital waste incineration plant, owned by AMA SpA, is located in Ponte Malnome, south of the Malagrotta landfill. Active since 1996 it was shut down in 2015. Currently it carries out transfer activities of expired drugs and abandoned used syringes. From 1964 to 1983, the site hosted Rome's first municipal solid waste disposal and processing plant.

(2) The Refinery of Rome Spa is an industrial complex of about 97 hectares, since 1965 destined to the transformation of the crude oil in various combustible products and fuels (LPG, gasoline, kerosene, diesel, fuel oils), now exclusively used as fuel deposit.

(3) The Common Depot (De.co. Scarl) is located north of the Malagrotta landfill and carries out activities of reception, transit, storage, storage, processing and mixing of petroleum products. The depot consists of 4 pipelines for fuel handling from the Rome Refinery.

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# The existing building as a source of energy: proposal of a method for the development of operational procedures for reuse

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**Abstract**
In the last decades the strategies of waste recovery are at the center of the legislator's reflections for the transition to a circular model. At the same time, the need for urban densification compatible with today's environmental requirements entails the risk of functional and socio-economic obsolescence of the existing building stock.
While the principles of design for disassembly are beginning to be increasingly integrated into the project process, for existing buildings, designed with technologies that did not provide for disassembly operations, this practice can encounter economic and technical barriers.
To define a reuse management model for the existing building, thus reducing the technical obstacles, we rely on the concept of embodied energy, defined as the difference between the energy required by all the elements that make up the building and the energy obtained by their valorization at the end of life. This definition poses problems when the analysis must be extended over time intervals in which significant technological evolutions have taken place. Overcoming these difficulties require a revision of the relationship between elements and building to assess the energy that can be extracted from the building through an appropriate set of procedures at the given time.
This article proposes a method for the development of operational procedures capable of increasing the potential of reuse as a system of exploitation of the energy incorporated in the existing buildings.

**Keywords:** Potential reuse, embodied energy, selective demolition, existing building, deconstruction.

## 1. Introduction

The phenomenon of urbanization is growing on a global scale. Today, almost 60% of the population lives in cities; according to the World Cities Report, the urban population trend has been growing since 1990 and is expected to continue to increase by 2050 [1]. To cope with the increasing population of cities, local policy strategies are basically twofold: densification within the old city walls or peripheric expansion in areas close to the big cities [2].
The sustainable development and the transition to circular models are leading to a search for solutions aimed at urban regeneration. To achieve these objectives, one option is the demolition of existing buildings and the replacement by new constructions [3]. As a result, the phenomenon of urban densification is often associated with the obsolescence of existing buildings that are no longer able to meet today's functional and environmental needs [4].
Thus, although urban densification could represent a way to sustainability today, urban densification strategies lead to an increase in construction and demolition waste.
The term "C&D waste" refers to solid waste from construction (DC), renovation (RW) and demolition (DW) activities [5]. Since the 2000s, international strategies and EU policies have increasingly focused on the development of circular resource models that encourage the reuse and recycling of materials in a waste-as-a-resource approach [6-9]. Several research projects are currently being conducted on the quantification of C&D waste and possible reduction strategies [10].

Focus on possible actions at the end of the building's life, directive 2008/98/EC builds a waste hierarchy according to the degree of sustainability: prevention, reuse, recycling, energy recovery and disposal.
This hierarchy emphasizes that the legislator's intention is firstly prevention, i.e. measures that are taken before a product or material becomes waste in order to maintain it in its present state. Reuse indicates any operation that allows a product or component, which is not waste, to be reused in the same original use. Recycling indicates operations that provide for material waste to be transformed into products and materials that may not have the same original use. Energy recovery refers to any operation that enables waste to generate energy, in the form of electricity, heat or fuel. Disposal is any operation that is not recovery [11-12].

In the literature, different methods for the transition to a zero-waste strategy are studied. The aim is to support stakeholders in this process by facilitating decision making.
Today, it is necessary to develop an informed process capable of supporting production and research in the field of construction to place the building in a circular, continuous, and controllable model, from its design to its valorization at the end of life, from its optimization to its intelligent operation.
Based on these principles, design for disassembly (DFD) is now beginning to be more integrated into the design process of new buildings [6]. Despite this, only 1% of the buildings are completely disassembled. As a result, deconstruction sites are still not widespread [16].

In this paper we are interested in the reuse of building components from deconstruction sites providing for selective demolition. For this purpose, it is important to define these terms.
Deconstruction, or "construction in reverse", is the selective dismantlement of building components [15]. This practice may encounter later barriers if we consider existing buildings, built with technologies that did not foresee disassembly operations [11].
The barriers to be explored and which slow down the practice of reuse are:

- economic - loss of value of the recoverable elements with respect to the new construction techniques.
- technical - lack of information relative to the elements and their states; difficulty on temporality of the demolition and reconstruction sites and necessity of storage; lack of knowledge of the technologies used.
- regulatory - unclear legislation in terms of certification of re-used parts.

## 2. Embodied energy and reuse potential

To define a reuse management model for the existing building, thus reducing the technical obstacles, we rely on the concept of embodied energy, defined as the difference between the energy required by all the elements that make up the building and the energy obtained by their valorisation at the end of life.
The concept of embodied energy refers to the life cycle of an element. The life pathway of an element is a function of time. The assessment of embodied energy at given time therefore depends on assumptions about unknown future events based on predictive models and relies on knowledge of construction methods from different periods. This can be problematic when the analysis must be extended over time intervals in which significant technological evolutions have taken place. This problem is relatively less impactful when assessing the embodied energy of buildings in the project state, based on the DFD.
To overcome this problem, in this research we rely on a revision of the relationship between the elements of the construction and the building. We define the elements as units of the construction, of different nature (a material, a set of parts, structural components or...) identifiable throughout the analysed process - without reference to their intrinsic nature.
The building is defined as a provisional association of elements, which have their own pathway in their life domain. The set of these elements constitutes a partition of the building.
The term "association" of elements in a building refers to the system of connection between elements, by assembly or aggregation. An example of an assembled system might be that of timber or steel frames, an example of an aggregation system might be the column-beam node of a concrete structure.
The revision of the definition of the elements-building relationship allows us to overcome the time dependency to quantify the embodied energy.

In this research, reuse is defined as a system for exploiting the embodied energy of the existing building. The reuse potential is then the energy value that is possible to recover from the building, imagined as a stock of elements that have just been produced and not associated, to insert them in a circular process.
Other definitions of reuse potential exist in the literature and refer rather to a measure that expresses the probability that parts of an assembly can be "disassembled simply, quickly and without damage, and thus reused" [17].

To carry out an analysis of the reuse potential based on the given definition, we choose an arbitrary reference state (*r*), close to the current state, in which the elements are imagined as if they had just been produced and not associated in the building.
The concept of "free embodied energy" is introduced by [18], based on an analogy with the second principle of thermodynamics. Starting from this concept, we propose in this paper a method to evaluate the available embodied energy of building components.
We rename the "available embodied energy" the energy that is possible to recover at the given moment, reference state, through the appropriate selective demolition procedures in a deconstruction site. This allows us to overcome the limitations of a time-dependent assessment.

The available embodied energy ($EEA$) is defined as the difference between the sum of the energies needed to produce all the building elements in a non-associated situation - this is a not-real life-pathway, calculated in the reference state ($Ec_r$) - and the energy required for the selective demolition operations, allowing the building elements to pass from the current state (associated) to the reference not-associated state ($Ed_r$) (Fig.2).

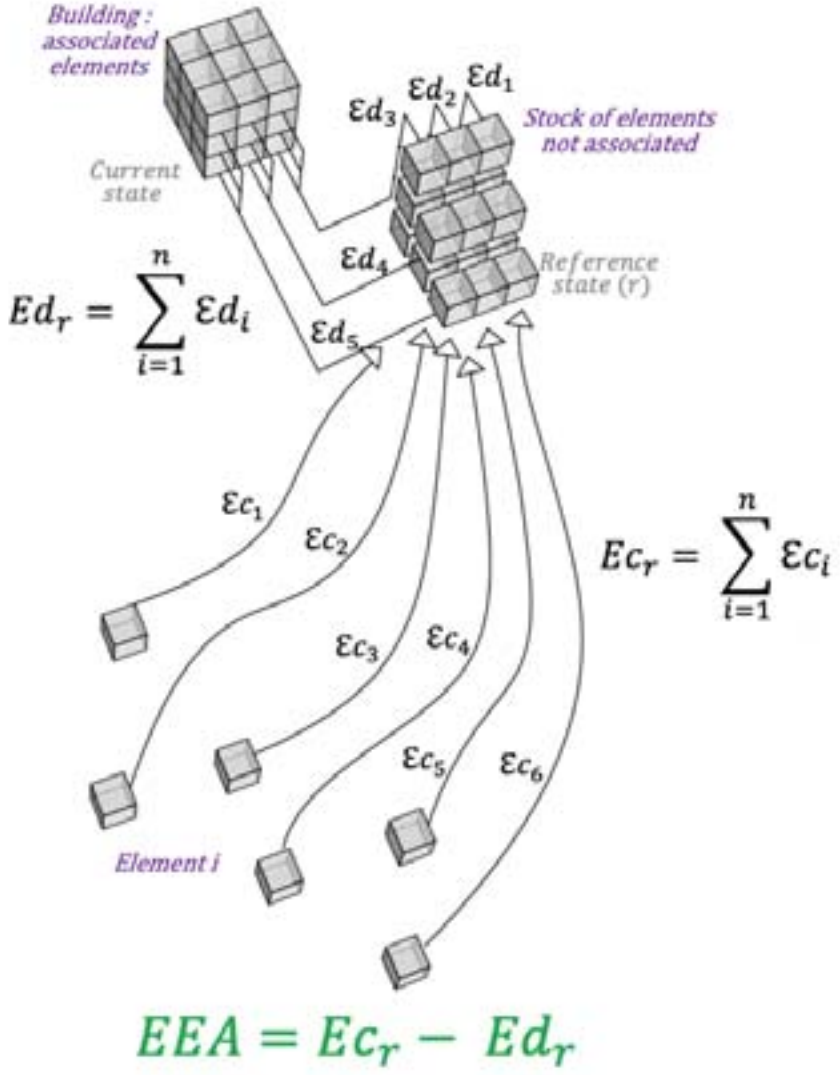

Fig. 2: Methodology for evaluation of available energy embodied EEA.

The term $\varepsilon_{ci}$ indicates the energy that is required to obtain an element *i* in this state if it were manufactured today. Among the possible fictitious paths in the life domain of each element and available by the context, we choose those able to minimize the required energy.
This calculation can be done with LCA methods stopped at the reference state, without projecting too far into the future. This assessment is carried out at the construction stage (module A1-A3 of NF EN 15804).

The term $\varepsilon_{di}$ indicates the energy required for the deconstruction path of the element *i*.

The definition of the selective demolition path implies the study of the necessary operational procedures to be performed. The next paragraph presents the method and the operational procedures associated with each phase to evaluate the overall selective demolition energy $Ed_r$.

## 3. Method and operational procedures

Based on the concepts and procedures proposed by Brocato et al. [18], we present here a method for the analysis of the reuse potential and the necessary procedures for the selective demolition process.

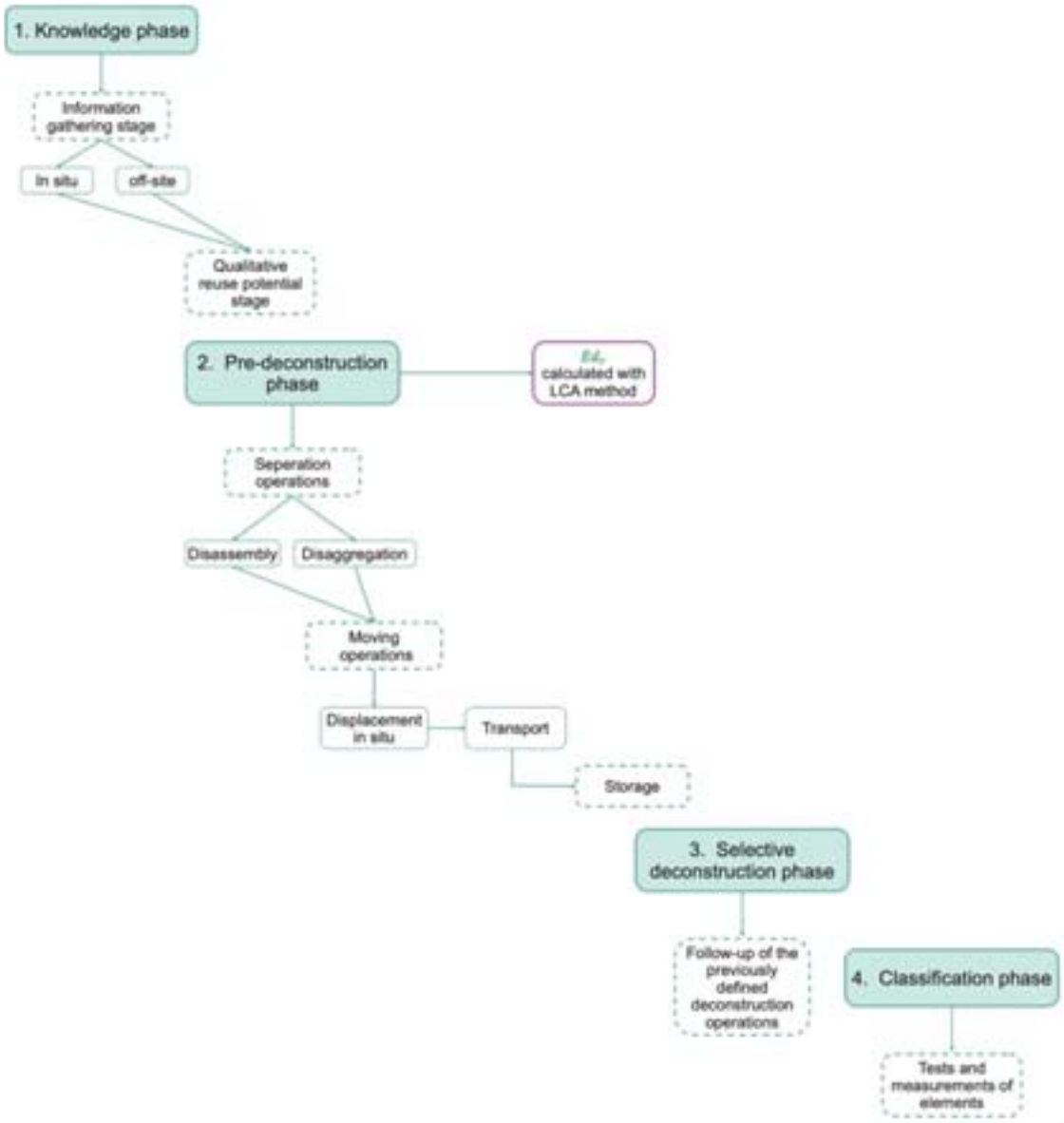


Fig. 2: Method for the analysis of the reuse potential and the necessary procedures for the selective demolition process.

### 3.1. Knowledge phase.

This phase is fundamental because it allows the collection of the necessary information on each element (information gathering stage) and the identification of the elements that can be reused according to the typology and the period of construction (qualitative evaluation stage of the reuse potential).

The information gathering stage can be conducted both in situ and off-site. The off-site data acquisition includes a documentary search to find plans, sections, elevations and any existing drawings or models of the building. For recently constructed buildings an informed BIM model may exist, for older buildings the information is often out of date.

The acquisition of information in situ allows the collection of geometric, material, structural and technological information. Today there are various digital tools that facilitate data acquisition and increase the accuracy of the survey. 3D scanners can be used to recover geometric information in the form of a cloud of points which can then be meshed for the precise reconstruction of a 3D model, possibly enhanced by physical data. Photogrammetry allows digital surveys to be carried out from photographic images. Recognition algorithms allow the integration of information concerning the characteristics of the elements from the photographs into a 3D model.

Once the information has been collected, the qualitative identification of the potential for re-use can be carried out. Since the existing building was not designed with technologies that foresaw the possibility of re-use, the classification of the elements is based on physical criteria and not procedural (predictable or immediately applicable).
The criteria are based on the analysis of topological, geometrical, typological, mechanical, and chemical properties. Opposing factors can be identified and a qualitative scale of assessment can be defined ranging from 10 (favorable to any reuse operation) to 0 (unfavorable to reuse).
The Fig.3 shows the factors that can be taken into consideration and examples applied to a building.

| Properties | Opposing factors | Examples |
|---|---|---|
| Topological | concentration<br>dispersion | concrete slab<br>cabling |
| | uniformity<br>multiplicity | window<br>tiling |
| Mechanics | structural<br>non structural | beam<br>insulating material |
| | resistance<br>weakness | beam<br>moquette |
| | ductulity<br>fragility | linoleum<br>tiling |
| | versatility<br>specialization | sheet metal panels<br>tiles |
| Technological | assamblage<br>aggregation | metal frame<br>reinforced concrete column-beam joint |
| Geometric | compactness<br>dispersed | reinforced concrete beam<br>electrical wire |
| | tolerance<br>accuracy | cabling<br>joinery |

Fig. 3: List of criteria and opposing factors for qualitative reuse analysis of elements.

### 3.2. The selective pre-deconstruction phase.

In this phase, for each element and according to its position, we construct a list of operations to be carried out to make it available; for each operation, several indicators are given: the time of the operations, the throughputs, the tools and machines, the manpower required, and the forecast storage volumes.
The selective pre-deconstruction operations are classified into two categories: separation technologies and displacement technologies.

Separation can be of two types:

- disassembly, which consists of dismantling a system that was originally intended to be assembled. This category includes, for example, the operations necessary to disassemble structural elements of a wooden frame.
- disaggregation, which consists of disassociating elements that did not provide for procedures that can be reversed. For example, the column-beam node of a concrete structure that was originally cast on site.

The moving operations are related to the dimensions of the separate elements. The issue of element dimensions has two main critical factors. The elements must be of a size that is compatible with the new construction project with the re-used elements; the dimensions of the elements must also be compatible with the technologies and prices of the relocation operations.

To perform this analysis of selective deconstruction operations, a reverse BIM model can be created. This is a digital twin of the building that contains the physical information of the elements and their

locations. This allows the organization of the selective deconstruction operation stages to be digitally managed by identifying the optimal fictitious path, while also looking out for geometric incompatibilities, risks and potential damage in the disassembly and relocation operations [21].
Using reverse BIM can contribute to reduce the construction impacts, improving site operations, and making parts and processes on purpose.
The last step is the storage operation, which can be done on site or at a medium to long distance site. Transport to the storage site or to the new construction site must also be considered.

These operations are then analyzed with LCA software. An assessment at the end-of-life stage of the elements is conducted (module C1-C4 of the NF EN 15804 standard). The sum of the assessed impacts gives a global evaluation of the $Ed_r$ energy.
At the end of this stage, it is possible to evaluate the available embodied energy $EEA$ of all the elements of the building in its current state according to Fig.1.

### 3.3. The selective deconstruction phase.

This selective demolition phase foresees the follow-up of the previously defined deconstruction operations (pre-demolition phase). When the operations follow each other, it is possible that the previously defined steps cannot be deployed, because of the subsequent information collected only during site operations. The presence of a reverse BIM model could facilitate the process, particularly concerning information integration throughout the project and execution of work, controlling site operations to the smallest detail, and giving the possibility to switch production from “on site” to “out of site” and conversely.

### 3.4. The Classification phase.

This phase includes the analysis of the disassociated elements *in situ*. This involves carrying out tests (mechanical principle) and measurements on their condition. This will allow the implementation of information on the possible conditions of re-use in the digital model or to classify them as recyclable waste or to be recovered according to the classification defined by the [12].
The information collected can also be stored in the elements, thus allowing the information ‘moving’ with the elements. One possibility is the implementation of a barcode, such as that used in organized retailing. Scanning the barcode attached to each item allows access to the database which contains all the information about the item.
Another possibility is the use of Radio frequency identification (RFID). This consists of a tag capable of storing the information and a reader which, thanks to the radio frequency, can read the information. The advantage of this solution is that RFIDs allow both the storage of information - without the need for a database - and the ability to trace the items.

## 4. Discussions and conclusions

The proposed reuse potential process, based on the concept of available embodied energy, is based on two impact assessments (LCA module A and LCA module C1-C4). It allows us to evaluate the available embodied energy without considering the time dependency, a concept whose limitations we have explained. It should be noted that the assessment of the available embodied energy, calculated according to the proposed method, depends on the nature of the demolition work and the planned techniques. This concept then incorporates the limitations and errors of the operational procedures that allow for its release.

The advantages of such an evaluation lie in the potential value of the existing building. Today, deconstruction projects involving selective demolition are not very common, mainly because of the loss of value of the reuse elements in relation to new construction techniques. The ratio between reuse value and recovery cost is more towards the latter. The preservation of reuse value could be increased by the implementation of an informed process as presented above. Correctly organized operational procedures and the deployment of correct selective deconstruction techniques could lead to an increase in the value of the elements and a reduction in the costs of the site.

With this method, a mapping the available embodied energy at the urban scale can be carrying out. This could also help the practice of deconstruction by providing an overview of the urban reuse potential and lead to an urban planning policy that integrates this data in the process.
This approach was presented for the city of Paris (Fig.4). Maps of water, electricity and petrol consumption have been created for reinforced concrete buildings from the 1940s to 2000s. They make it possible to identify the potential for reuse by homogeneous zone [18].

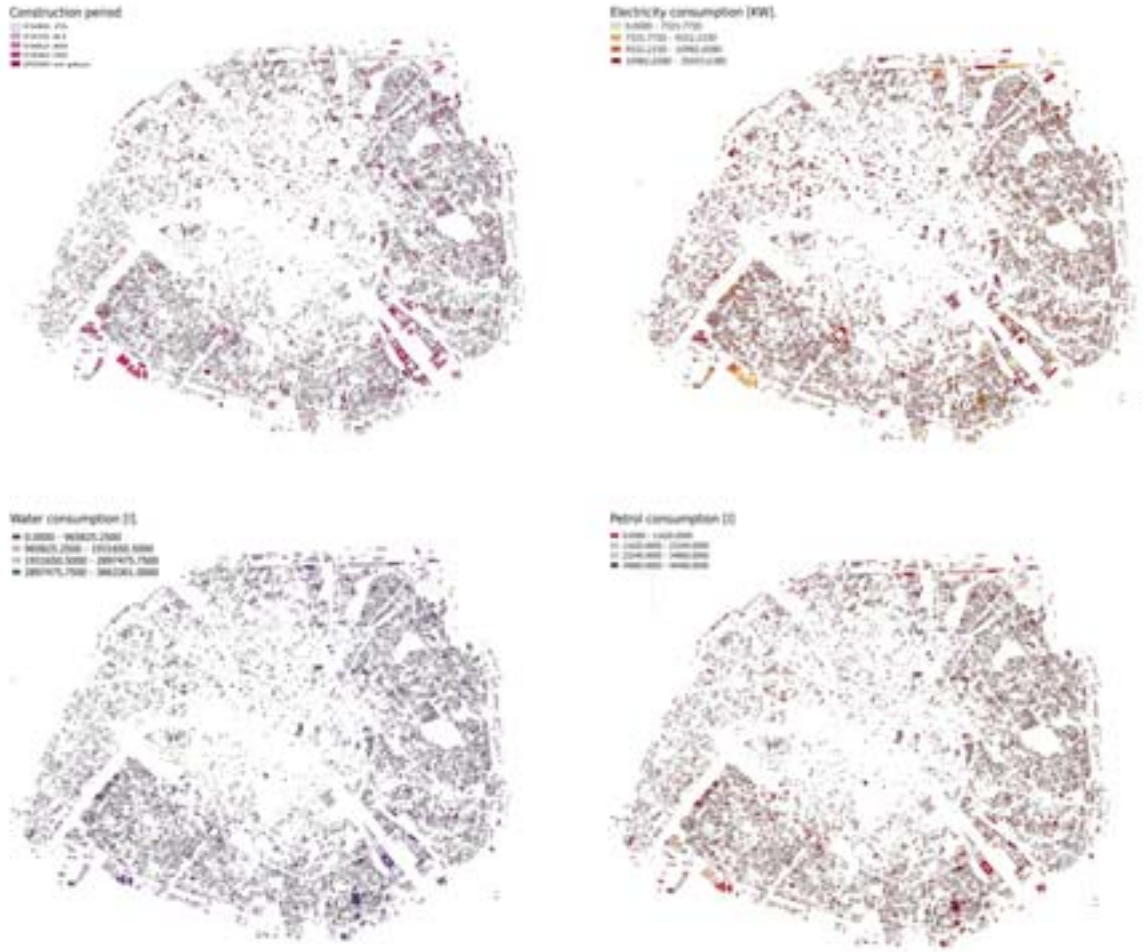


Fig. 4: Map of existing buildings in the city of Paris after 1940 (top right). Maps of the evaluation of the electricity consumption necessary for selective demolition (top right) water consumption (bottom left), petrol consumption (bottom right) [18].

Future developments are planned to present the assessments of the reuse potential with the proposed methodology applied at the building and city scale on case studies.

The transition to circular models can be achieved if a paradigm shift takes place. Information technologies offer today possible developments in this field thanks to the continuous flow of information that can ensure. The integration of data (environmental, energetic, mechanical, logistical) in the process of architectural design of new buildings - which foresee the use of reused elements - is essential for such an approach to become a possible future.

## 5. Acknowledgements

We would like to thank the late Maurizio Brocato, professor at ENSA Paris Malaquais and director of GSA laboratory between 2016 and 2023, for his considerable inspiration and research that made this work possible. This paper is the continuation of his research work on reuse elements in construction fields, developed in collaboration with researchers of GSA laboratory of Architecture School Paris Malaquais.

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# Genua Picta 1982-2023

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## Abstract
In 1982 the conference-exhibition entitled Genua Picta - Proposal for the research and recovery of painted façades was held in Genoa, which launched the systematic study of the survey and restoration of the pictorial decorations of the façade also opening up to the various aspects of intervention planning involving various local authorities: the Ministry of Cultural Heritage, the Cultural Heritage and Activities sectors of the Municipality of Genoa and the Liguria Region, the Faculties of Letters and Philosophy, Architecture, Science and Law of the University of Genoa, giving ample scope to the intervention proposals that took into consideration all the aspects related to the theme in question.
Thirty years after the Conference, the theme of color in architecture in historic centres, its recovery and enhancement remains an administrative and cultural emergency.
In Genoa in the 1980s, around 100 very damaged painted façades were identified, of which only forty still appeared with legible chromatic and graphic traces which were then investigated through a targeted filing investigation. This contribution presents a study on the current state of the never cataloged painted architectural heritage of the historic center of Genoa, using as an example the methodological approach of integrated survey, filing and restitution in the case study of the buildings in Piazza Pinelli.
This study stands as a creative and interdisciplinary initiative for enriching, sustainable and inclusive practices that concern general appearance of a city.

**Keywords:** painted façades, cataloguing, integrated survey, SLAM/UAV technology

## 1. Genoa: painted city
Genoa's 'Painted City' concealed beneath the grey horizontal layers of slate roofing and historical stone paving.
In 1982, the Genua Picta Convention/Exhibition, proposed the theme of the practice and recovery of painted façades, opening a debate at an academic level that still cannot be considered completely resolved. The "Colombiane" in 1992, the Jubilee in 2000, the G8 Summit in 2001, Genoa European Capital of Culture in 2004 and the Conference on Colour, Architecture and Environment, also held in 2004 and organised by Patrizia Falzone, contributed in no small measure to the awareness and introduction, also through the opening of many building sites, of a sensitivity to the valorisation of the existing, fundamental for planning aimed above all at restoration of lost values - among which, for Genoa, colour is fundamental - that constitute the identity values of places.
Regional Law no. 26/03 "Città a Colori" (Coloured Cities) introduced regulations for the recovery of the chromatic values of the city's historic centres and suburbs, setting out real criteria for the drafting of technical-operative tools available to municipal administrations by appointed planners.
The practice of painted decoration in Genoa was born in the second half of the 15th century as a "unification tool" of the new urban building realities, the result of the transformations of the mediaeval fabric, with recasts, elevations, building mergers and with the construction of the new Renaissance buildings, a sign of the Genoese architectural renewal. Hence the Genoese façades become evidence not only of the succession of different craftsmen and decorative, design and colour typologies, but above

all of all those contents, tangible and otherwise, that are linked to the historical, political, economic and social events of the city.
In a hypothetical journey through the colours of Genoa, and above all the different decorative typologies to which they are connected, we can identify the Gothic type starting from the end of the 15th century with ogival arches with white and black ashlars to surround the real holes, hanging arches, small twisted columns and multi-storey turrets; the Lombard matrix with monochrome/bichrome portions emphasising a painted architectural framework that becomes architecture itself, with niches and mythological and armoured figures. Again, from the first half of the 16th century, the "narrative", celebratory decoration of façades with scenes and figures in the urban interventions of the new 16th/17th century axes of Via Garibaldi, and those on an Alessian decorative style, with the use of decorative ashlar partitions, pilasters and coupled columns, a plastic decorative type that will be the inspiration for numerous painted façades of buildings in the Historic Centre. This decorative façade tradition also saw its application in the hinterland, in the fabric of Villa di San Pier D'arena and Cornigliano in the West and Albaro in the East.
The painted façades of Genoa, concealed by the narrow streets of the historic centre, contrast with the immediate perception linked to privileged viewpoints of the coastal strip, with the colours of the façades brightly and spontaneously linked to the complementary highly saturated colour contrast, sometimes with a strong material valence. The same material/chromatic valence can be found in the late 19th and early 20th century examples, especially in the Coppedè style mainly in the Levante Genovese area, and in the early 20th century urban interventions such as Piazza della Vittoria and Piazza Dante with the colours of the stone cladding. As far as the 'neighbourhoods' of Genoa are concerned, in our opinion a distinction must be made between the historic settlements, already mentioned, in the West and East areas, which have partly retained those colour values that have characterised them over the years, and the massive interventions envisaged by the P.R.G. of 1980, especially in the area to the west of the city, where the flattening of colour contributes to a total "loss of recognisability" of the object in the area, excluding any kind of belonging to the place on the part of the users, and then the colour project can be seen as a tool for redevelopment and social regeneration, so to speak "low cost". The Department of Architecture and Design of the Polytechnic School of Genoa on these issues has a historical tradition of research and conventions precisely in the field of colour projects and the recovery of buildings with painted façades.

**1.2 Genua Picta: Contents and Cataloguing**
In the introduction to the book Genua Picta, Carlo Argan writes: "The objectives of the exhibition and congress are in essence: 1) the exchange of information between specialists who are directly or indirectly interested in the problem of works of art exposed outdoors; 2) the determination of unitary directives and methodologies for a planned and scientifically up-to-date protective action; 3) the appeal to the interest of the authorities responsible for the conservation of a heritage exposed to the danger of progressive and soon irreparable damage; 4) the constitution of a permanent scientific nucleus, made up of art historians and scientists, for the periodic verification of the state of conservation of the complexes of works, the ascertainment of the causes of degradation, the control of the efficacy and duration of restoration work, cataloguing and documentation."[1]
The contributions in the context of the 1982 conference address the themes of the image of the city, of the iconographies and meanings of painted decorations as messages from patrons, of the evidence for lost façades, of the painted structure: the treatise, local models, of the built city and painted city: an investigation into the survey and perspective structure, of the façades in the reading of travellers and guides, of the reading of documentation, views and surveys, and of cataloguing.
The image of the city is described by an historical-iconographic survey linked to the transformations over the centuries, which highlights the difficulty of visibility of the painted building texture enclosed between the city walls and the porticos of the Ripa Maris. The perspective diagrams with the viewpoints of the decorated fronts highlight the interpretation of the squares and open spaces as scenic spaces.
The same applies to the chapter Built City and Painted City: a research about the survey and the perspective structure investigated through perspective diagrams of the spatial enclosures and the study of the relationship between building and painted decoration through the graphic survey of the painted façades of the palaces: Antonio Doria (Spinola-Prefettura) in S. Caterina, Angelo Giovanni Spinola in Strada Nuova, Peirano between Piazza Valoria and Via Giustiniani, Squarciafico in Piazza Invrea, Vincenzo, Gio Giacomo and Gio Batta Imperiali in Campetto and Scurreria, and Interiano-Pallavicini in Fontane Marose.
Lauro Magnani in his symbolic narration of decorative commissions writes: "reading the iconographic frequencies found on the façades painted between the beginning of the 16th century and the first decades of the 17th century, certainly does not reveal the variety and thematic richness found in the contemporary decorations inside the palaces themselves: the subjects represented do however allow us to identify some specific directions of interpretation. A decorative-symbolic tendency is flanked by, and then triumphs over, a form of pictorial rhetoric, which in turn we will see divided into two tendencies:

a private rhetoric, a personal exaltation of the public role of the patron, and a 'regime' rhetoric, a choral exaltation of canonical themes in function of an image of the republican order - the political image of the city - to which the individual patron adheres". [1]
The chapters dedicated to the evidence for the lost facades and the painted structure, sees historical-iconographic research through treatises, the study of local models and in situ surveys, still an open topic that is however addressed with new advanced methods of direct and indirect research, which intends to deepen and broaden the research in the current study. The methods of investigation in the 1980s involved a quantitative and qualitative approach of mainly direct and traditional terrestrial photogrammetry. Particular attention is paid in this study to cataloguing, which was divided into five sections: Location and Identification; Historical Research; Technical Research; Conservation Status and Causes of Degradation. (fig.1)

| Locationa and identification | Historical esaerch | Technical Research | Conservation State | Causes of Degradation |
|---|---|---|---|---|
| Planimetric identification | Bibliography | Wall support | Chronology of restauration | Tehnological |
| Painted surfaces | Direct and indirect icongraphic sources | Coating sunstrate (layers and types of plaster) | Legibility of each painted façade, coexistence of colour and graffity | Environmental |
| Description of pictorial decorations | Changes in real estate ownwershio | Painted film | Illumination of painted façades | |
| Visibility | Building dating | Stratigraphic analysis | | |
| Correspondence of façade painting and architectural organism | Painted decoration dating | Chemical analysis | | |
| | Cronology of painted façades' interventions | | | |

**Fig. 1:** Summary of the cataloging presented for the Genua Picta conference.

Each form was accompanied, also in view of the exhibition related to the conference, by a graphic and photographic survey of the painted façade: 85 palazzi with external pictorial decorations present, even if fragmentary. The number of palaces with lost decorations, on the other hand, cannot be considered precise, as approximately eighty were identified.
I believe that in addition to the established preliminary investigations, of particular importance, also for current considerations, are the laboratory analyses that have identified the chemical-physical action of rainwater and the mechanical leaching of surfaces as the main cause of degradation, in addition to the damage caused by renovations and the consequent typological building-architectural transformations, which have also subsequently seen integral decorative renovations with arbitrary reinterpretations.
In preparation for the conference and exhibition, a number of painted façades were recovered that presented:
a) full visibility of preserved frescoes
b) fragmentary frescoes
In the figurative areas, the gaps were treated with mortar plasterwork matching the surrounding original parts, in order to achieve, where possible, legibility of the figurative texts without resorting to reconstruction. Where such legibility was not recoverable due to the extent of the gaps, the same procedure was also applied, which at least made possible a tonal unification of the parts with the whole. In this case, the gaps were treated by nailing, on the reintegration plaster, the outlines of the decorative and architectural motifs.
The interventions adhered to criteria of extreme caution. The debate at the time brought to light the different operational approach of technicians working in Central and Eastern Europe: façade decorations were repainted with the aim of preserving the typological and visual characteristics of the city over time.
*"In relation to these two opposing attitudes, Paul Philippot's presentation at the conference was particularly interesting. Speaking about the links between the critical problem and the technical problem in the restoration of painted façades, he observed, amongst other things that these belong to two figurative categories at the same time, possessing both a pictorial and an architectural dimension that are inseparable from each other and that, together, become part of the urban space.*
*The phenomena of deterioration may have deprived the façade decorations of this original meaning, which is only realised when the two dimensions converge for the realisation of the overall project. With this in mind, Professor Philippot encouraged a type of intervention capable of reestablish, with all necessary prudence, the relationship between pictorial image and architectural structure."* [2]

## 2. The survey of painted façades

The survey of the façade finishes is a component of the architectural survey, indispensable for defining intentionality and technical/figurative achievements of the architecture, in its formation and transformation phases.

Furthermore, the link with the architectural survey is inalienable and direct, both because by surveying the color we mean the survey of the chromatic-material characteristics of the surfaces of the historic building, inseparable from the overall organism, and because the architectural survey is an indispensable reference for all the investigations on the facade, especially regarding conservation and forms of degradation.

Since color is inherent to matter, and matter to the built, architecture and color are in an indissoluble relationship, under many aspects: from the visual-perceptive one, to that of the architectural contents, to the technological-structural one; from the point of view of the visual/perceptive type, and of overall figurativeness, as the Gestalt and perception theories have long since demonstrated, the perception of the form takes place as a unit, as a colored form, because the two components, form and colour, do not they are never split in the perceptive process; under the aspect of the architectural contents, since the facade participates in the overall architectural intentionality, it is itself an architectural expression, which relates the building, in its constitutive, functional and expressive characteristics, with the surrounding space; in particular, under the technological-structural aspect, because the building is structurally connected to the external envelope and its finish, which is always defined by the three dimensions linked to the technological aspect, there always being a thickness, even only plaster or support layers when this finish is painted and gives a fourth, the time dimension, when it becomes the place of sedimentation of several chromatic/decorative phases, temporally and stylistically differentiated.(fig.2)

Thus the specific study of the finishes of buildings and urban spaces also constitutes a tool that integrates the investigation into the process of formation and transformation of the urban structure, re-readable through this aspect.[3]

It must be remembered, however, that the mere use of this methodology is not enough to guarantee the goodness of the result and the completeness of the investigations, for the purposes of acquiring data as reference material for the intervention project; this is instead strictly correlated to the seriousness and capacity of analysis and restitution of the characteristics of the state of affairs, which the operator can only achieve through experience and sensitivity acquired by working in the field for a long time. Therefore, the proposed methodology presupposes complete mastery of the different types of procedures, which can only be acquired through methodical and scientific application. In fact, for the very purpose of achieving quality it is indispensable to deepen the knowledge (survey and graphic rendering) of the decorative models, elements and details of the decorative structure of the historical finishes, because this decorative structure, even in the simplest cases, is always born in close interrelation with the overall architectural-structural organism, and it is precisely the lack of awareness of this fundamental type of link that has given rise to the figurative distortion and the ungrammaticality that is so widespread in recent renovations. (fig.3)

Therefore, the architectural survey of the fronts with the overall decorative structure, that of the individual decorative elements and that of the details has been developed and articulated in a particularly punctual manner, from scales 1/200 and 1/100, of the overall, to the scales of the individual building, 1/50, to scales 1/20, 1/10 or 1/5, of the constituent elements and details.[4] The studies and survey experiments carried out on historical façades for documentation purposes, but above all for conservation and maintenance, with a wide range of purposes, objects, and types of survey and restitution, as required in the various situations, which can be grouped as follows: regulatory problems in the restitution of the survey, the survey for documentation and the survey for the conservation and recovery project.

**Fig. 2**: Stratigraphy of the pictorial decorations of the façade of a building in Piazza Pinelli in Genoa.

| Visual/perceptual investigation SURVEYS | Historical/iconographic investigation SURVEYING AND INVESTIGATIONS | SURVEY AND RESTITUTION | SURVEY AND COLOUR MAPPING | SCHEDULE |
|---|---|---|---|---|
| 1.vision of the urban artefact<br>2.eidotypes<br>3.photographic reconnaissance from panoramic to detail | 1.planimetric identification of plots by size and type over the centuries<br>2.historical-iconographic comparison<br>3.photographic survey: elevation and details<br>4.typological building identification<br>5.Indirect sources<br>6.Identification of constraints<br>7.SWOT analysis | 1.direct survey<br>2.Indirect instrumental survey<br>3.Photo-recording<br>4.architectural detail survey of façade<br>5.detail survey of the decorative apparatus of the façade<br>6.photographic graphic processing<br>7.computerised graphic restitution at different scales of 2D/3D representation | 1.direct perceptual survey by comparison with colour atlases<br>2.instrumental survey: indirect objective reading using a spectrophotometer<br>3.stratigraphic analysis carried out according to NorMal Recommendations 12/83 using the technique of optical microscopy<br>4.graphic restitution of collected data NCS system | 1.general data<br>2.technological elements of the façade<br>3. survey of the typological features of the façade<br>4. survey of the facade's chromatic values<br>5.façade materials and decorative elements<br>6.mapping of degradation recommendations NorMal 1/88<br>7. PROJECT SECTION<br>colour proposal: NCS system<br>types of intervention |
| Instruments | | | Software | |
| Portable Laser GEO slam ZEB GO, Portable Laser GEO Slam HORIZON, Drone DJI Mavic Pro Platinum, n. 2 Cameras Nikon e Canon with telephoto lenses; Colour Pin, Munsell Book of Coloure, Stereomicroscope Leica MZ7.5. | | | Geoslam Hub, Geoslam connect, GeoslamDraw, Zephyr Aerial, Photoscan Metashape, Cloud Compare, Autocad 2023, Perspective Rectifier; Autodesk ReCap, Adobe. | |

**Fig. 3:** Updating of the methodology for surveying and cataloging the results of the ongoing research.

## 3. Piazza Pinelli in Genoa

The complex in question, consisting of two distinct buildings cadastralised at N.C.E.U. foglio 81, Mappali 175 e 177, is located in an area of ancient settlement, close to the Sottoripa porticos, erected around 1133-1134. The area on which the building stands began to be urbanised around the 12th century, when the large landowners, the Church and the Municipality, leased their land for building.

In 1414, the building at today's house number 1 consisted of two different building units: the one facing Piazza Pinelli owned by the Cella family and the one on Vico Morchi owned by the Morchius family.

Number 3 on Piazza Pinelli appears to consist of three houses, of which the one on Vico Morchi has a portico; all three units belong to Ludovicus de Scipionibus olim Ardimentus. [5]

In the 16th century, both buildings underwent renovation and extension work, on the basis of which the new vaulted atrium system and the portal at no.1 were realised.

In the 18th century, the complex undergoes a series of subdivisions in order to increase the accommodation possibilities of the building and, as a direct consequence, the morphological and decorative characteristics of the façade change: the holes are enlarged, small columns are inserted and the façade frescoes are realised. The new cataloguing of the current research places it among the building types of type H: multi-storey building on several elevations facing two sides - corner solution; and in the decorative types of type D: monochrome façade base with monochrome or rusticated base with complex decorative elements.[6]

Both buildings are interesting examples of 16th-century aristocratic palaces in Genoa's historic centre, built, as already mentioned, on pre-existing medieval structures, with the main façade facing onto the square and the rear façade facing vico Morchi. Abandoned for several years, the buildings underwent a conservative restoration in 2003 by A.R.T.E., under the supervision of the Superintendent's Office, which led to the recovery of the façade frescoes.

The façade of no.1 on Piazza Pinelli consists of a basement strip on the ground floor, a six-storey elevation strip, and a pitched roof with a mixed structure and slate slab roofing with three dormers.

The façade consists of three axes of windows of different sizes, which have 'Genoese' style shutters as external frames. The 16th-century portal in black stone with white marble half-columns and architrave with jugs, shields and helmets is valuable; the splay ceiling is in black stone and is decorated with griffins. The atrium has a black stone floor and a lunette pavilion roof, set on slate corbels decorated with foliage and frescoed by Cambiaso with episodes of mythological scenes in the central part and in the lunettes. [1] The staircase starts from the atrium, on the right-hand side, and has an initial ramp perpendicular to the front before continuing, up to the top floor, parallel to the front with a double ramp running side by side.

Throughout its development, the staircase has the same architectural features: slate steps, rampant cross vaults with stucco on the ramps and octagonal marble and slate tile floors on the balconies.

The staircase is embellished with a slate pilaster on the ground floor, marble columns and balustrades from the first to the third floor and the door jambs and architraves of the doorways also made of slate.
Regarding house no.3, the front on Piazza Pinelli consists of ground floor plus seven floors marked vertically by three axes of windows. The 16th-century portal in black stone with jambs adorned with imperial medals and shells and the architrave decorated with festoons, chalices and abraded coats of arms. Between the first and second floors, three rectangular mullioned windows with marble columns presumably dating back to the 16th century. On vico Morchi, one can still see the stone arches, now filled in, of the medieval porticoed house joined to the rear ones on Piazza Pinelli during the Renaissance renovation.[7]
The atrium is characterised by rectangular paving slabs of promontory stone and a lunette pavilion roof set on slate corbels. To its right is the beginning of the staircase, which features an invitation ramp with a balcony serving a raised floor. From here starts the first flight of stairs, perpendicular to the front, with a marble header column and barrel vaulting set on a slate cornice. Arriving at the first level, the staircase continues, with a 90° rotation to the left, to the last level with a course parallel to the front.
Throughout its development, the staircase has the same architectural features: slate steps, cross or barrel vaults on the ramps and octagonal marble and slate tile floors on the galleries. Embellishing the staircase are the door jambs and architraves of the slate doorways and the presence of an open internal courtyard defined by marine columns with leafy capitals. The roof of the building is pitched with a mixed structure and a covering of slate slabs. After the restoration, all the parts of high historical and artistic interest of the building that had been partially compromised by neglect were brought to light.

## 4. Integrated survey trials: UAV + SLAM technology

The ongoing research on the updating and "new cataloguing" of the painted architecture in the historic centre of Genoa is mainly based on new advanced survey instruments using UAV methodology and SLAM (Simultaneous Localization And Mapping) technology.
The survey concerns not only the painted façades but also focuses on the external-internal relationship of the historical architecture and the decorative narrative concerning it.
Adopting the integrated survey methodology (fig.5), the following survey campaigns were compared and systemised: terrestrial photogrammetric survey, aerophotogrammetry, static and dynamic laser scanning. Interesting is the digital representation resulting from the survey and comparison of different point cloud visualisation and processing software in the case study of Piazza Pinelli in Genoa.
The scans with ZEB GO involved the acquisition of data in several aligned work sessions using Reference Base to automatically store coordinates, with an accuracy of 1 - 3 centimeters repeatable in the operational environment for scans of up to 25 minutes. The first run carried out in approximately 7 minutes involved scanning Piazza Pinelli along a trajectory of approximately 37 linear meters, in which the instrument was kept at a constant height and at a movement speed of 0.5 meters/second. The other scans, carried out to survey the foyers and stairwells of the individual buildings facing the square, were performed in approximately 5 minutes per session, keeping the instrument as stable as possible at a cadenced pace, along a trajectory of approximately 25 linear meters along the vertical axis.
The SLAM system has an advanced calculation mode capable of modifying various parameters to reduce drift (error depends on the complexity of the survey area) even in environments hostile to calculation. Excellent performance in dimly lit and confined environments, workflow automation and high processing speed of multiple datasets were verified. Once the data acquisition phase is complete, through the GeoSlam platform, the workflow and process automation allows the rapid visualization of the 3D model, which can be investigated according to the three x.y.z. axes, particularly useful in understanding the vertical volumetric development of the stairwells. Point clouds were managed through Geoslam Hub and Draw software to generate and export multiple plans and sections both in 2D and 3D for subsequent import into the CAD environment, while .las files were used for cloud integration of points derived from the aerial photogrammetric survey.
The use of mobile mapping instruments based on SLAM technology has highlighted not only the simplicity and versatility of the operations but also how the previous knowledge of the architectural survey methodologies of the operator are among the factors that most influence the success of the process of acquisition and return of the data obtained from the survey. With the dj mavic pro platinum quadcopter planned manual flights were performed in the absence of gps and at an altitude maximum of 25 meters, as required by the area included in the ATZ zone, for the acquisition of the individual façades. Specifically, the flights were mainly concentrated on the base part and the first elevated up to a height of 10 meters, which thanks to the camera stabilization system (Gimbal), made it possible to compensate for the oscillations of the drone during the flight and, therefore, to take sharp, quality photos.
The individual photographic datasets were imported and aligned within the 3DF Zephyr software for the creation of the sparse and dense cloud. From these models a series of measurable orthophotos have been generated with a very high readability of the painted decorations; in fact, the high-definition texture has allowed the faithful transcription of the figurative and chromatic characteristics of all the really visible decorations and an interpretative reading of those faintly perceptible from the street level.(fig.4) The two

point clouds of the building coming from different systems (SLAM and Drone) have been processed and united by the powerful algorithm present within 3DF Zephyr, which allows you to scale, constrain and rototranslate the models. A photorealistic mesh of the main facade of the structure resulting from the union of the two models was generated. Each survey carried out with a professional drone and camera returns a 3D model that faithfully represents the object surveyed in the proportions of the parts. To make the distances metric, and thus scale our 3D model, it is necessary to take field measurements or add points from a total station. All this information is easily imported into the 3DF Zephyr photogrammetry software. For greater precision, it is also possible to select control points (which will then be associated with points derived from a GNSS system) directly from the images, which will be automatically reprojected onto the 3D point cloud and will be used to metrically scale the object, or to add one or more known distances between two control points. Finally, which is unique to 3DF Zephyr, it is possible to import scans from laser scanners and scale the photogrammetric project by aligning it to the laser survey. Once the model acquired with the professional drone has been scaled, it is possible to take all kinds of measurements, generate sections and contour lines, create orthophotos and export each element to the CAD environment.

**Fig. 4:** On the top photographic assessment during the inspection; Detailed orthophoto of the painted decorations in the elevation strip of Piazza Pinelli decorated façades, taken from drone aerophotogrammetry.

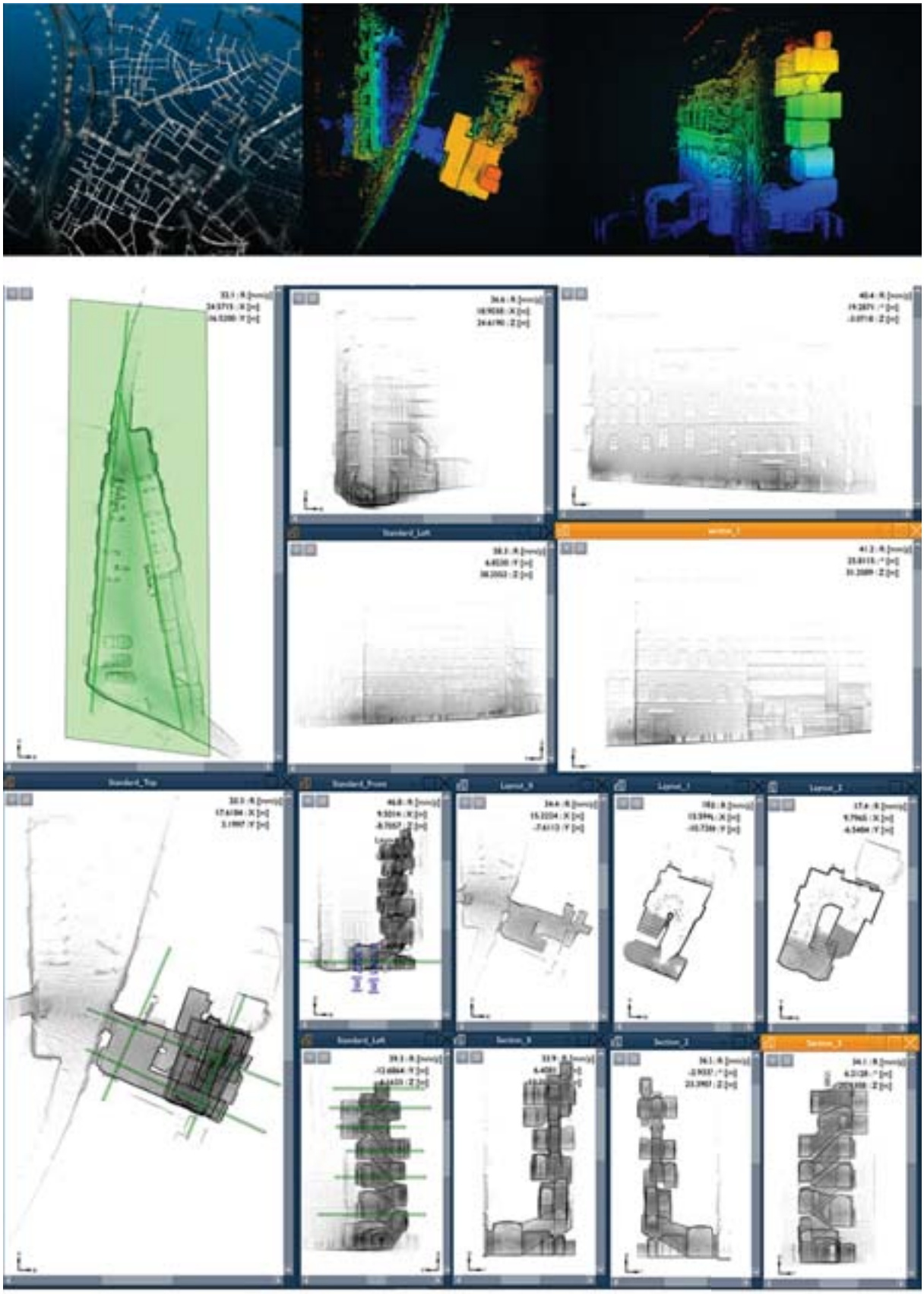

**Fig. 5:** Top left: Coloured dense point cloud performed with the GEO Slam HORIZON Portable Laser of the portion of the historical centre investigated; followed by graphic elaborations of synthesis of the monochrome dense cloud performed with the GEO Slam ZEB GO Portable Laser of Piazza Pinelli and the elevations facing it. Finally, elaborations of plans and sections obtained from the dense cloud of the atrium and the stairwell.

**Fig. 6:** First phase of research with a survey and photographic campaign to identify all the painted façades in the historic centre to complement the cataloguing of case studies in Genua Picta.

## 5. Conclusions

This contribution arises from the need to deepen a testimony of previous studies on the theme of the relief and color of the historic center of Genoa.

All this in order to solve the problem of the achievement of quality, both in the aspect of technical realisation and in the aspect of aesthetic realisation and cultural congruence. it is precisely the loss of quality that lies at the root of the progressive modification and degradation of this component and, with it, of the overall figurative characteristics of places.(fig.6)

The survey of the decorative and chromatic values is as in-depth as possible, and is extended to all the layers and/or minimal fragments of colour legible on the façades, both in situ and in the plaster samples taken, in an effort to decipher as far as possible the chromatic peculiarities of the finishes on the historic

façades, also in their temporal sequence, both in terms of hues and techniques, as far as the current situation, which is often already very compromised, allows.
The updating of the research methodology, the new technologies related to surveying and advanced representation have allowed the integrated experimentation of tools and software, giving a high precision of retrieval of quantitative and qualitative data also through the new cataloguing methodology.

While sharing the positions expressed in the article, the result of theoretical approaches and common elaborations, the paragraphs “Genoa: painted city” and “The survey of painted façades” are attributed to Giulia Pellegri, the paragraphs “Piazza Pinelli in Genoa”and “Integrated survey trials: UAV + SLAM technology” are attributed to Francesca Salvetti.

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# Protecting the past to save the present

**About the attempts to preserve cultural heritage before and after the Unification of Italy**

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**Abstract**
The task of protecting the heritage inherited from those who preceded us determines multiple objectives for the law: control, prevention, safeguard, enhancement, conservation, use, regeneration. Each of these goals represents an essential step in transmitting, to those who will succeed us, not only the tangible and intangible goods that history has given us, but also their meaning, the intrinsic value of each of them, as an expression of the human ability to mark the flow of history and to leave a trace.
The task of jurists is to establish rules, norms, laws, capable of imposing good practices finalized to rebalance the relation between man-environment-heritage by promoting a vision of global well-being, pushed beyond the borders of the states in the belief that the goods of each one are the heritage of all humanity.
In this field, a focus on the evolution of the juridical instruments set up to protect cultural heritage represents a useful tool to identify new paths to follow. In this field, the analysis of some socio-institutional and legal contexts must be considered a relevant laboratory for reflection about legal instruments. The analysis will show that current obstacles often existed in the past; they have influenced the development of law and society with effects that are still visible today. Differently, sometimes, even the solutions elaborated in the past give an answer to the various needs of the protection of humanity's heritage.

**Keywords:** Cultural heritage – identity - archaeological finds – Unification – private property.

## 1. The historical - artistic heritage: memory and identity*

We seem all convinced, together with Fëdor Dostoevskij, that *the beauty will save the world,* but, forgetting the meaning of these words in the famous novel, we attribute the greatest value only to the aesthetic beauty. [1] The culture of image characterizes our times and condition our social, personal and work relationships. Our society seems to be aimed at the unending search for what is beautiful, up to believe that all things that aren't beautiful don't and can't have any intrinsic value. On an existential level, this need has brought with it the frantic search for techniques and tools aimed at saving the aesthetic beauty, that of the youthful years, with the secret hope of being able to block, or rather, to put back the hands of the biological clock.
This trend, aimed at preserving beauty because of its intrinsic value, seems to be less pronounced when we discuss about the historical - artistic heritage of the country. Sensitivity towards this matter ends up being expressed only in words with vague and generic speeches. In terms of facts, however, personal interest dominates and wins: wild overbuilding, vandalism, theft of works of art are unfortunately frequent. Beyond the prosecution of crimes, there is a need for a cultural turning point and a new awareness about the centrality of this matter.

The task of jurists is to establish rules, norms, laws, capable of imposing good practices, which rebalance the relation between man-environment-cultural heritage by promoting a vision of global well-being, pushed beyond the borders of the states in the belief that the goods of each one are the heritage of all humanity.
Nowadays it seems possible also using the results of scientific-technological researches: they can be important tools in order to support legal and political decisions.
The task of protecting the heritage inherited from those who preceded us determines for the law multiple objectives: control, prevention, safeguard, enhancement, conservation, use, regeneration. Each of these goals represents an essential step in transmitting, to those who will succeed us, not only the tangible and intangible goods that history has given us, but also their meaning, the intrinsic value of each of them, as an expression of the human ability to mark the flow of history and to leave a trace.
In this framework, beyond the competences carried out by organizations of international importance, the political choices made by each nation are fundamental. It is undeniable that cultural heritage is a fundamental pillar on which the social and economic structure of the state rests.
Even without bothering John Ruskin, according to whom art should be preserved by the State and the great works of the past should be kept in museums available to all, we all know that we have to transmit to the future the values that heritage has passed on to us. [2] So we must protect in the best way our cultural heritage with a collaborative action not only to control, but also to promote a new relation between each man and his living environment.
In the variety of the state's goals, the conservation and the enhancement of the cultural heritage are very important. Aware of this role, the Italian Constituent Assembly, making a courageous and, for this reason, not unanimously shared choice, wanted to include the protection of the cultural, historical and artistic heritage of the nation among the fundamental principles. [3] In Italy, in fact, the art. 9 of the Constitution provides that the Italian Republic has the task of protecting the landscape and the historical and artistic heritage of the nation. This double reference, to the landscape and to the heritage, highlights the centrality of the relation between man and nature. This relationship is shown both in the conditions of the visible environment and in all the movable and immovable assets that represent artistic, historical, archaeological, ethno-anthropological, archival and bibliographic heritage.
Legislative Decree 42 of 2004, better known as *Codice dei beni culturali e del paesaggio*, was introduced in the line of the Constitution. It pursued the goal of proposing an updated organic legislation, compliant not only with the constitutional framework, but also with the European legal system and the international Conventions. In its provisions, it introduced various statements on which we have to reflect. First of all, it introduced a new meaning of the phrase "*cultural heritage of the State*": it includes cultural and landscape assets. Cultural assets include all immovable and movable things of artistic, historical, archaeological, ethno-anthropological, archival and bibliographic interest and all the other things identified by law because of their civilizational value. On the other hand, buildings and areas that are an expression of the historical, cultural, natural, morphological and aesthetic values of the territory constitute landscape assets.
The awareness that underlies such statements is fundamental: the roots of our country, developed over the centuries, take shape in the cultural heritage and in the form of the landscape. They testify to history, but they also build the memory of the younger generations, projecting into the future all the values, and the choices that embody the culture of the territory. From this point of view, all the activities aimed at guaranteeing the protection and the conservation of cultural heritage for purposes of public use must be combined with heritage enhancement performances.
Through these activities, the State guarantees its own memory and its values. So, in the midst of the globalized world, each nation finds itself. In this way the historical-artistic heritage becomes a fundamental resource for the identity of the State and an aggregation reason for the community. In the whirlwind of globalized relations, the cultural heritage is the anchor that keeps us tied to the territory and makes us part of a community. Its symbolic meaning becomes central in the construction of the identity. As a consequence, it is the first one to be hit when someone wants to destroy the identity of a State. In this way, there are important examples: Mostar bridge was destroyed by the Croatians not for military needs but because it represented a symbol of local traditions, of Turkish-Islamic derivation. It was at the same time a symbol of peace and the meeting between different civilizations. [4]
So cultural heritage assumes the mean of local or national identity and, for this reason, it must be preserved and valued. It offers people a link with certain social values, beliefs, religions and customs, allowing them to identify the specificity that distinguishes them from others, but also allowing them to draw bridges with other cultures.

## 2. The archaeological finds as a political tool

The cultural heritage contributes to create a profitable connection with the past and lays the foundations for the creativity of the future. In a diachronic and synchronic sense, we can say that, thanks to the memory of the past, each generation better understands its own specificity both in relation to contemporary generations living in different geographical contexts, and in relation to previous generations. The artistic heritage creates a link with the past and, at the same time, makes closer the relationship with the present time. From this point of view, the analysis of some socio-institutional and legal contexts must be considered a relevant laboratory for reflection about legal instruments. The analysis will show that current obstacles often existed in the past; they have influenced the development of law and society with effects that are still visible today. Differently, sometimes, even the solutions elaborated in the past give an answer to the various needs of the protection of humanity's heritage.
Each country can find its roots in the ruins and in the memories of the past and it can build its greatness upon them.
From this point of view, it seems useful to return to the precocious Neapolitan intuition of the eighteenth century: the use by Charles of Bourbon of the archaeological finds of Herculaneum and Pompeii. The study of the juridical solutions elaborated in that context allows us to understand the goals that the king attributed to those excavations and to the heritage obtained from those extractions.
We know that, under the protection of the King, the excavation of the towns destroyed by the volcanic eruption in 79 A.D. began. In 1738 they began in Ercolano and, ten years later, in Pompei: the amazing treasure of antiquity was gradually brought to light.
Naples became the focus of attentions of the researchers. While new ambitious building programs led to the construction of wonderful royal palaces, the excavations brought to light the legacy left by glorious ancestors. The city gradually changed its image to conquer the status of cultural metropolis. In the 18th century, the myth of Naples is intimately linked with the appearance of the collections of Etruscan, Greek and Roman antiquities. European aristocratic collectors found in Naples their paradise and gave free rein to their passion for collecting.
The passion for collecting was fueled by the archaeological discoveries: collectors aspired to possess that precious finds. There was no selection, everything that could enrich the private collections was extracted. The anxiety of private collectors to own the best pieces fed the understandable concern that the royal collection could be deprived of some important exemplars. Uncontrolled thefts would have brought works of enormous value on the antiquarian market, compromising the uniqueness of the royal collection.
The most immediate and concrete risk was that the treasures of antiquity often went out of the borders of the Kingdom to enrich the most important European collections.
This concern urgently required the adoption of rules able to protect the extraordinary artistic heritage finally brought to light.
In 1755 the King decided to adopt some rules that recognized the quality of *goods of public interest* to the artifacts found thanks to the archaeological discoveries. In Naples, on July 24, 1755, a Royal Dispatch of King Charles attributed, to the objects found through the excavations, the quality of «goods of public interest». Faced with the request from the antiquarian community, Charles of Bourbon wanted to state that all the ancient objects were the exclusive property of the Crown. [5]
The statement was very important: it meant that the archaeological excavations and the finds were a source of pride for the young King. Proud of the new course undertaken, the king and his expert advisors, had understood that the rich Neapolitan artistic heritage, beyond its intrinsic value and importance, constituted a providential political tool. From this point of view, the heritage brought to light was necessary to rebuild the image of the king's power but also to build the glorious identity of the new independent Kingdom. Royal excavations in Herculaneum showed that the new kingdom had the elements within itself, not only to maintain its artistic prestige without exporting sculptures from outside, but to build its identity on a civilized and glorious past. [6]
The capital of the new independent kingdom could recover its prestige through the intense and powerful contribution of the artistic heritage. It was capable to legitimize the sacredness of the monarchy and, at the same time, the identity of the Kingdom. What makes Naples different from other wonderful Italian cities was, of course, the amazing heritage of antiquities. Nowhere else could antiquity be so three dimensionally as on the Gulf of Naples.
From this consideration arose the need to ensure that all the finds were not taken outside the borders of the Kingdom. It's undeniable that, though Charles of Bourbon was interested in the excavations of Herculaneum from the start (1738), we have to wait till the mid-1750s to see the full emergence of this interest in terms of cultural policy. [7]
And indeed, on September 25, 1755 the Young King issued two Prammatiche. The first was the Prammatica LVII and the second was the Prammatica LVIII. [8] King's statement was clear: no person could extract, or have extracted, either by sea or by land, from the Provinces of the Kingdom and bring to foreign countries, any ancient monument [...] without the express permission of the Crown. [9] From the criminal point of view, the aim was clear: the looting and the trade of archaeological works had to be prevented. Only the King could grant the license for the extraction of antiquities. Cultural heritage

needed to be protect. In this way the bourbon legislation was clear: it gave primary importance to the preservation of heritage and national identity against the export and illegal enrichment of foreign countries. Indeed, the Caroline legislation was, not surprisingly, considered precocious and a clear expression of cultural awareness.
On the juridical level, the legislation was surely characterized from even more repressive sanctions that expressed the trust placed by the King in the dissuasive power of the penalties. The emphasis was focused on the prohibition of export. The main purpose of the rules was to prevent the release of the findings outside the borders of the State.
Despite the simplicity of the rules and the harshness of the sanctions, the protection did not have the desired effects. This legislation, therefore, could not solve the problem of illicit excavations and the clandestine sale of the findings: all these activities in fact continued to be perpetrated. For this reason in 1766, Bernardo Tanucci confirmed the provisions of 1755. On April 4, 1769, the publication of another Prammatica confirmed the ancient prohibitions. [10] The attacks against cultural heritage were far from being defeated.
The Bourbon legislation, in its own structure was clearly inspired by the contemporary legislation issued in Rome and in other towns to prevent works of art's illegal negotiations. Particularly, important precedents were the Edict of Cardinal Valenti, issued in Rome in 1750, and the Edict of the Council of Regence, issued in Tuscany in 1754. [11] In Florence, on December 26, 1754, a new edict born to light in the belief that in Florence and throughout the territory of the Grand Duchy the preservation of antiquities was necessary. The discovery of the Etruscan tombs in 1731 had created a big fuss around the excavations but it had also generated the need for legislation aimed at repressing both the phenomenon of illegal trade of archaeological things and that of the creation of the fakes. [12]
The common fact that emerges from the analysis of the rules is clear: the task of preserving the artistic heritage is entrusted to the law, the legacy that comes from the past must be protected for its intrinsic value. In Naples, in fact, since archeology was not considered important, the excavations was ended up being used as an instrument of political cultural legitimation of the monarchy and to spread the image of the Kingdom. [13]. Artistic goods are different from any other economic wealth: they are public goods, they belong to the Crown which becomes their only keeper. They are what can best represent the identity of the new Kingdom.
In a wider context, it should also be considered that in 1757 there was also the start of the slow publication of the volumes of «The antiquities of Herculaneum exhibited». [14] The highly valuable work was never put on the market, but offered as a gift by the Neapolitan court to the most prominent exponents of the European aristocracy to amaze them with the *grandeur* of the collection, and to promote the excavation enterprise. But King's program was more rich: his initiatives were also important to make classicism known around the world: the original of the bronzes found during the excavations in the Villa dei Papiri in Herculaneum were left in Naples, but the matrices were sent to Madrid and Mexico City, to the Academia de San Carlos, to allow everyone to admire them and experts to study them closely.
These initiatives went far beyond heritage conservation, they were aimed at enhancing an artistic-cultural heritage, which gave identity to a Kingdom tracing a bridge capable of connecting and keeping together countries, contexts and arts. The Vesuvian finds, Neapolitan cultural heritage, provided ancient material to be shared in view of a process of overall growth of economic and cultural importance.

## 3. Private property and public interest

In the pre-unification states of the Italian peninsula, the care towards the cultural heritage led to adoption of diversified rules. The variety of laws was remarkable: the artistic sensibility, the juridical perspectives, the goals were profoundly different. The pre-existing variety of legislation was the greatest obstacle in the formation of the new law for the unified nation. Furthermore, the Unification brought out a lively political sensitivity finalized to support the creation of a new reality based on homogeneous ethical-political elements capable of inspiring the renewed society as a whole. It was undeniable that, due to the particular way of its development, national unification was characterized by strong inhomogeneity between the north and the south, between city and countryside, which added to the undeniable datum of a less evolved Italy than the rest of Europe. [15]
From the juridical point of view, these problems increased that of the presence of very different systems and laws. So the Unification became more and more a complex operation to be carried out. In this particular matter, the greatest obstacles came from any possible regulation which implied restrictions on free initiative and private liberty. The cause was clear: public intervention would have to restrict individual initiatives and private property. The ideology of nineteenth-century liberalism opposed any form of public intervention aimed at limiting the principle of free trade and the intangibility of property.

Property, considered as an extension of freedom, was considered as a prerogative of anyone, at least on an abstract level. Thus, protecting it meant protecting what everyone potentially possessed. But, as has been suitably underlined, the substance was quite different from the form, because in an unequal society the protection of property ended up guaranteeing the right of some and preventing that of others, with the risk that the formal granting of a right could hide its essential negation. [16]
The consequence of this theoretical approach is that all political instruments and legal norms aimed at ensuring the public interest, through the establishment of a barrier to the right of private property, were considered as an unjustified sacrifice of individual right.
In liberal Italy, the belief in private property ended up inhibiting the adoption of means for the protection of cultural heritage.
As a consequence, the concept of “heritage” and that of “cultural heritage” radically changed. The political class did not go beyond the principle that the transformation and the destruction of urban buildings were forbidden only if they were of great artistic value. As a consequence, only monuments, great testimonials of the past, were to be preserved. [17] Works of art didn’t need a specific regulation because their circulation was regulated by the negotiating discipline of the civil code.
On June 25, 1865, the law n. 2359 was issued to regulate the expropriation of monuments sent to ruin by the carelessness of the owners. It was the only legislative sign aimed at protecting cultural heritage.
In the absence of a specific system regulatory intervention, the permanent effectiveness of the legislation of pre-unitary states was formally sanctioned. On June 28, 1871, the law n. 286 confirmed, operating a kind of transposition, the pre-existing legislation. [18]
The need to protect private property, considered as an extension of the freedom, ended up representing a barrier against any public interest. Private interest ended up crushing the public interest.
So the effort was to reconcile the intangibility of the individual economic sphere and private property and the need to protect the historical and artistic heritage of the nation. This was the ground on which they fought their hard struggle. The debate was rich of consequences. Furthermore, it was undeniable that, in the extreme variety of the laws, a complete and organic law was absolutely essential. This idea animated the debate among many jurists, scholars and politicians. They tried to translate their awareness on the normative level. The less of an adequate legislation to protect the cultural heritage created an extremely precarious situation in those towns that held the greatest treasures of antiquity and art. The delay in the adoption of the appropriate legislative tools in order to defend and protect the cultural heritage determined serious damage to the nation's historical and artistic monuments. Thefts of works of art, ruins, illicit negotiations became common.
This desperate condition lasted for about forty years. In fact, about forty years were necessary for the adoption of the first organic law about this important subject. After a long debate, on June 12, 1902, the law n. 185 was approved. It was the first organic text in which the protection of things of historical and artistic interest get a unitary discipline. It represented a real compromise between the different ideological positions and the culture of restoration. Its provisions were applied, for the first time, to monuments, buildings and movable objects with artistic value. [19]
This statement about the field of application aimed to define that the legislation did not introduce a new concept of public or private property. It aimed only to introduce rules for protection and conservation of some goods. As a consequence, it introduced the obligation for the Ministry of Public Education to form catalogs of monuments and objects of art and the obligation to denounce any contract of sale or mutual possession when the objects of the contracts were included in the catalogs, with the consequent right of pre-emption of the State on objects reported or ready for export. It introduced also the inalienability of the works of art owned by Communes, Provinces and ecclesiastical bodies. The provision aimed to preserve the precious local heritage. Moreover, the law recognized to private persons the right to proceed with archaeological excavations under government supervision and with the devolution to the State of a quarter of the value and price of the objects. Finally, there were some provisions concerned the appropriations of sums necessary for the conservation of monuments and the penalties for violations of all the provisions established.
The so-called Nasi law, although having an innovative aim, had a relative incisiveness. Steps forward were already made in 1909, when the Rosadi law introduced the declaration of cultural interest for works belonging to private individuals and the inclusion in a list for those belonging to the public. Moreover, it established that its provisions were applied to all movable and immovable things of historical, archaeological and artistic interest, with a notable expansion that gives the sign of a great juridical innovation.
Only in 1939, two laws, which represented two fundamental texts, profoundly innovated the subject.
An epochal turning point for the protection of cultural heritage is recorded with the Bottai Law n. 1089/1939, which, in addition to providing a complete definition of cultural heritage, entrusted the protection, affirming the principle of the right to public enjoyment of the heritage. [20]
The Bottai law was extended, in its sphere of application, by the law n. 1497. This law extended the legal protection to everything that was not contemplated in the Bottai Law and also to the parks, the gardens, the places with geological particularities and panoramic beauties. Overcoming the aesthetic

conception of cultural heritage, the law considered it as the most significant testimony of human history rather than a simple manifestation of beauty. It had to be protected not for its individuality, but in the light of its interrelationships with the spatial context and natural and social dynamics.
This is the most significant innovation in this subject, especially about the problems that occupy our analysis.
The Bottai law represented, for almost sixty years, the main regulatory reference about cultural heritage and constituted an essential reference for the Italian Constitution.
We know that the art. 9 of the Italian Constitution provides that the Republic promotes the development of culture and scientific and technical research. It protects the landscape and the historical and artistic heritage of the nation. The first paragraph of the article deals with the development of culture, while the second focuses on historical and artistic heritage. The close correlation highlighted between these two paragraphs underlines the new concept of culture. Thanks to the art. 118 of the Constitution, the State and the Regions will be envisaged for the protection of cultural heritage. [21]
Thanks to these rules, the Italian Constitutional Court has repeatedly stated that cultural assets are primary constitutional values, which cannot be subordinated to another constitutionally protected value, including economic ones. This statement outlines the need for an overall safeguard which is essential to the community. [22]
It is a consideration that we have to feel as primary, because what we have inherited from those who preceded us must be protected and safeguarded for future generations. Moreover, we have to understand how we can reinvent our relationship with the environment and the cultural heritage.
It is an urgent necessity because it concerns all of us: an urgency that must be listened by the legislator, by the institutions and by the citizens. This need requires us to overturn Fëdor Dostoevskij's maxim and to affirm optimistically that «the world will save the beauty».

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[1] "I believe the world will be saved by beauty." So claims Prince Lev Nikolyaevich Myshkin, the protagonist of Fyodor Dostoevsky's great novel, The Idiot.

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# Restoration, industrial design and drawing. A renewed Humanism for a renewed design concept the journal "Arte Italiana Decorativa e Industriale"

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## Abstract
«Only the continuous practice of a "measure" that has been built upon continuous education process may give reliance; people, only with an adequate formation, can measure the state of their wellness and at the same time they can act as the guarantors of earth quality, for a new development model based on a renovated Humanism».
By sharing the ideas expressed by Carmine Gambardella for the Call of the XXI edition of the Forum on Le vie dei Mercanti for 2023, the proposed contribution intends to recover the cultural positions of one of the fathers of Italian architectural culture, Camillo Boito.
The Milanese intellectual, original 'inventor' of the 'didactics for drawing' and director of the magazine "Arte Italiana Decorativa e Industriale", shows with his work in the realization of editorial initiatives, a particular attention to the innovation processes to be introduced in the field of furniture, architecture and conservation of building works built by human creativity. In this regard, the note that Editor to the Journal puts to explain how significant it must be to teach the essential characteristics of drawing in view of the project in Basic Training Schools is very significant.

**Keywords:** Camillo Boito, Arte Italiana Decorativa e Industriale, Design, Restoration end Innovation

## 1. Between Viollet-le-Duc and Ruskin: Camillo Boito

Belonging as an architect to the eclectic and neo-romantic period, Camillo Boito, involved in the culture of his time, sought in medieval architecture in general the possibility of their adaptation to modern needs, facilitating their assimilation to the contemporary, both in the building of new architecture and in the didactic commitment of a teacher in this discipline.

Camillo Boito, in fact, was the personality who most emerged in the last quarter of the nineteenth century in the field of historical studies of architecture. Born in Rome in 1836, died in Milan in 1914, he had trained as a student in Padua and Venice with experiences outside the Italian border and, in the lagoon city, he had his first chair of Architecture. He then found opportunities to teach in Milan at the Brera Academy when he escaped from the territories under Austrian influence.

Anno XII. GENNAIO 1909 N. 1

# ARTE ITALIANA

DECORATIVA E INDUSTRIALE

## ANTICHI ELEMENTI D'ARTE NUOVA

«As had happened in France for the authoritative figure of Viollet-le-Duc, the influence of Boito was nevertheless notable for the qualities of culture and brilliance of ingenuity that distinguished him. In fact, he too was a versatile writer and typically eclectic treatise writer, founding the magazine "Arte italiana decorative e industriale" and collecting ornaments from all times in the volume "ornaments of all styles" published in Milan in 1888. This made him co-responsible for the diffusion of the bad taste in architecture, just when Italy, having achieved its political unity, would have needed to base its own urban development, building and even celebrations on very different bases of genius and culture». [1]
The negative judgment of Carlo Ceschi helps to understand how until almost the end of the eighties of the last century, the work and activity of Camillo Boito was viewed with suspicion by critics and by the teachers of the Schools of Restoration, judgments, often conditioned by the scarce critical attention that had been reserved for the Milanese architect. Subsequently, Ceschi's severe judgment will be revised by subsequent studies which will grasp and appreciate Boito's not only the invaluable didactic role played but the subtle critical commitment in reading and enhancing the architectural heritage.

Fig. 2. Piatto persiano. Secolo XVI.

The critical position of Boito has been understood and read by architectural culture as a median position between the cultural positions of Viollet-le-Duc and the more radical ones of John Ruskin. In fact, speaking of Boito, he is spoken of as the initiator of the Italian path to the study of restoration in the face of the restorative and reconstructive solution of Viollet-Le-Duc and the maintenance one of Ruskin. An important cultural position of Boito refers to the logic of the distinguishability of the new intervention on the pre-existing structure, making the consideration that every addition must be evident and that, justified by the conservation needs of the ancient building, must not mislead the observer. For this reason Boito will suggest inserting the dates on which the intervention was carried out on the integrations. His most important contribution is in fact to be found in the approach he gave to the methods of the Restoration. In fact, he took an intermediate position between the fatalistic one of Ruskin, which was becoming fashionable, and the one that now went under the name of Viollet-le-Duc. He reacts to the first by refusing to accept the end of a monument just as one does not accept the end of a man without first having tried every cure to save him. He condemns the second for having led the restorers on the path of forgery and lies. It is easy to recognize in Boito's words a natural disposition towards that sensible and positive balance which formed the basis of the modern Italian school of restoration.

Piastrelle maiolicate eseguite nell'Officine dell'*Arte della Ceramica* a Firenze.

The fundamental concept of the distinction of the added parts from the original ones and the prudential one of limiting the interventions to the purely necessary were therefore confirmed. So even in dealing with the topic of freeing the older structures from subsequent additions, even without clearly identifying the historical reasons, he invites caution because every stratification has its value and must be respected. His attempt to classify the restorations into categories according to the type and age of the monument remains important, a criterion that he looked with great attention to the empirical experience of having to put his hand in the transformation of historic buildings with quite a few technical skills now abandoned or forgotten in doing traditional construction. Without prejudice to the by now acquired principles of archaeological restoration, he distinguishes in two other categories the restoration of the medieval building, which he calls pictorial and that of the Renaissance building, which he defines as architectural, and it is easy to understand for what substantial differences.

However, his theoretical formulation was already precise in 1879 when he presented a report on the restoration of monuments to the Congress of engineers and architects with a series of regulations which had an initial impact on the Ministry of Public Education which transferred them in circular letters to the prefects who however, they had great results.

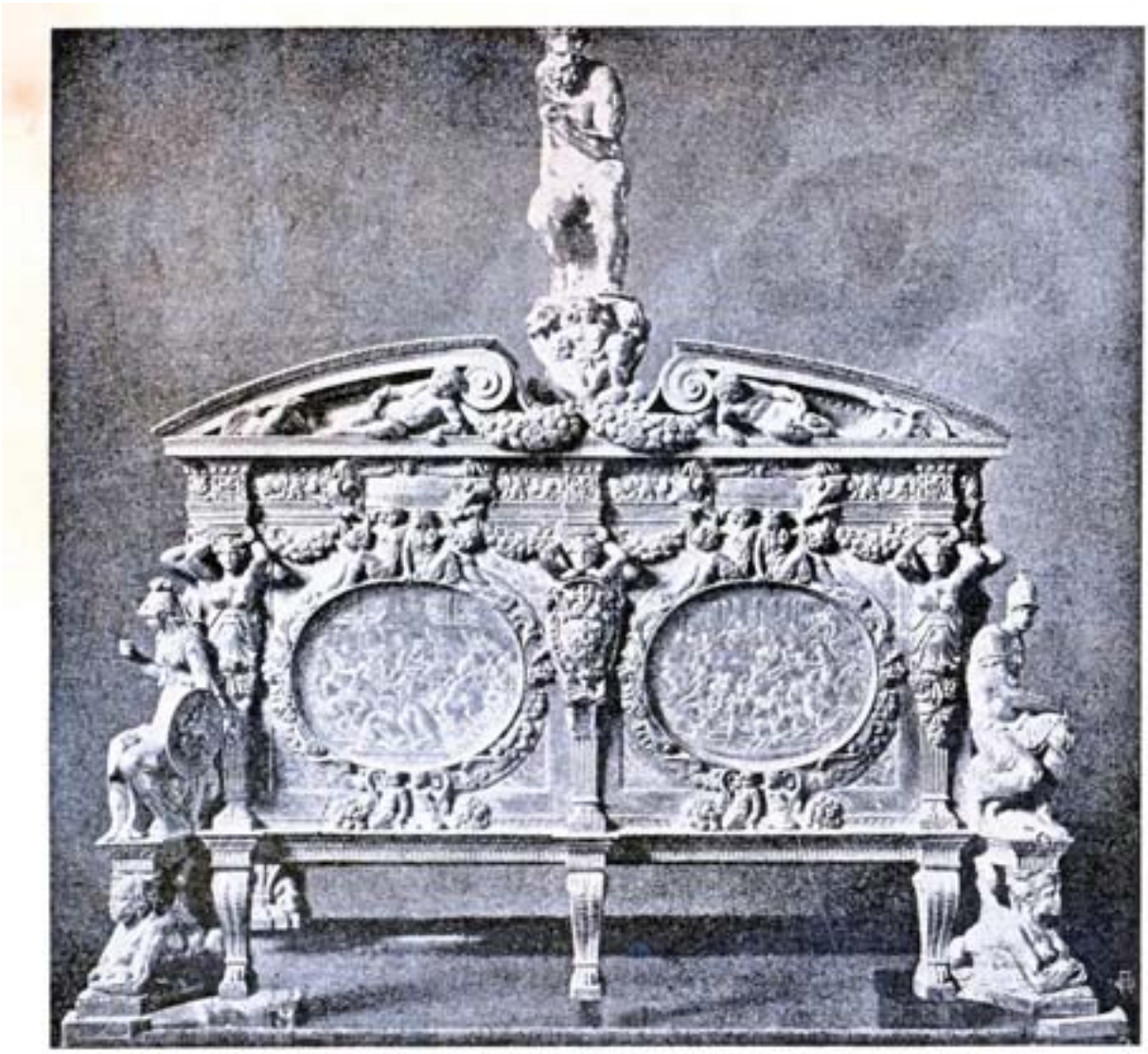
Thus Boito once again presented them at the III Congress of Engineers and architects in 1883 in Rome in the form of a motion which, due to the precision of the concepts, can truly be considered a first "Restoration Charter".

The fundamental principles were summarized in eight points:
1) Difference in style between the new and the old.
2) Difference of materials from factory.
3) Suppression of outlines or ornaments.
4) Exhibition of the old removed pieces, opened next to the monument.
5) Engraving on each renewed piece of the date of the restoration or a conventional sign.
6) Descriptive epigraph engraved on the monument.
7) Description and photographs of the different periods of the work, placed in the building or in a place close to it, or description published for the prints.
8) Notoriety.

## 2. Section

### 2.1 The text by Camillo Boito

The magazine L'*Arte Italiana*, after twelve years, enters a new series: but it does not change its intentions, ways and appearance. Solo would like to proceed with greater certainty, widening the field to subjects and employing designs intended for industrial craftsmen and decorative arts artists, without restricting the studies and models in favor of professional high schools too, where the composition is fundamental and where the operators face and they solve the common daily problems of those who actually work. To achieve this goal, that is, to free itself from the more purely didactic part, Arte Italiana will give life to a new publication, this one, although derived from the old Periodical, will carry out an autonomous task; and we say old periodical because, being an art magazine in Italy, a dozen years old may seem a respectable age.



Cassetta Farnese nel Museo Nazionale di Napoli.

In this way the Arte Italiana magazine will proceed more smoothly. And its ambition is to cooperate in the dissemination of good artistic taste, especially among those people who have responsibilities in the field of art. We refer to technicians capable of making or recommending purchases or called to indicate prestigious locations for artistic works or who have management responsibilities in factories,

laboratories, workshops, production or educational institutes who can have a more incisive influence on the direction and fate of the arts of which we speak. Unfortunately, in Italy there are very few industrialists who realize how the value of certain productions to doubles with the singular elegance of the invention and of the form; there are very few entrepreneurs who look for artists capable of doing well and know how to reward them worthily. It therefore happens that skilled draftsmen are rare in Italy, while they are numerous in France, Belgium, England, Germany. And it is in this that the main reason for the deplorable inferiority of a part of our industries must be sought; while instead, even here, when the entrepreneur who presides over the production of art objects has the ingenuity and panache of the artist, the prodaction triumphs. Here also the beautiful and the useful, when they are widely understood, completely agree.

Targhetta da pugno nel'a R. Armeria di Torino. Sec. XVI.

Fig. 1. Da un tappeto persiano della raccolta posseduta dalla Manifattura dei Gobelins.

*Arte Italiana*, and thus its subsidiary publication Models for elementary and secondary schools of art applied to industries, will gladly welcome good attempts at even daring novelties. Like the various ways of geometrizing or stylizing the straightforward types of nature; investigations into the forms best suited to the uses of objects and most responsive to the materials in which the objects are formed; the ways to obtain the most evident, the most vigorous manifestation of aesthetic ideals in our contemporary society: these are the worthy studies in which our publications would like to cooperate. Therefore we will abound, especially in Italian art, with examples of the so-called Stil novo, without deluding ourselves that it is truly a style, since a style cannot bear fruit without solid and deep roots. A Stile becomes such through consent and willing adherence and also when, almost unconsciously, he is welcomed by the creators and by civil society.

Fig. 3. Piatto di Damasco, Sec. XVI o XVII.

Cancello della *Aemilia Ars*, in ferro battuto.

We are still too far from convinced acceptance for a language that we can identify as style. Nor can hasty or artificial experiences, such as, for example, the last and in many ways worthy Turin Exhibition of New Art, really cause the sure maturation of an art that turns towards a style.
However, the courageous efforts, albeit partial, have by now produced in the connoisseurs and also in the public a beneficial dissatisfaction with the imitations of the past, and generated a climate of acceptance for objects that are useful and appropriate to contemporary life. So for now, instead of the style of an era, let us content ourselves with the manner of a small group of artists or of each of them in particular. They can become, in part, the forerunners. And Italian Art, the reader knows, is not frightened by excesses in boldness and presumptions; these excesses, when guided by conscience, always turn out to be more profitable and more respectable than the exaggerations of the usual and the forbidden. Yet it must be added that in one thing the prophets or apostles of the Arte nova seem blind to us; in believing that the knowledge of the art of the past slows down or hinders the aspirations to that of the future.

Ricamo della *Aemilia Ars*, di Bologna.

Indeed, we believe that full knowledge of the past is essential to fully understand the present and to clearly imagine its aesthetic reasons and ideals. Those who would like to snatch and throw away from the Schools like shackles or chains, the glorious arts of ancient and modern centuries, are (we have said it several times) the anarchists of thought. Ignoring the past cannot be a method of sustaining the new; and, likewise, the denial of the past does not feed and does not create the right conditions for the flourishing of today's art. It is an atrocious slander of today and tomorrow. In our periodical and in the other, new one magazine that derives from the first, we will therefore continue our path serenely, offering the precious specimens of past centuries, from antiquity to our own time, and at the same time offering to the praise or criticism of scholars the courageous and honest attempts in recent days.

[Camillo Boito]

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# ‘Historical' ecology and new Humanism: the perspective of the ancients.

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**Abstract**
The debate on environmental issues and on the relationship between man and nature is a highly topical topic. However, it has a significant precedent in the classical world, where the problem of environmental alterations, due to an excessive exploitation of the earth's resources, was already very much felt. In fact, although the ancient world, due to the scarcity of the population compared to today's one, was not able to produce quantities of non-biodegradable residues such as those connected to extraction and waste deriving from industrial processes, yet many authoritative exponents of classical culture they are concerned with the growing risks associated with the progressive depletion of essential resources and have even designed technologically advanced solutions.
If these solutions are little known today, due to the serious shipwreck of scientific production of Hellenistic period and the scarcity of interdisciplinary studies in this regard, the fact remains that reflecting on good practices for designing adequate solutions implies knowledge of the past and of philosophical speculation-literature and scientific on topics that are not a prerogative of contemporary man.
The reflection of the classical world on environmental issues therefore constitutes an inescapable premise for facing the future and promoting new models of development based on a renewed Humanism that has its roots in the past in order to preserve the future.

**Keywords:** ancient Ecology; pollution; *ruina montium*; historical Ecology.

## 1. History of ecology and historical ecology

The problem of ecology in the ancient world, Greek and Roman, was considered by the moderns above all in relation to the attitude of the ancients towards the question of the relationship between man and the environment. In the first instance, it asked ourselves, that is, what "ecological sensitivity" the ancients manifested (Hughes 1975).
Other studies have subsequently tried to focus attention not so much on what the ancients thought of the relationship between man and the environment, but on what actually occurred in antiquity on this side: the works of T.W. Gallant on the precariousness of the life of the Greek peasant and on the systems developed to deal with the uncertainty of the situation and by O. Rackham on the "historical ecology" of individual Greek regions, such as Boeotia. This second line of studies, precisely of "historical ecology", still needs to be widely enriched and requires a series of skills that are in part unrelated to the historian of antiquity. The first, which we could rather define as "history of ecology", has instead been sufficiently investigated.

### 1.2 Man and the environment: the perspective of the ancients

In considering the relationship between man and the environment, the ancient world largely favored the problem of man's influence on the environment. In the fifth century the theory of "environmental determinism", promoted by the school of Hippocrates, appears widespread in Greece, according to which the natural environment, distribution of resources, climate predetermine the physical and cultural characteristics of the population.

The problem finds an echo in Aristotle (*Polit.* 1327 b 23 ff.), who distinguishes between the European peoples living in cold regions, full of courage and lovers of freedom, but insufficient in intellect, and the Asian peoples, with a reflective and of artistic temperament, but cowardly and servile, to conclude, in a typically Hellenocentric sense, that the Greeks, living halfway between Asia and Europe, can claim the qualities of both, and are therefore daring, intelligent, free and endowed with best institutions. The significant attention paid to the problem of the influence of the environment on man is counterbalanced by a less sensitive awareness of the impact of human activities on the environment.

A further legitimation of interventions on the environment derives from the widespread conception that nature is aimed at man, expressed very well by Aristotle (*Polit.* 1256 b 15 ss.): «Plants exist in sight of animals and other animals in view of man … If nature does nothing useless or imperfect, it is necessary that she has done all these things in view of man». This conception, which Xenophon also believes belongs to Socratic teaching (*Mem*. IV, 3, 10: the existence of a provident divinity is demonstrated by the fact that animals «are born and grow for the benefit of man»), is characteristic of the stoicism, as appears from the fragment 1153 of Chrysippus, preserved by Cicero (*de nat. deor*. II, 14, 37).

Roman culture recovers, through Posidonius, the Greek idea that the environment has a strong influence on man. The *laudes Italiae* of Varro, Virgil, Propertius express the idea that the superiority of the Romans is due on the one hand to the better environment in which they live compared to other peoples, on the other to the intelligent intervention of man on it: having great technical skills, superior to those of the Greeks, the Romans have a strong capacity to transform the environment and are particularly sensitive to the celebration of *homo faber*, as Cicero attests (*de nat. deor*. II, 60, 150-152).

Not differently than in the Greek world, and even more so, the Roman landscape is therefore a strongly anthropized space and rich in evidence of these high intervention capacities, such as *centuriatio*, irrigation works, aqueducts, the road system, *limes*; on the other hand, *solitudines* (uncultivated expanses) and *silvae* (wooded, dark and difficult to access areas) significantly constitute the space of barbarism. In the context of ancient culture, the position of Theophrastus appears original, the only author who seems to express, in his research on plants, a properly “ecological” point of view.

Theophrastus sees the natural environment as having its own purposes, certainly not completely independent of man who is part of the environment, but nevertheless autonomous: in this, he overcomes Aristotelian anthropocentrism, linked to theoretical reasons, and also distances himself from from what will later be of the Romans, due rather to reasons of a practical nature (*Metaph*. IX, 34).

## 2. History of ecology and historical ecology

In a cultural context such as the one described, which tends to legitimize any type of human intervention on the environment, the only form of environmental protection seems to be connected with religious constraints: the only places that do not allow human intervention are, in fact, those perceived as "sacred", that is, as spaces for the manifestation of divinity. In the mentality of the ancients, the natural environment actually constitutes the privileged place for the activity of the gods, so much so that the cult was originally practiced in natural spaces where the presence of a superior power seemed to manifest itself (impervious and isolated places or struck by lightning, woods, caves, springs).

In cases of "sacred" space, it was believed that man's interference with the environment provoked a reaction from the divine, as various myths attest: the protection of wooded areas was applied, consequently, only to the alse or sacred groves (Haesch., *Pers*.; Callim. *Ad Dem*.).

But where space has a profane character, and that is in most cases, the Greek man feels free to manipulate and transform it as he pleases; the attitude of the Roman man appears no different, in a context that unscrupulously places side by side with the protection of sacred woods.

Thus, since Homer the presence of tall trees in Greece is associated with topographical marginality: a sign that already in the high archaic period the forests that had apparently characterized the most ancient Greek landscape began to be cut down, until the presence of woods was reduced, around 200 BC, to the most remote mountainous areas. Natural regeneration was unthinkable, both because it was very slow, and because of the consequences of the fires, and because of extensive grazing.

Deforestation is one of the factors with the greatest environmental impact in Greece, not only due to the needs related to agriculture, pastoralism, the various economic activities and subsistence needs, but above all due to the need for timber for shipbuilding.

Numerous testimonies confirm the importance of timber from ships: international treaties, such as that of around 393 between the Macedonian ruler Aminta III and the Chalcis of Thrace, contain conventions on the importation of this type of timber. Sometimes it also seems to capture some concern for the protection of the forest heritage: Plato (*Nom*. VIII, 843 e) provides for a fine for farmers from whose

lands fires have started that have damaged neighboring trees; Ptolemy III Evergetes forbade the cutting of trees on his properties and requested, in case of damage to the forest heritage, to proceed with replanting (Hunt 1934, 210).
Even in Rome, deforestation is one of the most significant factors of environmental degradation. Linked to the needs of building and shipbuilding activities, as Strabone (V, 2, 5) attests with regard to Pisa, which owed its ancient prosperity to the fertility of the soil, to the stone quarries and to the timber used for the construction of ships and for the construction of sumptuous residences, it caused serious hydrogeological instability, as revealed by the frequent flooding of the Tiber, and permanent deforestation in many areas of Italy, but, as in Greece, it was associated with natural catastrophes rather than with human error.
One of the most significant testimonies on the damage caused by deforestation remains the much discussed Plato's (*Kritias*, 110 d ss.). In the large passage, which describes the environmental conditions of ancient Athens, Plato underlines the profound changes that have occurred over time on the Attic landscape: Attica, once rich in fertile plains and imposing mountains covered with forests, waters and pastures abundant, has now become mostly barren and arid, almost completely devoid of tall trees. Plato identifies three main elements as the cause of the modifications: the leaching of the soil, deforestation, the contraction of water resources (which, in fact, required particular attention to the water supply in Athens in the second half of the 4th century BC).
The original cause of these various factors is identified in intense and prolonged rains, therefore in natural phenomena, even if of a cataclysmic nature; however, the role of human settlements in accelerating environmental degradation does not seem to be understood. The passage is mostly understood as a testimony of the consequences of uncontrolled deforestation on the Greek landscape: but, apart from the fact that Plato insists precisely on natural causes, in fact, as noted by Rackham, it does not in reality constitute a testimony on the damages of deforestation (Rackham 1996, 33-34). In fact, Plato affirms that the leaching of the land causes desertification, not that deforestation creates the conditions for the leaching and subsequent disappearance of the vegetation: the step must therefore be considered with greater caution, even if with all the interest it deserves.
The question of the relationship between deforestation and soil erosion is perhaps best understood by a fragment of Theophrastus preserved by Seneca (*Nat. Quaest*. III, 11, 2-4): the philosopher recalls that the felling of the forests of Mount Emo by a Gallic people caused the appearance of a large quantity of water, and that the same phenomenon had occurred near Magnesia. If Seneca is skeptical of Theophrastus' link between deforestation and flooding, Pliny appears more convinced in this regard (*Nat. Hist*. XXXI, 30, 53), who takes up and accredits the news, recalling that in fact «the forest normally retains the rain water and distributes them».
Other activities with a strong environmental impact, such as to be perceived by the ancients themselves, are first of all the mining activity, which involves invasive excavations, diversion of watercourses, air and water pollution: Herodotus (VI , 47) recalls that the mines of Thasos appear as "a large mountain, all thrown upside down in research"; Pliny (*Nat. Hist.* XXXIII, 1, 1) deplores the violations of nature in search of precious metals: «We try to reach all the intimate fibers of the earth ... marveling that sometimes it opens wide and starts to tremble ... Man has learned to defy nature».
Extractive activity (such as agriculture, hunting, fishing, timber harvesting) also raises the question, not ignored by the sources, of the excessive exploitation of resources: it seems to be present in the famous chorus of Sophocles' *Antigone* (vv. 332 ss.), which on the one hand celebrates man in his ability to subjugate and transform the environment, on the other grasps the risk of depletion of natural resources. Agriculture in this passage is seen on the one hand as a positive activity, because it is carried out in harmony with nature whose inextinguishable resources it exploits, on the other as a violation of the earth, “consumed" year after year by human work: the man «the most excellent of the gods, the Earth imperishable indefatigable, consumes turning the plow year after year and with the equine offspring revolted».

### 2.1 An emblematic case: Las Médulas

Las Médulas, in the province of Leòn (Spain), is an emblematic case of the situation described. It was the most important gold mine, as well as the largest open-pit gold mine in the entire Roman Empire. The spectacular landscape of Las Médulas resulted from the *ruina montium*, a Roman mining technique described by Pliny (*Nat. Hist.* XXXIII, 70-78). The technique employed was a type of hydraulic mining which involved undermining a mountain with large quantities of water. The water was supplied by interbasin transfer. At least seven long aqueducts tapped the streams of the La Cabrera district (where the rainfall in the mountains is relatively high) at a range of altitudes. The same aqueducts were used to wash the extensive alluvial gold deposits.
What became the Roman province of *Hispania Tarraconensis* was conquered in 25 BC by the emperor Augustus. Before the Roman conquest, the indigenous inhabitants obtained gold from alluvial deposits. Large-scale production did not begin until the second half of the 1st century AD.

In the book XXXIII of his *Naturalis Historia* Pliny (23-79) who was himself a *procurator* (high status official linked directly to the emperor) in Spain and visited the mines distinguishes three forms of gold exploitation:
*1. Aurum fluminum*: Gold from river sands.
*2. Aurum canaliense*: Gold following veins in solid rock.
*3. Aurum arrugiae*: Gold obtained from the *arrugiae*, underground excavations used to collapse the rocks in a process known as *ruina montium* (collapse of the mountains).
It was the third type of exploitation the one used in Las Médulas. We will focus now in the description of this technique that involved the transport of a great amount of water to the area of exploitation and the construction of channels and reservoirs. We must note that there is a consensus between the authors that describe this technique in the sense that the systematic use of hydraulic force was used to produce the *ruina montium*, though as it can be seen below, this point is not specifically indicated in the text of Pliny: «What happens is far beyond the work of giants. The mountains are bored with corridors and galleries made by lamplight with a duration that is used to measure the shifts. For months, the miners cannot see the sunlight and many of them die inside the tunnels. This type of mine has been given the name of *ruina montium*. The cracks made in the entrails of the stone are so dangerous that it would be easier to find purpurine or pearls at the bottom of the sea than make scars in the rock. How dangerous we have made the Earth» (*Nat. Hist*. 33, 70).
Channels bring water to Las Médulas from the eastern mountains and are in general 80-100 km long and up to 2 m wide, maintaining a constant slope between 0.2 and 0.4 %. The water depth was up to 10 cm. (Fig. 2) and dug real channels. A small collecting dam is found in the beginning of the channels and small tunnels and terraces are found along them, but never aqueducts.

**Fig. 1:** Las Medulas: *ruina montium*.

The bigger reservoir in the area was La Horta in Las Médulas and had a capacity of 18000 $m^3$. It was located in the upper part of the mining area and water was taken from here for the mining operations.
Once a rock mass containing gold had been identified through a thorough prospection, in a first stage this rock mass was excavated with tunnels. Then, a great amount of water was let to fall from the reservoir into the tunnels and it produced a collapse of the rock mass. More water thrown on the fallen material helped to send it to the wash channels, where gold was separated by a system similar to that used in modern mines.
Only the heavier cobbles and boulders, which could not be sent to the wash channels because they could obstruct or even destroy them, were separated by hand and piled in great accumulations that are now called “murias” by the people of the area.

They were made in this way to take full advantage of the hydraulic force for the collapse of rocks. As a result of this, rock prisms remained elevated near to the exploitation front after the *ruina montium* was conducted. They are common in the area and show vertical cliffs intersecting in different directions that cannot be explained by any geological process observed in the area, but only by the collapse of human made galleries (Aller et al. 2013).

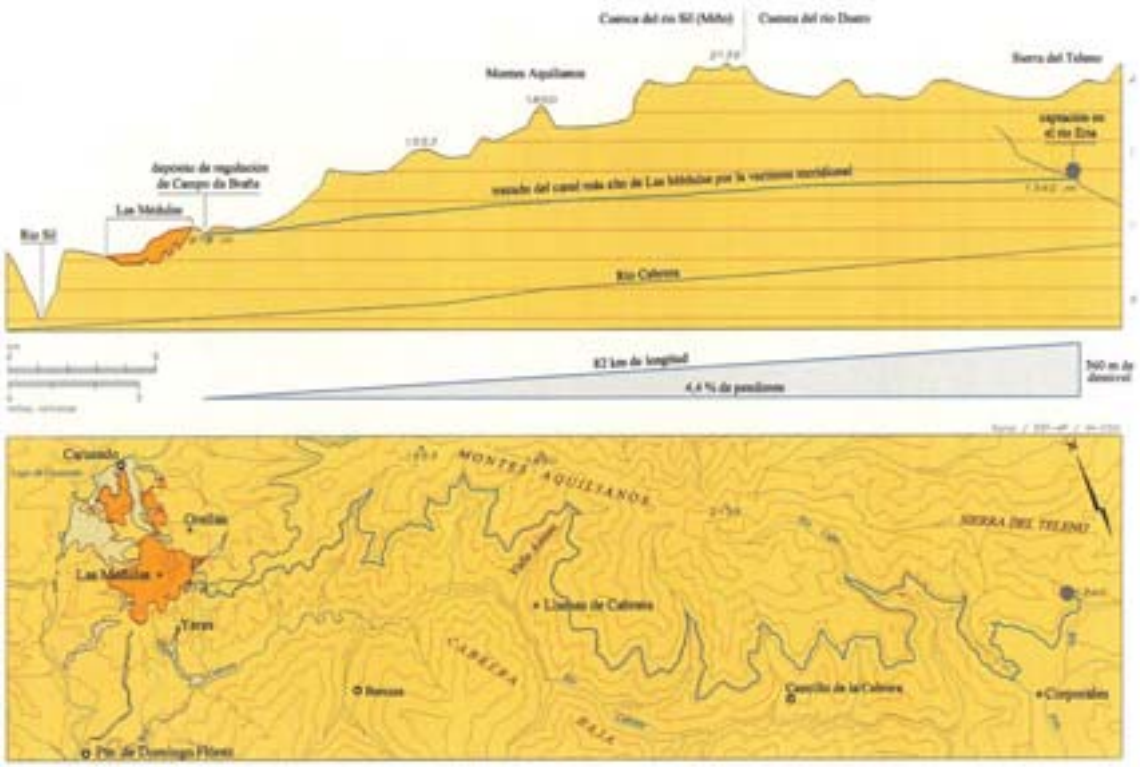

**Fig. 2** The higher channel in the area of Las Médulas (Aller et al., 2013).

Another interesting aspect is the great amount of debris resulting from the washing operations in the mine. This debris produced an obstruction in the valley that gave rise to the Carucedo lake.
The Roman occupation is recognized in the areas with rests of the gold mining operations, channels and debris accumulations, but also in some villages that have been excavated. Near to Lago, the archaeologists have identified a *domus* (Roman house) with plenty of comforts where the directive class lived and there are also miner villages at different points of the area.
Las Médulas mine was in operation from the beginning of the first century to the end of the second or the beginning of the third century, when work ceased in all the gold mines of NW Spain. The reason for this end is disputed among the scholars but all agree that the exhaustion of the ores was not the cause. Calculations of the amount of gold obtained in Las Médulas mine along this time span give c. 5 tons of gold (Aller et al. 2013).
The massive scale of mining at Las Médulas and other Roman sites had considerable environmental impact. Ice core data taken from Greenland suggest that mineral air pollution peaked during the Roman period in Spain. Levels of atmospheric lead from this period were not reached again until the Industrial Revolution some 1,700 years later.
The inclusion of Las Médulas as a World Heritage Site was controversial for similar reasons. The delegate from Thailand opposed the designation because he considered the site a result of human destructive activities as well as harmful to the noble cause of environmental promotion and protection (21 COM VIII.C-Decision).

### 2.2 The deforestation

Hand in hand with the intensive exploitation of underground resources, in Roman times, since the Republican age and throughout the Empire, there was a progressive and inexorable process of deforestation.

Before the Second Punic War, the territory of the Peninsula was covered by extensive forests. Then, as Rome gradually expanded its dominion, the forest contracted for two fundamental reasons: on the one hand, entire regions were confiscated and became part of the ager publicus to then be redistributed to veterans and merged into large estates; on the other hand, the necessities of war and the rapid expansion of the economy required huge quantities of timber. In particular, the pitch used to caulk ships, waterproof containers, paint walls and ceilings, package cosmetics and medicines was obtained from conifers. The extraction of pitch was contracted out by the State to companies of tax collectors and was of great importance, due to the related turnover, in some areas such as the Sila.

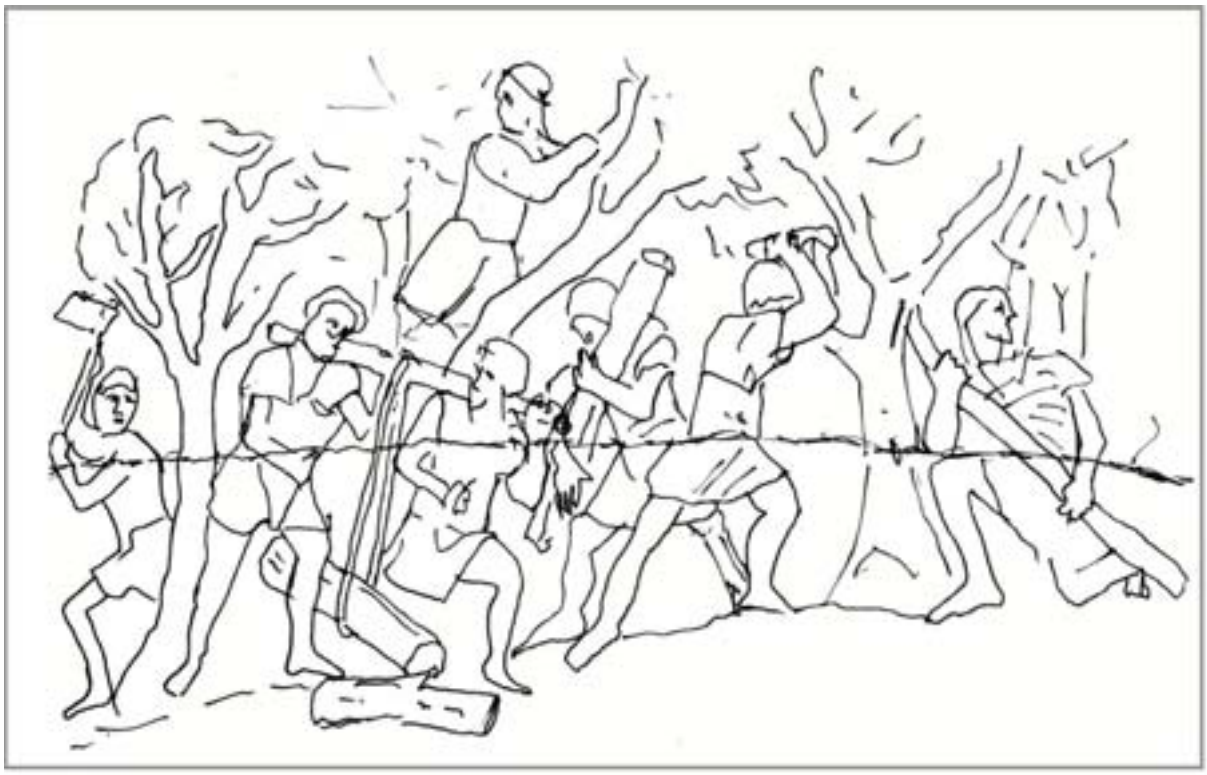

**Fig. 3** Tree cutting during a siege in Trajan's Column (grafic rendering).

### 2.3 The water problem

The problem of water, its use and its pollution is deeply felt in the Greek world. In 430 B.C.E. a decree (*IG* $I^3$ 257) in Athens forbade certain serious forms of pollution. Some significant peculiarities make this document, the first known in the field of territorial protection, an *unicum* (Campone 2022). The resolution taken by the *boulé* was aware of the kind of environmental degradation in question; it was equally aware of the causal connection between environmental degradation and certain routine economic activities; it acknowledged that practices more respectful of the environment were consequently called for; it believed that activities that were disrespectful of the environment could no longer be left to individual discretion; it is issued during the severe plague epidemic that broke out during the Peloponnesian War. The decree clearly treats degradation of the environment as an illegal activity, and it, already known to epigraphic scholars, has been studied for its topographical implications. Today instead it must also be analyzed in relation to the current ecological problem and the current health emergencies, also to highlight the aspects of an unprecedented ecological transition and in order to deduce some constants of the human reaction to certain events.

During a serious health crisis, the text introduces a concatenation –unprecedented for the times- between pollution and damage to health, all the more significant as it clashed with the economic interests of a particular sector (the leather tanners industry).

Although motivated by religious scruples, the rule documents the awareness of the Athenian community, which seeks to introduce behavior that is more respectful of the natural environment, without neglecting the economic aspect.

The stone with the inscription was found in the 1920s at the foot of the eastern slope of the acropolis and is now preserved in the Epigraphic Museum of Athens (EM 12553). It is a fragment of a Pentelic marble stele, broken at the top and bottom, but intact on the sides (h. 34,5 cm.; l. 44 cm.; sp. 15, 7 cm.). Despite the shortcomings, the text can be translated as follows: "(the present decree) be inscribed on a stone and let it be placed on both sides. (It is not allowed) to put skins (in the river), and thus to pollute

the Illyssus by the mounth of Heracles' temple, or to practice tannery and dispose of the waste in the river".
The inscription expressly refers to the river Ilissus and the temple of Heracles by the city gates. Hence we can locate with some precision the location of the environmental problem.
The decree is explicitly intended to protect a holy site, yet its effects are also economic, and the protection of public health also appears to be a primary concern. The removal of hazardous and noxious materials from the vicinity of the temple will achieve two related results: public attendance at the religious site will increase, and so will donations.
In the inscription, seriously incomplete, it speaks of the sum to be allocated in order to prepare two equal *stelai* and the archon *basilèus* is given a mandate to see to their realization. On the other hand, it is not clear who is responsible for actually observing the prohibition.
The geographic data is significant: the Ilisso river originates from the northwestern slope of the Hymectus, flows west to south of Athens, outside the walls of Themistocles. After the urban center, it joins the Eridano and flows into the Cefiso, which flows into the Gulf of Falero.
The area crossed by the river was known in ancient times for the richness and freshness of the waters and, in Roman times, it was the site of prestigious villas, such as that of Atticus, a friend and correspondent of Cicero.
Many theories have been advanced so far regarding the decree: according to some, it is a rule that delimits the area to be protected; according to others, it is a "sacred" law since reference is made to the archon *basilèus*, while the publisher of the decree (Lind 1987: 15-17; Lind 1990: 157-159) highlighted that it was issued not by a minor territorial body, but by the *boulé*.
The long-held hypothesis that the pollution was caused by those who went to the sanctuary of Heracles and washed the skins of animals sacrificed to the god in the river does not seem valid. Only recently (Rossetti 2002) has the decree been interpreted as the first ecological standard: the city would have taken measures against private entrepreneurs, to impose behaviors that are more respectful of the natural environment.
The water problem is also felt by Aristotle, as well as by Plato (Campone 2022). Among the four essential conditions "for the city", the Stagirite, in a famous passage from his Politics, specifically lists «the natural abundance of water and springs» and adds that otherwise «they must be provided for by arranging rainwater tanks, capable and numerous, so that water would never run out if war cut off the city from the rest of the territory. Since we need to think about the health of the inhabitants and this depends on the happy position of the area and secondly on the availability of healthy waters, we need to give thought to this too and not lightly [...] Therefore in far-sighted states, if the sources are not all equally pure and there is not in abundance, drinking water must be kept separate from that used for other uses» (*Pol*. 1330 b 4-7).
Aristotle repeatedly insists on the quality of water and the well-being that can derive from drinking water not only for men but also for animals. He points out that in certain regions farmers are convinced that the quality of the water even has an influence on the birth and growth of animals.
The above annotations would seem to express some awareness of ecological problems or at least they seem to underline the attention even of farmers towards water quality.
Of the relationship between water and primitiveness we find several examples also in the Stories of Herodotus. Sandanis, the counselor of Croesus, wanting to dissuade the rash king from waging war on the Persians, illustrates the scarce attractions of Persia, emphasizing how its inhabitants are still a wild people, a people placed on the edge of the state of nature: they do not drink wine, but water (Hdt. 1, 71; 4, 183). Drinking water –or rather drinking only water– is a sign of cultural backwardness, since living on water is equivalent to collecting, like animals, what nature spontaneously offers. Water is for basic needs and ensure survival. In this sense particularly significant about the relationship between water and primitiveness is what Herodotus himself reports about the nomadic Libyan populations: those who live along the coast are the most civilized and drink milk, those who instead they live inward, leading a life that borders on the ferinity.
The pollution of river courses shouldn't have been an extraordinary event especially in the vicinity of the great sanctuaries and places of worship. Significant in this regard is what Strabo observes regarding the Aretusa spring in Ortigia which was considered a "resurgence" of the Alpheus, the largest river in the Peloponnese. The waters of this source became turbid as a result of the sacrifices of oxen made in particular circumstances in Olympia (VI, 2, 4).
Alongside these phenomena of environmental pollution, the forms of withdrawal of water, a fundamental natural resource, must be considered.
Also in this case it is the Athenian example which allows us to have a deeper knowledge.
We know that in Athens there were the offices of "superintendent of the waters" (*epistátes hydáton*) who ensured that there were no subtractions or abusive derivations and of "curator of the fountains" (*epimeletès krenôn*). From Plutarch we learn that Themistocles had held the position of superintendent of the waters, and, with the fines inflicted on those who subtracted or diverted the waters, had had a

bronze statuette made of the so-called "Water Carrier" which he had offered as a votive offering to the Mother some gods (Plut. *Them*. 31, 1).
That this office was considered very important can be deduced from what Aristotle himself refers who, in the Constitution of the Athenians, underlines that it was one of the few magistracies, which concerned the common administration, remained elective together with the treasurer of the funds military, those of the holidays as well as the posts related to the war. An example of controversy for alleged derivation of public waters is found in Demosthenes in the oration *Against Callicles*. All of this is an explicit reference to the difficulties of finding water resources for Greek cities.
Ancient Greece lacks a serious water supply policy. The individual cities limit themselves at most, as already highlighted with regard to Athens, to regulating relations between private individuals and to preventing or punishing the abusive exploitation of community waters.

**2.4 Pollution, wars and peace. The *topos* of *locus amoenus*.**
In essence, in the Greek and Roman world, the celebration of man's ability to intervene and transform ends up prevailing, nor does the need for man to develop a certain sense of responsibility in protecting the environment seem to be perceive.
In this regard, it is perhaps worth noting that the development of an adequate environmental sensitivity was also impeded by the frequency of wars, whose impact on the environment was generally very strong.
The relationship between the natural environment and war is reported by the sources in a different sense. On the one hand, the environmental situation can expose or protect against enemy attacks: if in Herodotus the beauty and prosperity of Europe constitute an incentive for the Persians to attempt its conquest (VII, 5, 6), Thucydides believed that the scarce fertility of Attica had protected it from invasions, while other Greek regions due to their fertility had been exposed to foreign aims (I, 2, 3-5). On the other hand, war seriously damages the environment, causing devastation due to raids or fires and the pollution of agricultural areas and waters (through the shedding of blood and the presence of corpses) and encouraging the withdrawal of natural resources (for example through the construction of siege engines); some aspects of the law of war, such as the ban on deliberately polluting waters, testify to a certain concern in limiting the environmental damage caused by conflicts.
Greek cities generally had limited dimensions: only a few large cities, such as Athens and Corinth, could pose serious environmental problems, also because they were progressively developing cities, that is, cities that grew spontaneously and without a rational plan. Colonial cities, or in any case built on the basis of the Hippodamian "geometric" system, reveal a more orderly layout, with a rational distribution of religious buildings, public structures and areas destined for private construction, and therefore such as to ensure greater livability for their inhabitants. However, the great classical and above all Hellenistic cities (interesting, in this regard, the description of a great metropolis like Alexandria in Theocritus' *Syracusans*) were certainly afflicted by problems such as overcrowding, traffic, noise, water and air, the limits of the sewage system, the difficult disposal of waste. It is no coincidence that in the Hellenistic period an idyllic vision of life in the countryside and of the rural landscape developed which was completely incompatible with the hard life of the Greek farmer and, in fact, not very widespread in classical literature.
In any case, the classical Greek city remained on a human scale and was able to ensure a good quality of life: Aristotle, in the *Constitution of the Athenians* (50, 2), recalls that the officials called astynomoi had the task of see that the sanitation workers did not dump the garbage within ten stadia of the walls, that the streets were not blocked with buildings, that the balconies did not overflow onto the streets, that there were no pipes that discharged into the street, that the corpses were collected . In the same sense - protection of public health and the quality of life of the citizen - the tasks of the market inspectors (*agoranomoi*) should also be understood, who had to take care of the goods, so that they were sold "pure and without adulteration" (51, 1).
Particular attention was paid to the aspect of the quality of life in the urban context by the Athenian democracy, which set out to guarantee a certain quality in the daily life of its citizens not only at a public level, by organizing spaces for politics and worship, but also in the private field, ensuring social communication in a framework of widespread comfort and well-being, through the availability of service structures such as theatres, gymnasiums, baths, gardens, arcades, fountains (Musti 1986, 109-119).
The testimonies relating to the problems of urbanization are particularly extensive for Rome: to the usual problems of crowding, noise, traffic, smoke and dust pollution, the danger of collapses and fires, deficiencies in the sewage system, we must add the danger deriving, for the drinking water, from the use of lead pipes (of which the toxicity was also known, as attested by Vitruvius, VIII, 6, 10-11, who proposed to replace the lead pipes with terracotta ones.
Sensitivity towards these problems is heightened among the Romans by the fact that they generally feel strongly the concern for the healthiness of the environment, for example in the choice of places for the construction of cities, houses, farms, public buildings; in the sources we often find the denunciation of

building speculation, which places human settlements in contrast with agricultural activity and with the natural order.
The contrast between city and countryside is inserted along this same line, with the typical idealization of the *locus amoenus*: not unlike in Hellenistic poetry, nature is seen in the idealized perspective typical of urban societies, which contrasts the serene life of the countryside with that, insane and chaotic, of the city; but alongside this idealization there is also the rejection of the wild world, the *locus horridus* in which nature takes on dramatic and hostile contours.
The theoretical and practical attitude of the ancients towards the environmental question therefore seems to move, with significant continuity between the Greek world and the Roman world, between the need to control nature and bend it to human needs and the perception of the limits of those lifestyles that no longer appeared in harmony with nature itself.
Thus Pliny, after having stigmatized the behavior of men, who pollute rivers and natural elements and even poison the air which is essential for them to live, trusts in the greatness and magnanimity of nature to support man's need to continue in any case to pursue progress, committing to "make life better" (*Nat. Hist*. XVIII, 1, 2-5).

## 3. Conclusions

The reflection on nature is, in the ancient world, not univocal and limited above all to the Greek world rather than to the Roman one.
Moreover, the ban on cutting down trees or cutting, stealing and transporting firewood as well as grazing livestock inside sanctuaries are among the most common in the Greek world, and reflect, on the one hand, as P. Brulé observed, the daily concerns of the Greeks, with respect to the shortage of wooded areas or land to be reserved for grazing animals, which often led farmers to violate the space; sacred of shrines; and on the other hand, the religious scruple expressed in such prohibitions which tended to remove areas destined for the worship of divinities from daily use, keeping an ecosystem unchanged and separate in which human and superhuman, plant and animal organisms coexisted harmoniously under divine protection.
In the famous *Oath of the ephebes*, the young Athenians invoked, as witnesses of their commitment to the defense of Attica, in addition to a circle of gods linked to the sphere of war, the borders of the fatherland, wheat, barley, olive trees and figs. Like the other divinities, these elements, constitutive of the Attic landscape, are here invested with a capacity for action which serves to give efficacy to the promissory act. The boundaries of the homeland, the wheat, barley, olive trees and figs of Athens are powers capable of ensuring the keeping of the promise of the young man, engaged in his military service or of punishing him in case of perjury. Man and nature are mutually called into question in the defense of the territory and the boundaries that delimit it.
This induces us to review some critical positions and to rethink the man-environment relationship in ancient times in less anthropocentric terms.

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# AI and green transition: solutions for to nudge people towards correct waste management practices

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Abstract
Artificial Intelligence (AI) can play a significant role in accelerating the green transition by enabling more efficient use of resources, reducing emissions, and promoting sensibility in various analysing: it can optimise waste management by analysing data on waste production and identifying opportunities for recycling and reducing waste.
Here are some examples of nudging in waste management:
• Recycling reminders: AI-powered chatbots or mobile apps can send recycling reminders to users based on their location or the types of materials they have recently disposed of;
• Gamification: AI-powered games can be designed to encourage users to recycle and reduce waste;
• Personalized feedback: AI algorithms can analyse an individual's waste disposal patterns and provide personalised feedback on how they can improve their waste management practices;
• Social influence: AI algorithms can be used to analyse social media data and identify influencers who are promoting sustainable waste management practices;
• Behavioural intervention is used to identify behavioural barriers to correct waste management practices and develop targeted interventions to address these barriers.
This article aims to analyse the future of waste management, and AI-powered nudging looks promising, with many possibilities for improving efficiency, sustainability, and behaviour change.
In particular, we will analyse the possibility that these tools have to modify the perception of the problem of garbage in urban spaces with a specific interest in those transformations necessary to face the climate change underway.

**Keywords:** AI, Green Transition, Perception, Urban perception, Waste management

## 1. Introduction

Waste management is one of the three main contributors to climate change, one of the vital challenges for the future of human society and our planet. As a result, the European Parliament declared a state of climate emergency in Europe and urged all Member States to reduce greenhouse gas emissions by 2030 and to zero by 2050.
Proper waste management is a fundamental aspect of the ecological transition and the protection of the environment; the use of Artificial Intelligence can be an excellent solution to push people towards correct recycling practices and can revolutionise the contemporary research landscape by analysing large amounts of data more quickly and efficiently than was possible in the past. It means discoveries and trends that would otherwise have been difficult or impossible to spot can be made faster.
AI is changing how we work: many work processes, from routine tasks to complex decisions, can now be automated, freeing people from tedious and repetitive tasks and allowing them to focus on more value-added tasks.
However, AI has also raised concerns about excessive automation and the possible lack of work that results from it, thus generating a debate on the need for continuous training and reskilling to help people create new skills and adapt to market changes.

AI is transforming our work and research, offering new opportunities and challenges. Therefore, it is essential to understand and adapt to its impacts to maximise its potential and minimise its possible risks.

## 1. Nudging and visual representation

Nudging is a theory of behavioural economics that can be translated as a "gentle push", a positive reinforcement or an indirect suggestion that can influence people's behaviour in a predictable way but without prohibiting the individual's choice. Nudging is, in practice, a science that studies how we can positively influence people's behaviour without forcing or forbidding them to do something.

A nudge is "any aspect of choice architecture that alters people's behaviour in predictable ways without prohibiting the choice of other options and without significantly changing their economic incentives. To count as a mere prod, the intervention should be easy and inexpensive to avoid. Prods are not orders." (Thaler & Sunstein, 2009)

Nudging uses a combination of subtle stimuli, such as the arrangement of objects or the labelling of products, to guide people's behaviour; it is based on the theory of behavioural economics, according to which people do not always make rational decisions but are influenced by factors such as emotions, the surrounding environment and social influences.

A typical example of nudging is the "default option" or the default option. For example, when offering a donation option for a good cause, presetting the donation option is an essential nudging technique. In this case, the donation option preset implicitly suggests that donation is preferred and makes it more likely that people will opt for it.

Research published in PNAS (Garnett E., 2019) on methods to increase vegetable consumption in university cafeterias is one of several successful examples of nudging, gentle and non-explicit encouragement to make better choices for one's health or the environment.

Nudge, in general, can be defined as descriptive or injunctive, referring to the type of message: in particular, a descriptive nudge is a message that provides information about the behaviour of others. In contrast, an injunctive nudge is a message that indicates what people should do.

Descriptive nudge focuses on using social information to influence people's behaviour. In this type of message, a description of the behaviour of others is provided to encourage people to follow their behaviour. For example, a sign indicating the number of people who have already used the bicycle to work can be considered a descriptive nudge.

On the other hand, an injunctive nudge focuses on the use of directions or instructions to influence people's behaviour. In this type of message, an indication of what people should do to encourage them to take a specific action is given. For example, a sign stating, "Use your bicycle to get to work", can be considered an injunctive nudge.

However, research has shown that descriptive nudges may be more effective in promoting sustainable behaviour than injunctive nudges. This is because descriptive nudge uses social influence to motivate behaviour, while injunctive nudge can be perceived as a restriction or obligation, leading to resistance or adverse reactions from people.

The visual representation and communication tools through images are essential for communication and education in general: using pictures and pictograms can help provide recommendations on comparisons and guide choices.

Visual representation is one of the techniques used in nudging to influence people's behaviour sustainably, including in waste management. For example, visual cues or persuasive messages can encourage separate waste collection or reduce water waste. An example of the application of visual nudging with visual representation was an experiment that led to a significant increase in the separate collection of garbage by students of the Sant'Anna University of Pisa (Cosic C. & all 2018) through the use of posters that encouraged recycling by speaking the percentages of recovered material of the University with those of Harvard. In addition, visual representation can be an effective way to promote sustainable behaviour without imposing rules or sanctions.

To implement the nudge strategy, however, it is necessary to establish constant communication that contains information and feedback. In this way, it is possible to create a decision-making environment that pushes people to make good decisions for their interests.

For example, using colours to signal the degree of danger can effectively push people to make good decisions for their interests.

Environmental nudging techniques, in particular, offer several advantages: First, these techniques can help guide people's sustainable behaviours.

In addition, nudges can be used to promote collective action and environmental protection.

The green nudge policy focuses, in particular, on creating decision-making processes that push people to undertake valuable solutions for the well-being of the community, to contribute to the promotion of sustainable behaviour and to improve the quality of the environment.

Visual communication is used in many areas, including advertising, security and sustainability, and through images, colours, and layouts, it communicates a message.

Visual communication focuses on using visual elements to capture attention and convey a message effectively; for this reason, it is effective in environmental nudging projects.
An example of visual green nudging is the labels for communicating the ecological value already in use with different types of products: the representation methods take up those of the colour variants from red to green for the energy consumption certifications of appliances and homes.
The gentle push in this image exploits the association between red as a stop danger message and green with the meaning of natural green light, taking up the colours of the road regulations. This association makes the message clear and fast.

Fig. 1: Examples of Nutri-Score, Planet Score and Eco-Score labels for the classification of different types of products

Fig. 2: Examples of labels to highlight the impact of the product on CO2 production.

## 3. AI, Green Nudging and municipal waste management, practical examples

Proper waste management is a fundamental aspect of the ecological transition and the protection of the environment. Artificial Intelligence can be an excellent solution to push people towards correct waste management practices.
One possible application of AI is intelligent robots that can recognise and dispose of waste correctly. For example, these robots could be used in public areas such as parks or beaches, where people often abandon waste inappropriately.
Robotics and artificial intelligence can also be used to achieve recycling targets and increase the value of material flows; They can play a central role in automation and provide useful information to solve operational problems and improve the efficiency of recycling processes.
In addition, AI could be used to develop mobile applications that help people manage their waste correctly by providing information on how different types of waste are disposed of and the nearest collection points or by offering incentives such as discounts or rewards for those who dispose of their trash correctly.
AI could be used to analyse data on waste generation and management to identify areas where more action and improvements are needed by developing a more effective and targeted waste management strategy. The use of Artificial Intelligence can be an effective solution to push people towards
Good waste management practices and thus contribute to the ecological transition, the effectiveness of nudging in the environmental field is recognised at the European level.

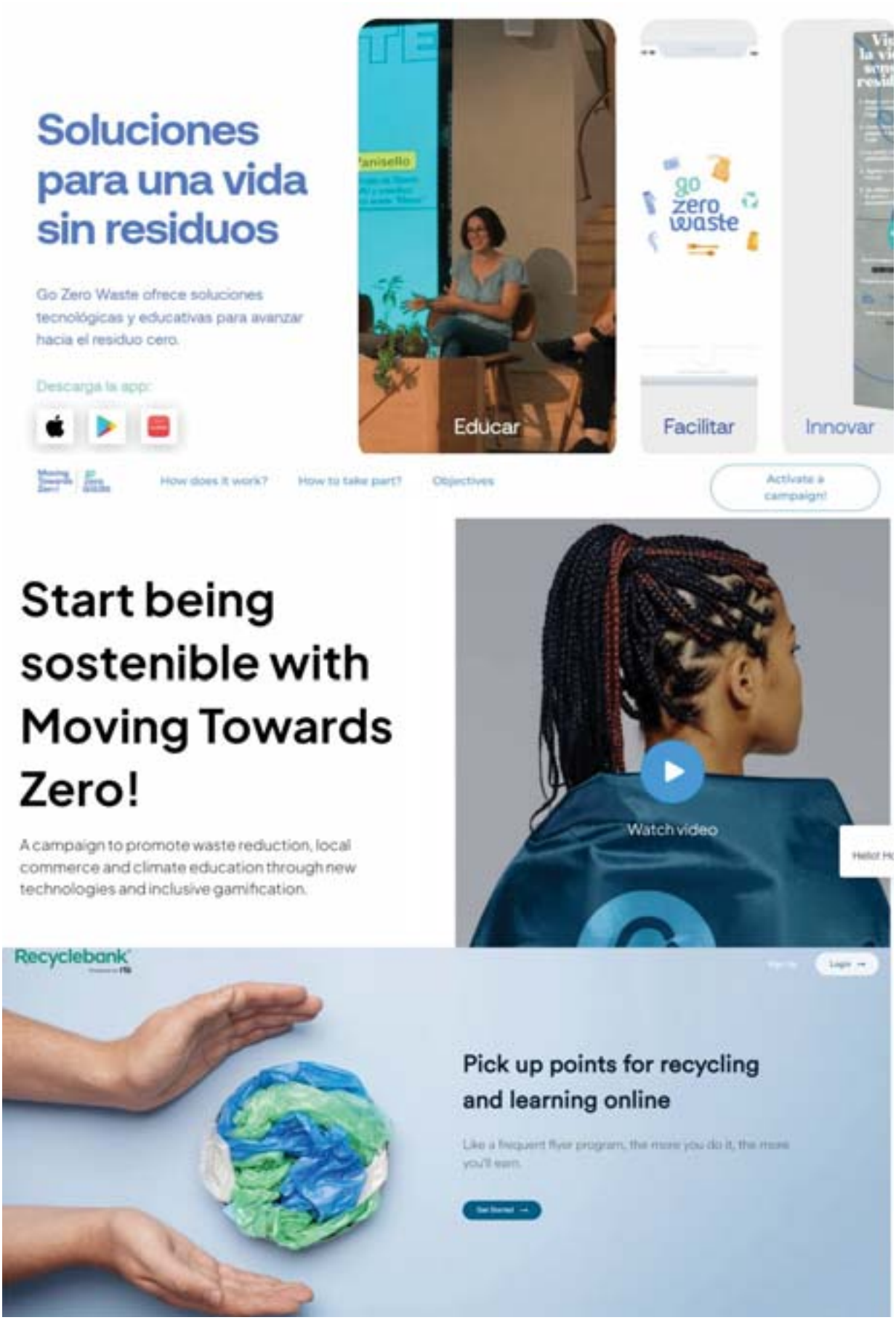


Fig. 3: Examples of sites dedicated to recycling incentive projects that combine gamification and artificial intelligence.

Recycle Bank, for example, is an AI-powered mobile app that helps users identify types of recyclable materials and provides information on how to recycle them properly. It also sends personalised recycling reminders to users based on their location and waste collection schedule in their area.
Gamification is a technique that uses elements and mechanics of games to motivate and engage people in non-playful activities such as work or learning. Thanks to gamification, creating an engaging and fun experience that encourages people to actively participate in an activity, achieve specific goals and improve their performance is possible.
Artificial intelligence (AI) can improve the gaming experience and customise game mechanics based on users' preferences and habits. In addition, AI-powered games can be designed to raise awareness about important issues such as recycling and waste reduction.
AI-based games make it possible to create an engaging and interactive experience that can incentivise people to change their behaviours positively. For example, a game might reward users who recycle properly or reduce waste, increasing awareness of these activities' importance.
Gamification can be an essential strategy to motivate people to participate in an activity and improve their performance actively. AI can further enhance this gaming experience by customising game mechanics to users' preferences and creating games that raise awareness about important issues such as recycling and waste reduction.
A possible application of gamification in municipal waste management could be to encourage people to recycle correctly through apps or games that offer prizes or awards for the correct disposal of waste. In addition, a scoring system or ranking could be created among the various households or neighbourhoods of the city based on the amount of garbage adequately disposed of.
Gamification and artificial intelligence can be used to promote recycling and waste reduction. For example, the Catalan startup "Go Zero Waste" has created a platform that offers personalised challenges through an application in collaboration with local governments, schools and educational organisations with several objectives.
"Go Zero Waste" creates technological solutions to promote the reduction of residues through challenges with municipalities, companies and educational centres. In addition, the startup has launched a resolution to encourage the removal of residues and the local economy thanks to gamification.
The "Moving Towards Zero" platform combines the best of gamification and digitalisation into a flexible platform that helps transition to relevant behavioural changes. In addition, the platform uses artificial intelligence and green blockchain to achieve its goals.
The project allows the launching personalised challenges for a community or a group of people to encourage adopting new sustainable habits. In addition, the startup facilitates the technologies and tools necessary for the implementation of the campaign, including continuous technical support and department.
Adopting a zero-waste lifestyle can significantly benefit the environment by reducing waste in landfills or at sea, reducing the environmental impact of waste production and disposal processes, and promoting the circular economy.

## 4. AI, Green Nudging and Ethical and legal implications

Green nudging is a technique that uses subtle interventions to push people towards sustainable behaviours, but using these techniques raises some ethical implications.
For example, visual nudging could be considered manipulative and restricts people's freedom of choice. In addition, the effectiveness of nudging techniques depends on people's ability to decode people's emotional world, which could raise concerns about data privacy and security. However, encouraging techniques can help promote sustainable behaviour and improve the environment's and society's well-being. In addition, integrating nudge into European policies has been recommended as a support tool for fostering sustainable behaviour.
Using nudging in public policy raises ethical and legal implications that must be addressed at the political level.
Nudge projects aim to improve people's decisions by changing how options are presented rather than changing the choices themselves. However, some argue that nudges are unethical because they overextend government control to behaviours that should not be controlled. The effectiveness and ethics of nudge politics are also debated, as they capitalise on psychological insights into human behaviour to inform central policies. Ethical issues largely depend on whether nudges promote or undermine people's autonomy and freedom of choice. Therefore, it is essential to address the practical and ethical issues of nudging in public policy, considering the complex moral, social and cultural problems of unconscious influence.
L'introduzione dell'intelligenza artificiale (AI) e del green nudging ha aperto nuove opportunità per migliorare il nostro mondo dal punto di vista ambientale, ma anche ha sollevato preoccupazioni riguardo alle implicazioni etiche di queste tecnologie.

To address these ethical concerns, experts suggest developing moral norms governing the use of AI. These rules should include transparency, consent, accountability, fairness and privacy. For example, AI should be transparent in data collection and processing, and those involved should be able to consent to use their data. In addition, organisations that use AI should be accountable for AI's actions and ensure fairness in data processing.
Green nudging can interfere with people's free will, pushing them to make specific choices rather than leaving them free to decide. In addition, green nudging can promote particular ideologies, creating social pressure based on what is considered "right" or "wrong". This can lead to a lack of respect for diversity of opinions and values.
Artificial intelligence can raise ethical concerns about data privacy and security. For example, machine learning and data analytics techniques can allow organisations to collect sensitive personal information about their users and use it for improper purposes, such as discrimination or manipulation. To avoid these risks, strict ethical standards and laws that protect the privacy and security of user data are needed.
In addition, using artificial intelligence can also raise concerns about moral responsibility and liability. For example, suppose AI is used to make crucial hiring, lending, or holding decisions. In that case, there may be a risk that decisions will be influenced by bias or errors in the algorithm without human responsibility. In this case, regulations are needed to ensure transparency and accountability in decisions made by AI.
Nudging, on the other hand, can raise ethical questions regarding manipulating human behaviour. Nudging is based on the fact that people are influenced by small changes in their surroundings, such as advertisements or default choices. Although nudging can promote positive behaviours, such as physical activity or energy saving, it can also manipulate people's choices without consent. To avoid these risks, ethical norms and laws are needed to guarantee transparency and informed consent in using nudging.

## 5. Conclusion

In Italy, the waste recycling rate is the highest in Europe, reaching 83.2% of total waste, which is more than double the European Union average and higher than all other large countries, such as Spain (60.5%), France (54.4%) and Germany (44%). Moreover, Italy is one of the few European countries that, despite already a high recycling rate, improved its performance between 2010 and 2018, with an increase of 8.7% (Repubblica, 24 November 2022).

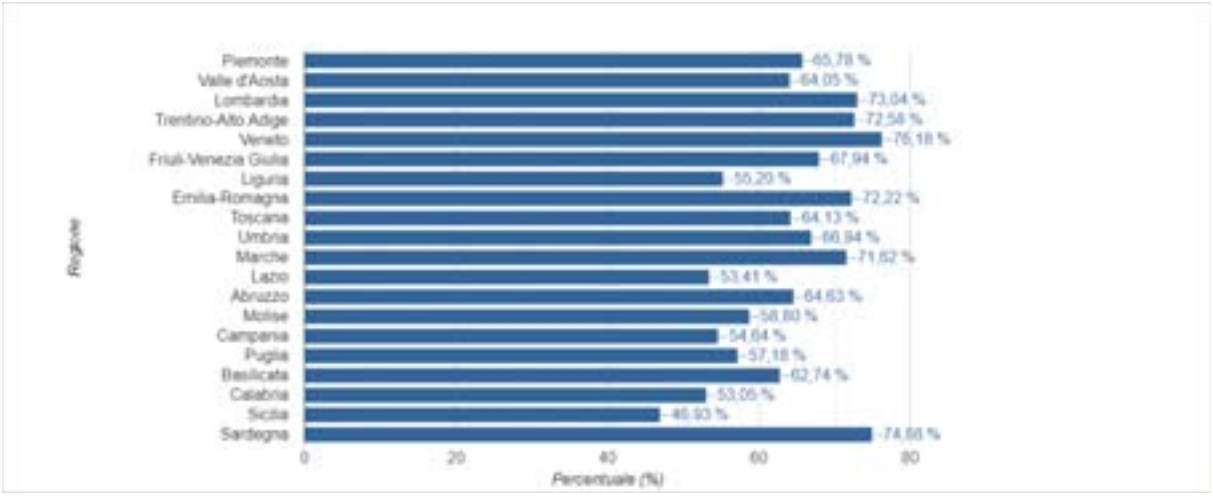

Fig. 4 Refreshing graph of the percentages of recycled waste for Regione.in Italy, data for the year 2021

In particular, the city of Treviso, with 88%, ranks first for the amount of recycled material for provincial capitals, while the city of Genoa, with 39.92 % (Data from the Liguria Region – Environment Sector), is far below the Italian average.
The factors that determine this result are many: from the logistical difficulties in waste management given by the conformation of the city itself, squeezed between sea and mountains with a lack of space for plants able to deal with the size of waste flows of a large city, to the problems of involving the local population in recycling practices.
For these reasons, in a situation like the one in Genoa, nudging practices combined with AI can offer the active involvement of citizens in waste management practices: the urgency of finding solutions that provide a significant improvement in awareness and education not only in schools to young people but

methods that can also reach the adult population and that rapid trigger results in the choices for recycling.

Fig. 5 Images of recycling and waste collection centres of AMIU city of Genoa.

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# Dwelling on Earth by learning from Nature. Urban and building systems more sustainable and resilient through the use of Nature Based Solutions and Biomimicry

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## Abstract
In the last two and a half centuries, an instant compared to the 4 billion years of the Earth's life, the human species has compromised every ecological niche on the planet, upsetting the delicate balances of homeostasis that regulate the biosphere. In 2020, the mass of all man-made artefacts made by humanity, over one trillion tonnes, exceeded the mass of all living organisms. The growing impact of the human footprint on the planet is accompanied by a strong increase in urbanisation even in the oldest economies, where population growth is almost zero. UN projections predict that by 2050 some 70 % of the world's population will live in urban areas. This will lead to an inevitable growth in the number and volume of new buildings. Globally, according to the Global Alliance for Building and Construction (GABC), there are about 245 billion square metres of buildings on earth today. Without corrective measures, another 230 billion will be built in the next forty years and 70 % of these will not be covered by mandatory and shared energy and environmental efficiency standards. One can therefore understand how cities and buildings constitute a strategic and necessary area for achieving the environmental and decarbonisation goals of Agendas 2030-2050. In relation to these goals, the contribution intends to explore the potential of Nature Based Solutions (NbS) and the biomimetic approach to regenerate and transform urban and built environments.

**Keywords:** Urbanisation, Climate Change, Green technologies, Nature Based Solutions, Sustainability

## 1. Climate issue and human settlements
The summary report 'Climate Change 2014' [1] published in 2015 by the Intergovernmental Panel on Climate Change (IPCC), a reference point for the 2015 Paris Agreements, unequivocally establishes the phenomenon of global warming and the impacts on the other components of the climate system, highlighting how the human factor is considered the dominant cause of global warming by 95% of the international scientific community. Concentrations of carbon dioxide, methane and nitrous oxide have increased by 40%, 150% and 20% since 1750, reaching the highest values in the last 800,000 years (IPCC data, 2015). Since 2016, the concentration of CO2 in the atmosphere has consistently exceeded 400 ppm, currently reaching a daily average value of over 420 ppm. Currently, according to data published in the monthly report of the Italian Air Force (Monte Cimone observatory for atmospheric conditions in southern Europe and the northern Mediterranean), the average monthly CO2 concentration for the month of March 2023 was 424.69 ppm. [2]
Projections of future climate gas emissions vary over a very wide range of values depending on whether climate policies are implemented or not. In all scenarios assumed, however, surface temperatures are projected to rise during this century by at least an average of 1.5°C above pre-industrial levels. In fact, in some climate hotspots, such as the Mediterranean area, this value has already been reached and warming is proceeding 20% faster than the global average. [3]

Without significant mitigation measures, i.e. substantial and sustained reductions in greenhouse gas emissions, the global average temperature could rise much more, between 2 - 4 °C and more. Continuing to emit climate-altering gases into the atmosphere will produce further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe and irreversible impacts on humanity and natural systems. Already now, climate change impacts human life and natural systems with the increase of extreme weather phenomena such as floods, flooding or, on the opposite side, severe droughts. There is also an increase in the number and duration of heat waves, which have a greater impact in urban areas with serious effects on morbidity and mortality in the population (World Meteorological Organization (WMO) and World Health Organization (WHO) data) [4]. Exemplifying the consequences caused by these changes at a local level, in the report on Climate Vulnerability in Turin [5] drawn up by Arpa and the Environment Department of the City of Turin, possible scenarios were elaborated using high-resolution simulations obtained with the COSMO-CLM regional climate model (at 8 km horizontal resolution) produced by the Euro-Mediterranean Centre for Climate Change (www.cmcc.it). These are the same simulations used for the National Climate Change Adaptation Plan of the Ministry of the Environment and already used in scientific works [6]. The climate scenarios for the Turin case were calculated on the basis of the Representative Concentration Pathways (RCP) developed by the IPCC panel. These scenarios indicate a representative pathway of greenhouse gas and aerosol concentrations for a given climate target, in terms of radiative forcing in 2100, which in turn corresponds to a given climate emission pathway. In all three RCP scenarios (RCP 8.5, No climate protection, RCP 4. 5, Limited climate protection, RCP 2.6, Consequent climate protection), temperatures and related thermo-hygrometric discomfort indicators will continue to rise at least until the middle of the century, when, depending on the actions actually implemented, they may either be stabilised or in the worst case, they will continue to grow, irreversibly altering the local climate, which will be characterised by higher temperatures in summer and winter, with the highest deciles rising from 30 to 45 degrees in the case of the RCP 8.5, No Climate Protection scenario. In the face of the worrying data of these scenarios, the application of the 2030 Agenda and the adoption of policies to achieve the UN Sustainable Development Goals must urgently be expressed more concretely, through incisive and effective actions, declined at the local level with diversified tools and strategies, and through measures to assess results shared and applied at different strategic, national and international levels.

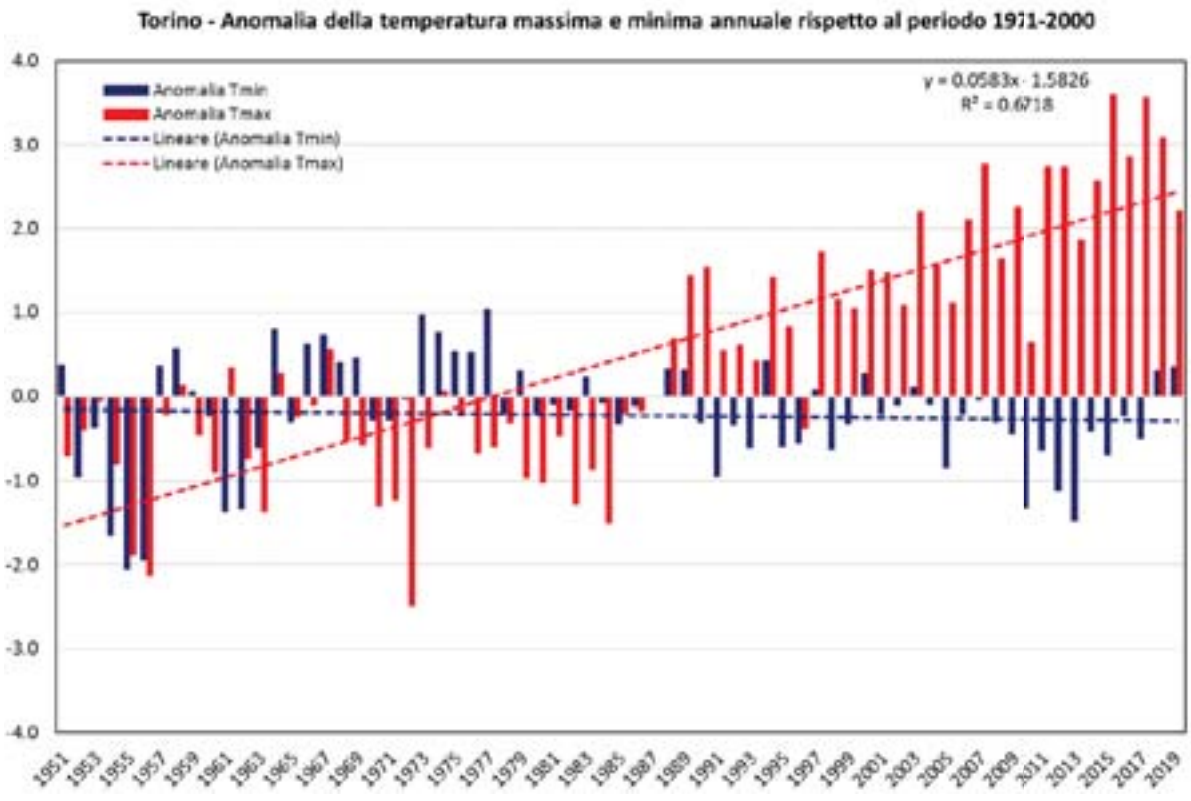


**Fig.1:** Turin annual temperature anomalies compared to 1971-2000. Source Climate Resilience Plan, City of Turin 2020

### 1.2 Urban phenomena and sustainability goals

The urban and building issue, which directly affects our way of inhabiting the Earth, plays a relevant role in relation to sustainability goals. Today's cities, in different ways depending on geographical and local contexts, are major dissipators of the biosphere's energy and environmental resources. It is not possible to implement effective strategies to curb climate-altering emissions and decrease humanity's global ecological footprint without major action on cities. Urban areas represent better than any other phenomenon the size and intensity of the impact of human activities on the planet, and if we want to achieve concrete results in the climate and environmental field, we need to rethink and completely transform the urban model we have inherited from the past. Indeed, contemporary cities are major consumers of all primary resources on the planet, from water to food, including energy and environmental stressors, and are responsible for about 80 per cent of CO2 emissions into the atmosphere [7]. Currently, more than 50 per cent of the world's population lives in cities and the trend is constantly growing. According to the UN's World Urbanization Prospects 2018 [8], by 2050 almost 70 per cent of the world's population will live in urban areas, reversing the historical ratio of urban to rural population. Furthermore, urban growth is usually accompanied by negative effects such as traffic congestion, overcrowding, unemployment, environmental pollution, corruption, poor infrastructure, weak institutions and, especially in developing countries, housing insecurity (more than 1 billion people worldwide live in slums, bidonvilles, favelas, etc.), social and spatial segregation, and low participation in social and political life [9]. In countries of older industrialisation such as Italy, the 1970s and the first energy crisis are generally considered the watershed between the end of the period of concentration of urban areas and the beginning of a phase of dispersion, characterised by the slowdown in the process of demographic growth of cities, the displacement of citizens into the urban crown and the consequent progressive transformation into metropolitan areas. The phenomenon of urban sprawl, understood as the haphazard and uncontrolled urban expansion towards peripheral areas combined with declining population density, is one of the most evident land-use changes in the contemporary world, especially characteristic of the oldest industrialised economies [10]. In Europe over the last twenty years, urban areas have continued to expand with an increase in built-up area of about 20 per cent, compared to only 6 per cent population growth [11]. The consumption of vacant land is also very evident in Italy, where large amounts of agricultural land have been urbanised, in the face of a population growth that is substantially stagnant. All this to the detriment of the nation's biological capacity. At present, in the absence of a framework regulatory instrument at national level and in the presence of rather heterogeneous regional rules, the scenarios opening up for land use in Italy second ISPRA Observatory could have very different consequences. If the objective of achieving a zero increase in net land use in 2050 were pursued with conviction, this would mean 818 km2 of new land lost between 2017 and 2050. If, on the other hand, the trend observed in 2017, i.e. in conditions of low economic growth, is confirmed, 1772 km2 per year would be lost. Under conditions of strong economic recovery, without strict regulation, the values of land consumption in recent decades could be reconfirmed, reaching 8073 square km of land lost in 2050 [12].

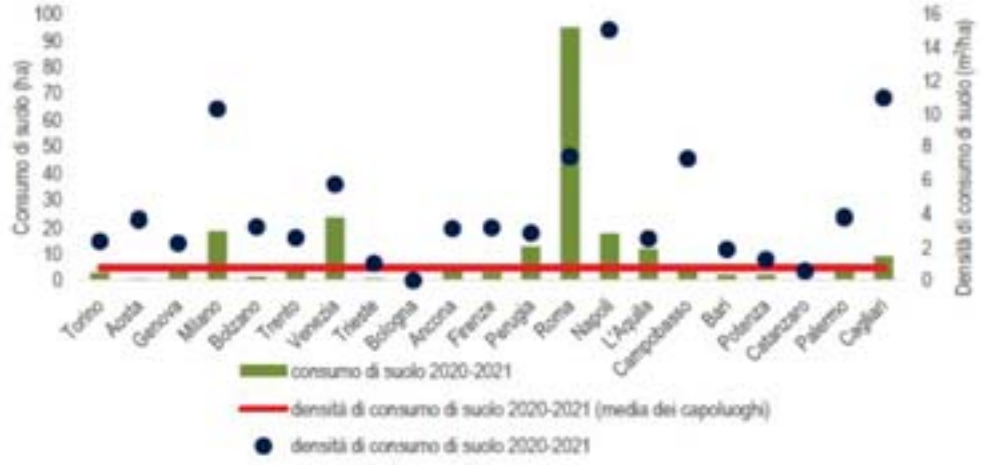


**Fig. 2 :** Land consumption between 2020 and 2021 in total hectares and in square metres per hectare in regional capitals and autonomous provinces. Source: ISPRA elaborations on SNPA data and cartography

As highlighted above, our cities are the product of settlement dynamics linked only in part to the increase in world population, for the rest they are the physical-spatial representation of the distortions and imbalances in the development model of human societies characteristic of the liberalist market economy (business as usual). Taking Italy as an example once again, the industrial cities, especially in the north, experienced a significant demographic increase accompanied by a similar spatial expansion in the period of the so-called economic and building boom of the 1950s-1970s. This massive and uncontrolled increase caused in many cases almost a doubling of the physical size of urban areas that crept, with the building of mega suburbs marked by low building and environmental quality [13] into the surrounding agricultural areas, destroying their ecosystem, natural and anthropic value. Since it is unrealistic to think of demolishing most of these buildings, it is essential to implement wide-ranging strategies that put in place redevelopment actions and projects at different levels of scale, territorial, urban and building, involving the energy performance of individual buildings and neighbourhoods, up to vast environmental and landscape regeneration programmes. Given the complexity of the problem and the interconnection between anthropic and natural systems, a multi-scalar and systemic analytical and also pragmatic approach is required.

### 1.3 Built surface areas and volume of buildings on Earth

The growth of urban areas does not only entail the loss of vacant land and urban sprawl or concentration, but is inevitably accompanied by growth in the volume and surface area of buildings, with proportions that are now truly impressive. In 2020, the mass of all man-made artefacts made by humanity, over one trillion tonnes, exceeded the mass of all living organisms [14]. According to the latest Global Alliance for Building and Construction (GABC) dossier data [15] buildings and construction are responsible for 36 per cent of global energy consumption and 37 per cent of total CO2 emissions. The global built-up area is expected to increase by 75 per cent between 2020 and 2050, 80 per cent of which will be in emerging and developing economies [16]. As a result, the demand for raw materials is also expected to double by 2060, a third of this increase will be directly related to the construction sector (GABC, 2021 cited). In order to achieve the goals of the 2015 Paris Climate Accords, and to limit the increase in global warming to within 2°C in this century, the energy efficiency of buildings should improve by at least 30 per cent compared to 2015 levels by 2030. All this in a scenario that foresees an increased and continuous demand for energy, especially for the air-conditioning of buildings, since most new construction will take place in so-called emerging countries located in geographic areas with mostly tropical or subtropical climates. In 2020, almost 5% of the world's energy was used for cooling buildings. Over the past decade, the annual growth of air conditioners in emerging and developing economies has seen India grow by 15.7%, Indonesia by 13.1%, China by 7.9% and Mexico by 7.8%. By 2050, it is estimated that 54.5% of the world's air conditioner fleet will be located in three regions: China (491 million, 25.3%), India (406 million, 21%) and North America (158 million, 8.2%) (GABC, 2021 cited). Overall, since the early 2000s, the use of energy for space cooling has doubled from 1,000 terawatt-hours to 1,945 terawatt-hours, due to multiple factors: warmer climate, increased urbanisation, and the greater prevalence of air conditioners in homes, most of which are of poor efficiency and operate using energy from fossil fuels [17].

## 2. Buildings and green solutions

Analysing the problem of compatibility between the human ecological footprint and the Earth's capacity to support it, and moving down from the urban to the building level, it can be generally observed that the emergence since the mid-20th century of prefabricated and industrialised building systems based on reinforced concrete, which are easy to use and cheap, combined with the availability of energy from fossil fuels, has laid the foundations for the long-term unsustainability of this building model that is so widely used today. These multi-storey buildings have been replicated in every climate and in every location for practical and economic reasons and today make up the majority of the buildings that populate our cities. The construction quality is often mediocre and they are buildings that consume a lot of energy for heating and cooling, energy mostly from fossil fuels. These buildings so prevalent in our cities are therefore the result of past choices, now obsolete, and for the most part in need of upgrading not only from an energy point of view but also for all the environmental implications at the urban scale. Another critical aspect that has inevitably entailed, and will still entail in the future, the spread of these building models is the increase in demand for air-conditioning, which on the basis of the United Nations' demographic and urban growth forecasts over the next few decades will mainly affect emerging countries, but also the Mediterranean area and southern Europe. In many ways in relation to sustainability goals, this can be considered the most important challenge of the coming years from a

building perspective. More sustainable technical solutions can partly be sought in the lessons that come to us from historical building traditions, based on practices related to the characteristics of climates and places, following bioclimatic principles and using local materials and techniques with low environmental impact.
Other solutions can instead be sought in innovative approaches that arise from observation and application of the principles of functioning of natural organisms to building systems, through a design method based on the biomimetic spiral, which starting from the definition of the problem and context extrapolates the essential elements in biological terms, abstracts the principles and then emulates them trying to apply them to the problem. This biomimetic approach seems very promising and has resulted in projects with very efficient performance of the building envelope and innovative plant solutions with low energy costs. For example, the East Gate Harare Centre complex in Zimbabwe designed by Mike Pierce (1996) maintains a constant temperature inside the building thanks to a passive ventilation system inspired by the observation of the functioning of termite mounds, or Council House 2, also by Mick Pearce in Melbourne (2005), whose façade is inspired by the functioning of tree bark, and thanks to this has reduced CO2 emissions by 87%, electricity consumption by 82%, gas by 87% and water by 72% [18]. The building expels stale air at night and injects 100% fresh air during the day. The building's cladding louvres move with the sun to reflect and collect heat. Inspired by Nature are also the microalgae-based bio-reactive façade of the BiQ House in Hamburg (Ove Arup, 2013) or the homeostatic façade designed by Decker y Yeadon (2014) in New York consisting of a double glass skin with dielectric elastomers inside, capable of shielding itself depending on the building's external temperature. Like living organisms, it manages to maintain a constant internal temperature in different external climatic conditions, or the water-reactive façade made of wooden foils that mimic the functioning of tree cones to protect their seeds, conceived by Chinese designer Chao Chen. Inspired by Nature, they can also be considered the simplest horizontal and vertical green roof systems that are gaining ground in building and even urban redevelopment, due to the potential environmental benefits of the context in which they are inserted. The use of these systems, their versatility and ease of use open up many possibilities for the redevelopment of buildings and neighbourhoods. Vertical gardens, such as those now famous by Patrick Blanc, and green roof systems in general bring many environmental benefits to the urban level, thanks to ecosystem performances similar to those of natural systems, such as CO2 absorption and oxygen production, improvement of air quality through the interception of particulate matter and pollutants that come into contact with them, the filtering and purification of pollutants contained in rainwater, the regulation of the building's temperature through the evapotranspiration of plants that causes the cooling of surfaces and the surrounding air (which also means less need for air conditioning systems). Alongside the biophysical and environmental benefits, there are also qualities of a perceptual and social nature, because the presence of vegetation in the urban context increases the comfort and well-being of human beings and all living species, especially in compromised and degraded areas.
The challenge that these solutions imply also concerns the need for a change in the approach and management of the design process. All actors involved in the building process, such as planners, architects, mechanical and electrical engineers, but also contractors, clients, operators and end users, should work collaboratively from the initial project phase to define the energy objectives and performance of buildings and their use.

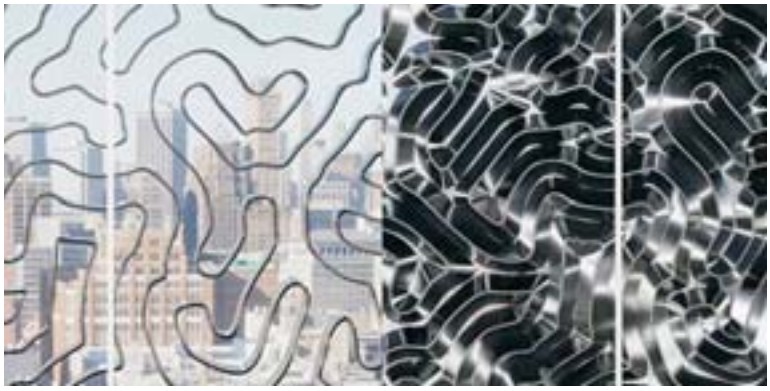

**Fig. 3:** Homeostatic Façade System: double meteoropathic envelope. Decker y Yeadon, 2014. Source https://www.researchgate.net/Research Gate

At the site level, the designer should adopt strategies based on bioclimatic architecture in accordance with the building tradition of the location, such as optimal building orientation and spatial configuration, considering open spaces, vegetation, mutual shading, water bodies and volumetric compactness. At the building level, the implementation of simple strategies such as efficient insulation, shading and ventilation can be very effective in reducing energy demand. Furthermore, in accordance with bioclimatic principles, ventilation corridors can be used in urban areas to improve wind flow, so that it can blow away heat and pollutants, alleviating the urban heat island effect and air pollution. Other economies of scale can be implemented at neighbourhood level with the introduction of smart grids and district heating or cooling systems that can be optimally dimensioned considering the diversity of building use patterns. For example, district cooling systems can reduce energy consumption by around 35% compared to conventional air-cooled chilled water systems and by 20% compared to individual water-cooled systems (IEA, 2018, cited p.52).

## 3. Living the Earth in harmony with Nature. Nature Based Solutions technologies

Given the impact of urbanisation at a local and global level, alongside the need for the dissemination of environmental certification protocols for buildings (today only a fraction of the world's countries have adopted them), environmental regeneration and energy requalification of buildings at the urban scale should be considered as the primary and fundamental strategic actions to be implemented to make our development model more sustainable, both on the resource side (environmental and energy) and on the social side (equity and inclusiveness), and more resilient. The sustainable development goals of the 2030 Agenda that directly or indirectly concern urban phenomena, such as Goal 11, Sustainable Cities and Communities, Goal 13, Climate Action, and Goal 15, Life on Land, cannot be pursued and achieved individually but must be integrated in a series of strategic actions coordinated at different levels, from the local to the national (and international) scale, in which the city is considered from a systemic perspective, in its complex and fundamental interconnections between the anthropic and natural systems. This direction is explicitly indicated by the European Commission, which identifies Nature Based Solutions (NBS), the strategies and actions inspired by Nature, as the main tools to be adopted to "pursue objectives such as increasing the sustainability of urban systems, restoring degraded ecosystems, implementing adaptive and mitigation actions with respect to climate change, and improving risk management and implementing resilience" [19]. The use of Nature Based Solutions aimed at the design of Green and Blue Infrastructures (GBI), networks of natural and semi-natural areas planned at a strategic level with other environmental elements, designed and managed to provide a broad spectrum of ecosystem services, can become fundamental tools for transforming the foundations of urban design of cities and territories in an ecologically oriented perspective. Listing some positive cases of NBS design, in the Barcelona metropolitan area the use of Nature's Ecosystem Services (ES) were used to define strategic multifunctional areas to be integrated in a Green and Blue Infrastructures project. This network aims to integrate in the municipal planning of Municipal Urban Development Plans and in the regional planning, in the Partial Territorial Plan of the Central Counties the conservation of biodiversity with the improvement of SE provision through a multi-scalar approach, [20]. Again in Spain, the ecosystem approach has been used in the design of a regional green infrastructure, through a participatory design process that was assumed in the Partial Territorial Plan of the Bilbao metropolitan area and included in the recent 'Spatial Planning Guidelines' of the Basque Country that bind the implementation of network strategies at different territorial scales [21]. A further example of integrating a Green Blue Infrastructure project based on ecosystem services into the planning process is the Kommunenplan of the city of Oslo. This is a green network project aimed at protecting existing natural areas and creating new urban green spaces for the community, connected by a dense network of bicycle and pedestrian paths for daily commuting. The new expansion areas of the city, foreseen by the Plan, are integrated in the GBI project being characterised by a series of nature-based design parameters/criteria (rain gardens, infiltrating trenches, draining pavements, etc.) aimed at increasing urban resilience by contributing to the regulation of rainwater in response to the intensifying effects of climate change [22]. In Beijing, China, ventilation corridors are being designed to reduce urban heat, increase ventilation and protect land used for climate and environmental improvement. Five primary corridors, each 500 metres wide, will connect the city's parks, rivers, highways and low-lying areas. Several 80-metre secondary corridors will join them to create a ventilation system to prevent the accumulation of smog. Similar systems have been developed in other Chinese cities since 2014, including Shanghai and Fuzhou (GABC, 2021, cited p. 83-84). Concerning Italian examples, in Turin a Climate Resilience Plan was developed in 2020 by the municipal administration and with the support of Arpa and the University of Turin, which is based on NBS Strategies and the ecosystem services of

natural systems for the implementation of the 2030 Agenda goals. Among the actions already initiated, in relation to the goals of mitigating the risks and problems related to climate change in the metropolitan area, there is the implementation of the city's tree and forest heritage, the launch of urban regeneration programmes and projects through micro interventions at the neighbourhood level through the creation of small green areas (rains gardens) designed to manage rainwater and able to lighten the load on the urban drainage network, produce shade to improve the health and well-being of citizens and provide other ecosystem services. There are also plans in some suburban areas, some in progress, to integrate public greenery by means of green roofs (green roofs, roof gardens, green walls), which perform this adaptive role by capturing solar radiation for energy transformation in evapo-transpirative processes. Green roofs are able to perform the mitigating effect and can reduce the surface temperature of the roof and the temperature of the surrounding air, achieving significant savings in energy consumption.

## 4. Conclusions

Overall, the experimentation and adoption of solutions based on Nature and green technologies, together with a design approach inspired by Biomimicry, in a multi-scalar and systemic perspective from the city to the building, aimed at redirecting the flows of matter and energy of the metabolism of cities in a circular and non-linear sense, proves effective in decreasing the ecological and carbon footprint of human settlements, fostering biodiversity and improving environmental quality and well-being, not only of the human species. The technical solutions that are indispensable alone, however, are not enough to restore a condition of balance between human needs and those of the biosphere. A progressive cultural, scientific and technological revolution of human societies that understands the interdependence and interconnectedness of all living and natural systems on the planet seems indispensable. In fact, the adoption of all these strategies to repair the damage caused by the pressure of human systems on the environment implies not only the recognition of the enormous strategic value of the Ecosystem Services offered by natural systems that must be protected and preserved, but also the transformation of the current cultural and economic paradigm, which places Humanity outside and above Nature. Instead, what is needed is a new cultural vision capable of recognising Nature's role as Model, Measure and Mentor, according to the principles indicated by Janine Beynus of Biomimicry [24], a holistic science that, making use of multi and interdisciplinary skills, studies the functioning of natural organisms in order to derive principles to be applied to forms, processes, systems and strategies useful in solving human problems in a sustainable manner. Despite the fact that the objectives of sustainability pose enormous challenges to be faced, an encouraging sign of the start of this transformative cultural process is given not only by the many examples of the positive application of solutions inspired by Nature for territorial and urban planning and building design, whose repertoire is much broader than the cases cited here, but also by the innovative urban regeneration and transformation projects now underway in some of the world's great cities, such as Paris.

**Fig. 4:** Mountain Towers. Solar, hydrodynamic and planted towers bio-air conditioning the urban heat-island phenomenon. Paris Smart City 2050. Source https://vincent.callebaut.org/

This great and historic city is implementing a series of very interesting interventions involving some symbolic places such as the Champs Elysees [25], which, on the advice of the Paris municipality, are the subject of a major re-naturalisation project for 2030 (designed by the PCA-Stream architecture firm). Moreover, the winning project of the call for tenders launched by the City of Paris as part of the Climate and Energy Plan (2014) is entirely based on biomimetic principles inspired by Nature. Vincent Callebaut's visionary project, Paris Smart City 2050 [26], is in fact based on biomimetic solutions, in the use of materials, operation, energy supply, organic forms inspired by similar ones from the natural world such as mangroves, nests, beehives, and so on. Callebaut's project consists of eight types of high-tech green towers with different characteristics depending on the contexts for which they are intended, with the main objective of achieving the Paris Climate Agreements and reducing climate-changing gas emissions by 75 %.
If, as a human species, we want to continue to dwell on Earth by restoring and maintaining a balance between ourselves and the millions of animal and plant species that populate the planet, hopes for reconciliation with Nature also run through proposals that may seem utopian today, such as Paris Smart City 2050, but which may instead represent a concrete hope for change.

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# KNOWLEDGE ASPECTS OF CULTURAL HERITAGE: DIGITALISATION AND VIRTUAL DISSEMINATION

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## Abstract
The conservation and enhancement of cultural heritage requires detailed documentation, both in terms of location, shape, colour and geometry, but also in terms of more historically and artistic characteristics. Today's digital technologies make it possible to accurately measure and represent three-dimensional objects at different scales, from architectural structures to archaeological objects, and thus to represent - qualitatively and quantitatively - all the features of the rich and diverse heritage. The aim of this article is to describe how new digital methods can be used in the field of cultural heritage, not only to document the current state, but also to trace its philological exegesis, whose significant transformations will thus be preserved and represented in digital form.
In the last few years, the development of integrated acquisition and representation methodologies for the three-dimensional documentation of heritage can increase the possibilities of heritage understanding and valorisation.
This paper presents the context and need for heritage digitisation and proposes a methodological approach to develop a digital heritage roadmap for built heritage.The specific case of Via Garibaldi in Genoa proposes a methodological approach to develop a digital platform dedicated to the built cultural heritage and the items preserved in it through high resolution 2d visualisation, historical-urban reconstruction of the site and detailed holographic visualisation.

**Keywords:** Cultural heritage, photogrammetry, olografic representation, Via Garibaldi, Genova

## 1. Introduction
Cultural heritage reflects the identity of a territory and links a population to its past; it is rooted in the history, architecture and traditions of a community. It is a cultural heritage shared with all nations and guarantees local identities. In this sense, the valorisation of cultural heritage is essentially based on the preservation of its authenticity and the way it is represented in innovative media and its proper transmission to future generations.
At present, digitisation constitutes a primordial element for the preservation and enhancement of heritage, be it tangible or intangible natural heritage, and makes it possible to provide the public with free access to heritage elements, without temporal or geographical constraints and accessible to all. In the following, the paper firstly outlines the definitions of key terms and the general requirements for digitising cultural heritage, and consequently the approach and method adopted in this work.
For half a century, science and digital technologies have been progressing together, opening a new era for the knowledge, conservation and dissemination of heritage works and objects. First through research, then progressively in cultural projects built in the context of cooperation between heritage institutions and professionals implementing innovative methods of acquisition, observation and multidimensional analysis. New mediation systems were thus invented, tested and evaluated.
Initially reserved for exceptional operations, the use of digital images has spread thanks to a process of “democratisation” stimulated by the progressive simplification and automation of instrumentation and processing. Because of its threefold capacity to record reality, to explain its optical and geometric

properties and to reproduce the results of the interpretation that can be made of it, the digital image, in two or three dimensions, is today an irreplaceable working tool.
Thus, the range of investigation and diagnostic tools used to acquire knowledge is being enriched day by day with sensors and image analysis and processing algorithms.
In the fields of art history and architecture, 3D images, which have been over-publicised and sometimes modified, enable the restitution of documented or hypothetical previous states of different phases of creation. It is increasingly being approached within a scientific framework that brings together the humanities and social sciences, experimental sciences and digital sciences; and it is in this interdisciplinary approach that its high potential is best expressed in terms of the organisation and management of the documentation produced around a heritage object (historical study, state of preservation, temporal follow-up, etc.).

The archiving and sharing of digital content offers the possibility of a real pooling of the data produced by the various actors and services dealing with the heritage object, making its digital representation a privileged access point to the photographic, bibliographic, analytical and archival documentation concerning it, accumulated over time and the operations carried out.
Observing this new context of data and knowledge production, one understands to what extent the daily use of digital images brings to light issues and research objects that question the various actors on their professional practices and their relationship with the works. Indeed, it is far beyond the technical challenges that innovative uses of digital technology for the study, conservation and dissemination of heritage develop. They induce new modes of observation, analysis and representation, necessarily conditioned by the singularity of viewpoints on the heritage object and the knowledge mobilised for its understanding.
This upheaval of practices stimulates new debates, brings to light new concerns and new questions. It leads to a process of appropriation that results in the construction of a genuine technological culture closely linked to the mechanisms of understanding, interpretation and dissemination. It is therefore a plural look towards the future, to anticipate the emergence of new questions generated by the use of digital technology (as well as by the accumulation of content), and towards the past, to emphasise, reaffirm and claim the historical continuity of the modes of operation.
In this work, considerable efforts are made to harmonise and integrate different competences, points of view and sensitivities within a multidisciplinary and interdisciplinary framework that allows for the collective construction of innovative approaches.

The research describes and analyses how 3D images, systematically linked to other related digital resources, act not only as revelators of the history and objects bequeathed to us by the past, but also as a dissemination tool fully in line with the needs and expectations of the 21st century. Used with science and in the context of a solid project, it is able to make any kind of heritage accessible and understandable, be it the medieval furnishings of a castle, Renaissance sculptures, or models of cities. The example presented in this article demonstrates the great heuristic value of images and 3D restitution: for the understanding of complex elements such as the urban space of Via Garibaldi in Genoa, or for the exploration of new avenues of research such as the use of holographic representations in the field of lost cultural heritage.

## 2. Metodologhy

The applications of geomatics to cultural heritage can refer to two main areas:
- the documentation for study, knowledge, conservation and restoration: geomatic techniques, the products of which are now digital, allow for a geometric but also qualitative description and can constitute survey and investigation tools, diversified but able to be interfaced with each other thanks to methods and algorithms for data transformation and fusion;
- the control and monitoring of the condition of movable and immovable property, which can be applied to the object itself or to the geographical environment in which it is located.
The methods and tools used in cultural heritage surveying cover a wide range, due to the variety of objects and the precision required. Surveying is a very complex operation both methodologically and operationally. It requires a good understanding of the object to be measured, from which strategies can be defined to obtain the best possible result.
In particular, the current spectrum of methodologies and tools used is extremely broad, from direct survey methods, which although simpler are no less noble and useful, to the more sophisticated indirect measurement methods. Nowadays, the multi-resolution approach and the integration of different techniques (photogrammetry, laser scanning, topographical survey, etc.) often provide the best results in terms of accuracy and optimisation of the final product (2D or 3D).

In the field of cultural heritage, laser scanning (via triangulation or time-of-flight) and structured light systems have been very successful in recent years, allowing geometric data to be acquired more easily, both on simple objects and more complex structures.
In general, active sensors are able to provide large volumes of 3D data directly and in a short time, which are usually rendered in the form of a dense cloud of points, often with the radiometric value of each point added. The relative ease of point cloud acquisition has certainly influenced the rapid spread of this technology. At the same time, the morphological complexity of the objects considered has made it essential to develop completely original software for processing the data, different from that used in topographical applications (Rinaudo 2011). The amount of data still requires significant processing time (registration, classification, segmentation, editing) to extract the most important geometric features of the scene, or to create continuous polygonal geometric models.
Photogrammetry, which has been the most widely used method since the earliest applications of geomatics to cultural heritage, has been widely demonstrated and can be applied to describe the survey of objects, both for architecture and topography, for documentation, monitoring and restoration purposes. Especially in recent years, thanks to the development of computer technology and the spread of digital images, many interesting software and hardware solutions have been proposed, which considerably reduce the cost of instrumentation and expand the community of users.
These tools are widely used for 3D reconstruction of architectural objects, rigorous modelling of cities, as well as monuments and statues, resulting in complex models. The complexity stems both from the abundance of data acquired and processed, and from the articulation of documented forms. A common feature of the systems in use today is their extreme portability, combined with an increasingly limited cost.
Laser scanning and photogrammetry provide a very similar first-generation product, also in terms of accuracy, the point cloud, which makes them easily complementary. In fact, their integration shows enormous potential, with each technique compensating for the disadvantages of the other depending on the situation. They can also be used in special applications, e.g. with laser triangulation, when it is necessary on the one hand to detect the geometry of very small objects and on the other hand to create 3D models that can be used in new ways of representation, such as virtual exploration and navigation routes in museums and libraries or in virtually reconstructed environments.
Although it is not so much a question of geomatics as of documentation of cultural heritage, the way in which digital data from the surveying process is represented must also be taken into consideration. Here again, the overlap and integration of geomatics with computer vision is evident: in addition to traditional representations, in which vector renderings are integrated into orthophotos and rectified images, three-dimensional models, possibly textured, are increasingly being offered, which can be visualised and navigated via animations or virtual reality applications.
In the context of the International Workshop, "Architectural Order and Contemporaneity" held in Athens (Fig.1), the in-depth study of the survey of cultural heritage highlighted how digital representation for the learning of culture proposes to rethink instrumental strategies to realise alternative forms of enjoyment of places, performing a direct application in some works within the Acropolis Museum.


Fig.1 As part of the Workshop "Architectural order and contemporaneity - drawing as a universal tool of knowledge", organised by the dAD department, 03- 06 June 2019, Athens. Photogrammetric reconstruction of a statue of a female goddess, possibly Aphrodite Pandemos. Late 5th century. BC, Acropolis Museum Athens (Author's elaboration)

The representation of cultural heritage with the help of virtual visualisation systems is growing, as it offers a unique level of understanding of heritage. The distinction of virtual visualisation from other forms of representation such as drawings is on the one hand that the digital model created can be easily

adapted to new interpretations, and on the other hand that it provides an interactivity that brings the user closer by making cultural heritage more popular. Digital representation for communication and learning about culture propose to rethink communication strategies and tools such as virtual and augmented reality, interaction through gestures, device localisation and multimedia technologies, make it possible to transform the visit of a place from a purely passive event to an active and engaging experience.
It is precisely in this perspective that the logic of the contemporary museum (real place) as a place of representation par excellence, where we move from a space of mere preservation to a place of representation and experience of reality in its many forms, falls.
The challenge of the research is represented by the possibility of a visual and immersive modality of artefacts, complex and not, existing and not, through a reconstructive vision in the round without the use of personal devices.
The main objective of the research is to obtain an easily reproducible system for representing the model, guaranteeing scientific consistency, visual and geometric accuracy and semantic understanding.
The characteristics of the represented architecture very often indicate to the representer the most efficient and direct way to externalise the most important meanings; this is tantamount to theorising that there is an 'objective' idea of architecture, its parts and its essence that should be realised, accomplished in 'space as information'.
Using the digital medium, there is always the need to obtain correct representations in accordance with the point of view of the discipline. Secondly, digital applications can be used to make the projective principles that give rise to axonometric and/or perspective views more evident, in other words, they must create awareness and cognitive processes: facilitating the ability to read how forms are arranged in space and why they are seen that way.
Since "space is the protagonist of architecture", so "the history of architecture is first and foremost the history of spatial conceptions". Representing architecture means representing space, and the better the technique used, the better the communication and its perception. For this reason, research aims to use this technology for the communication of architecture, aiming at the maximum dimension of the holographic image, the possibility of close interaction and the optimisation of the three-dimensionality of the object to be communicated.
Today it is possible, through different types of holographic projections (Fig.2), to take the model of architecture out of the monitor and transfer it onto surfaces in open spaces, up to the three-dimensional representation of objects at scales close to reality, in empty spaces, replacing the traditional analogue model.
Holographic projections allow the user to manage the recomposed image in empty space, as one might do with a classic plastic representation, managing visual perspectives autonomously.
The narration through holographic projections is, therefore, suitable in that the possibility of interaction and fruition by the user is innovative, with the achievement of the narration of heterogeneous environments, realising with coherent multi-projections an image that restores three-dimensionality, allowing interaction with the model.

Fig.2 Results of the study for the holographic representation of Villa Ottolenghi's contemporary art collection according to research objectives (Author's elaboration)

## 3. Case study: Via Garibaldi in Genoa

Cultural heritage constitutes the material inheritance of the history of a people and is the product of a process of accumulation and stratification that is measured on the scale of generations. Italy possesses an extraordinary one, universally recognised for its uniqueness, which constitutes a founding element of national identity and contributes to the quality of individual and collective life of the Italian people. The considerable amount of architectural, archaeological and cultural heritage in our country implies a constant work of protection and valorisation in order to allow an optimal use and guarantee its perpetuation over time. In order for the protection and enhancement of cultural goods and activities to be effective, the issue of knowledge in the field of conservation is of particular importance. Within projects aimed at the conservation, recovery, cataloguing and valorisation of architectural and archaeological heritage, the fundamental operation for the investigation, in order to examine the multiple characteristics of the object of study, turns out to be the survey. Indeed, the survey makes it possible to highlight the form, structure and any stratifications, as well as to analyse the relationships between the parts and the whole, the material and chromatic characteristics and the state of conservation of the asset. The possibilities offered by technology today make it possible to acquire a large amount of data in a relatively short time and with a detail never achieved before. The use of modern remote-controlled systems with photogrammetric and survey functions is establishing itself as a key element in today's architectural survey systems, paving the way for new three-dimensional representation techniques that can be applied in the field of the study and recovery of Italy's cultural, architectural and archaeological heritage. The city of Genoa offers one of the largest and best-preserved historical centres in the Italian peninsula, and due to its considerable size, needs a streamlined, state-of-the-art system of valorisation and protection.

From the mid-15th century onwards, Genoa witnessed a practice of building renovation that led to a rethinking of public spaces and enriched noble buildings externally with extraordinary façades with stucco, marble or painted decorations; majestic atria, refined gardens characterised by fountains and nymphaea; and internally with frescoed salons, sumptuous furnishings and valuable collections of paintings. Via Garibaldi, formerly known as Strada Nuova (Fig. 3), was famous from its origins precisely because of the presence of these residences facing the street itself; it is in fact an example of Renaissance allotment grafted onto a dense fabric of a medieval nature. A large part of the area was acquired by one of the most illustrious Genoese families, the Grimaldi, who financed part of the work, helping to transform one of the most infamous areas of the Superba[1] into a privileged area of considerable luxury. The street was designed in 1550 by the architect Bernardino Cantoni, who conceived of it as a rectilinear axis of considerable size about 250m long by 7.5m wide. The magnificence of the area was such that the Republic of Genoa decided to establish a list of all these residences in order to classify them, with a subdivision based on prestige, with the intention of using them as suitable residences to host personalities visiting the city or during the *Grand Tour*. The prestige of the architecture, the decorations of the palaces and the attention given to them by artists such as Pieter Paul Rubens and Cesare Brandi led to “Le Strade Nuove e il sistema dei Palazzi del Rolli” being included in the UNESCO World Heritage List in 2006.

Fig. 3 - Ground floor plan of Via Garibaldi in Genoa. (Author’s elaboration)

[1] The city of Genoa was known as “La Superba”, the English translation of “The superb”, during the XVI century.

### 3.1 Agisoft Metashape – photogrammetry using satellite images

In the last decade, the use of photogrammetry in the field of architecture has made it possible to detect the size, position, shape and colour of the subject under consideration by means of high quality photographs taken; *Structure from motion* technique is used with the aim of producing an image with pixel values starting from the distance of points with respect to a known point.

When it is necessary to reconstruct a 3D model at any scale - urban, architectural and detailed - from two or more 2D images, one of the software packages used is Agisoft Metashape. To generate an *SFM* model it is advisable to take photographs in manual mode in order to control ISO, aperture and shutter speed more precisely; in order not to create variations in the image dataset within Metashape the previous settings must be kept fixed for the entire photographic set. It is important to bear in mind that when a *Structure-from-motion* model is created, it does not have the same reliability as that obtained by means of a laser scanner survey, but it is very valid for an overall perception of architectural, chromatic and volumetric nature.

Agisoft Metashape, by uploading the images taken and transforming them into .jpeg or .tiff format, is able to identify the shooting points of individual photos and recognise homologous points in the various shots by processing them into a sparse point cloud. It is then advisable to create a dense point cloud with a greater degree of detail in order to be able to use it in the subsequent 3D modelling. In fact, using the latter as a basis, it is possible to shape the dense cloud into polygonal surfaces, transforming it into a mesh on which a texture can then be easily superimposed.

For the case study of Via Garibaldi in Genoa, it was decided to use satellite images retrieved from Google Earth in order to try and employ an even more expeditious methodology for point clouds with remotely retrieved images. It was decided to acquire the photographs at a scale such that it would be possible to include the entire Via Garibaldi, and to do so required around forty frames with an overlap between them of around 40%; although usually the required overlap of shots is around 60%, in this case 40% seemed more than appropriate. Compared to a dataset of images taken with a camera or from a drone, it was not possible to modify the photographic parameters on time, and the zoom in some cases did not always remain the same, but despite the noise due to the quality of the images, the process of aligning the cameras and subsequently merging them turned out to be less complex than previously thought. The processing of the dense cloud, on the other hand, had some problems, perhaps due to the density of the surrounding urban fabric and the similar colouring of the area; the dense cloud was nevertheless created and allowed the mesh to be created with good precision and its texture (Fig. 4). To make a cloud that is scaled, it is possible to use measurements taken from Google Earth according to the margin of error one is willing to accept; in our survey, measurements were not a prerequisite, which is why resizing using google earth proved optimal.

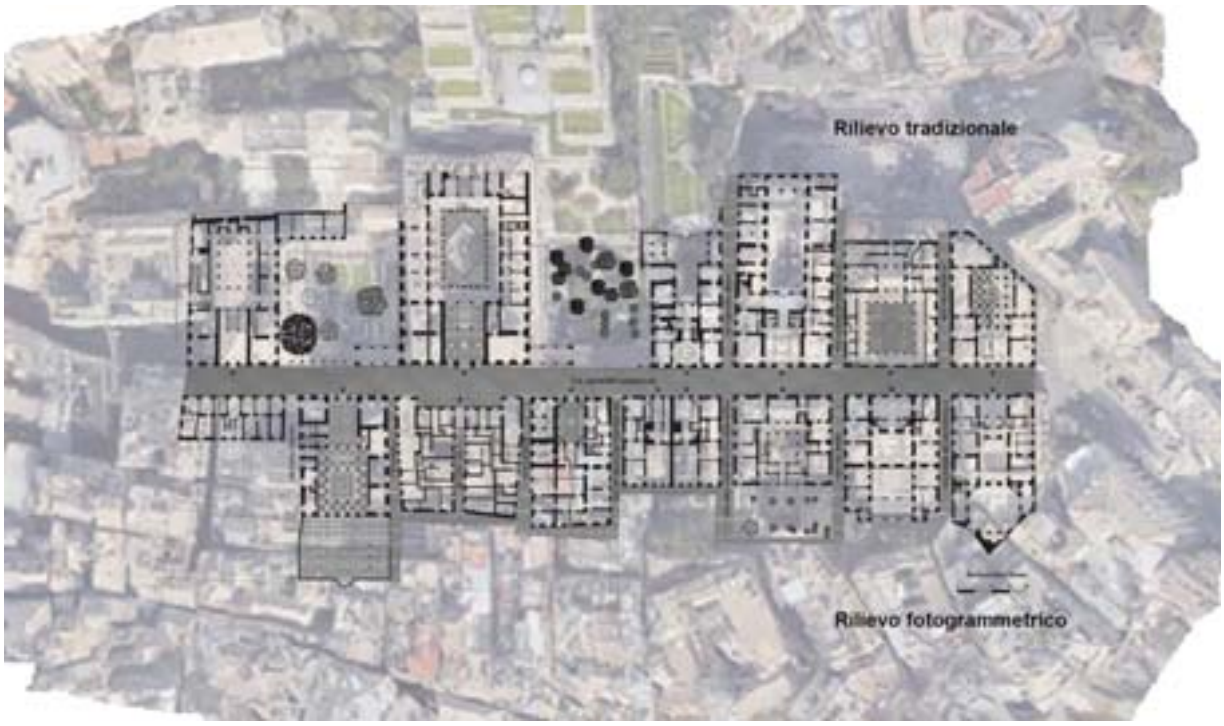


Fig. 4 - Superimposition of the traditional survey over that obtained by photogrammetry with satellite imagesof Via Garibaldi in Genoa. (Author's elaboration)

As can be seen in the image n.3, where the traditional survey has been superimposed on the photogrammetric survey, it can be seen that, despite the imprecise measurements and the poorer quality of the photos, compared to those taken traditionally, the superimposition shows a good result. It is therefore conceivable to use this methodology as it is more expeditious at the expense, however, of a lower quality of images and measurements in the final result. The results are better in less compact building fabrics and over a more circumscribed area in order to avoid forcing the software to re-join homologous points, which will lead to a greater error in the result. It was therefore experienced that the limitations of this approach are related to the noise of the images and their processing within the software which caused some grey areas. In general, satellite imagery photogrammetry is an efficient and cost-effective way of acquiring topographic and geographical mapping data. As technology evolves, photogrammetry is constantly evolving and improving, which means that it is increasingly able to meet the needs of the market and industries that require a high level of accuracy and reliability in geospatial surveys.

**4. Conclusion**

The article set out to investigate the efficiency of digital tools in relation to the degree of management of the complexity of cultural heritage, i.e. to understand the degree of effectiveness of a tool both in objective terms of achieving a given objective and in terms of functional accessibility by the user.
Dealing with methodologies, contents and themes that in a transversal way relate to history, information technology and communication theories, the path undertaken makes use of a transdisciplinary perspective capable of finding convergent solutions to apparently distant problems.
This definition outlines a current field of study that fuses humanistic culture and IT skills with the aim of studying, preserving, enhancing and communicating cultural heritage through digital representation technologies. Indeed, the recent history of Virtual Cultural Heritage has shown that today's cultural communication can make use of advanced visualisation technologies, such as Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), real-time three-dimensional representation, stereoscopy, haptic and multimodal interfaces, to implement innovative cultural dissemination strategies based on interaction and immersion.
The interest in the knowledge of the architectural heritage of the built environment, together with the need to prefigure its valorisation, places at the centre of the study the themes connected to the methodologies and practices of the survey, representation and communication of architecture; survey understood as an indispensable cognitive tool of the cultural heritage aimed at documentation and fruition.
The union and systemisation of the results obtained from this path effectively respond to the initial hypothesis where the dissemination and learning of culture propose to rethink the communication strategies of a cognitive method aimed at the valorisation of the cultural heritage according to a new fruition aimed at users.

*All the authors shared the principles of the study presented here, the opening paragraph and methodology paragraph were written by Sara Eriche; the case study paragraph and conclusion paragraph were written by Martina Castaldi.*

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# Stefania Filo Speziale's *palazzina* at the Parco Grifeo in Naples. An example of private housing for the middle-class

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## Abstract
After introducing the figure of Stefania Filo Speziale (1905-1988), the first Neapolitan female architect and her fundamental role in second post-war Neapolitan architecture, the paper will focus on the building realized in the Parco Grifeo in Naples between 1955 and 1959 by her studio. Straddling the Chiaia and Vomero districts, not far from the contemporary masterpiece of Palazzo Della Morte (1951-57), the *palazzina* is another example of a middle-class dwelling on the slopes of the Neapolitan hills, establishing a strong relationship with the landscape and the sea facing the South. It also represents a further example of auteur architecture in the park, a kind of middle-class enclave, originally a noble property occupied by trees and gardens, sold since the end of the 19th century and urbanized mostly after WWII, which hosts a series of interesting architectures, from the Castle by Lamont Young (1902) to Palazzo Decina by Michele Capobianco and Giulio De Luca (1956-60).
From the autograph project drawings, the paper will highlight the modifications that the building by the Filo Speziale studio underwent during its construction, also describing its current state.

**Keywords:** private housing, landscape, postwar architecture heritage, gender architecture, Mediterranean architecture.

## 1. Introduction
A few years have passed since the figure of Stefania Filo Speziale was finally lifted out of heavy oblivion. The main reason for her *damnatio memorie* is the La Cattolica skyscraper (1954-58), probably her best-known and least successful project, built in the center of Naples and accused by much of the contemporary criticism of failure to fit into the historical context. The name of the first Neapolitan female architect, designer of the first Neapolitan skyscraper, has since then been hastily linked to building speculation and the so-called "hands on the city", i.e. that period of post-war reconstruction in Naples named after Francesco Rosi's well-known film and corresponding to Achille Lauro's term of office (1952-57 and February-November 1961). The consequences were severe, not least the fact that she herself disposed of her archive before her death, effectively precluding historians from being able to reconstruct her career based on a fundamental source.
A series of publications and conferences contributed to the rediscovery of Filo [1] [2] [3] [4]. The MOMOWO conference offered the opportunity to place her within the variegated panorama of the female architects of modernity [5]. Gender reading seemed an essential key for what was in fact the first Neapolitan architect, the first university female professor of a composition subject, and the author of over one hundred and fifty works. In this vein, there are other contributions in which I have participated, also thanks to the Open House initiative that in 2022 dedicated a day of study and an itinerary through some of Filo's architectures; an initiative that had the merit of involving not only many scholars and university students, but also several "non-experts" [6].
Based on these experiences, this paper intends to return to a reflection on the works that she realized in the field of private housing between the 1950s and 1960s in Naples. The *civile abitazione* [private housing] was then a booming sector, thanks to the impetus that the economic boom gave to the construction industry, as well as to the new lifestyles that exploded in post-war Italy, with the spread of a new prosperity after the hard years of the war. Filo's *palazzine*, *condomini* and villas are among the most beautiful in Naples. They are mostly concentrated in the city's middle-class neighborhoods of

Chiaia, Vomero and Posillipo, establishing a very strong relationship with the site, such that they are in constant dialogue with the landscape, taking advantage of the irregularity of the Neapolitan hills, overlooking the Gulf that occupies the position of the Mezzogiorno.
Filo realized many projects, some of which have yet to be studied, and it cannot be ruled out that there are others yet to be discovered. Based on recent research conducted under my impulse on the occasion of the 2022 Open House event dedicated to the architect, we have been able to attribute a building designed in the Parco Grifeo in Naples, hitherto unpublished, by her studio. On this building is focused this paper.

**1.2 Stefania Filo Speziale**

Of aristocratic origins, her full name being Filo della Torre di Santa Susanna, married in Speziale, the young Stefania was educated during her childhood and youth by her grandmother and unmarried aunts, who directed her towards the study of art history, but also mathematics and languages: French and German. She enrolled, as was customary at the time for those who wanted to study architecture, at the Academy of Fine Arts, graduating from the new Regia Regia Scuola Superiore di Architettura in Naples in 1932, even before the Faculty was established (1935) [7]. She was the only woman of the “first generation” of Neapolitan architects; her colleagues included Carlo Cocchia, Giulio De Luca and Renato Avolio De Martino.
Eight years later, at the rather advanced age for the time of 35, she married the Crocian historian Giuseppe Carlo Speziale. Her private life was not easy. With her husband severely scarred by participation in the MAS actions during the war, and then a young widow with two children to raise, she worked with abnegation and dedication both in her profession and in teaching. Marcello Canino, Dean of the Faculty and undisputed teacher of the “first generation' of architects”, immediately chose her as his collaborator, soon becoming his “right-hand man”.
At the height of fascism, when the profession of architect was considered a man's business, she began her apprenticeship. She worked on the project for the Triennale delle Terre Italiane d'Oltremare (1940) in Canino's studio from 1937, contributing not only to the northern sector, where she designed the entrance and a series of important pavilions that were unfortunately destroyed, but to the entire urban project [8] [9].
At the same time, she embarked on a university career. At a very young age, she was appointed to teach “Caratteri Distributivi degli Edifici” (1937), and then became a full professor of the same subject (1955). It was only in 1970, however, that she was able to take over the chair of “Composizione Architettonica”, the most masculine subject in the Faculty.
As part of the courses she taught, she developed a series of texts: the handouts "Scuola e architettura” (1938), "I Musei" [10], which were followed by her two books “La casa di abitazione” [11] and “Del Corso di Caratteri Distributivi” [12].
His first work was the Metropolitan Cinema-Theatre (1948) [13]. Conceived in a natural cavity below the ancestral Palazzo Cellammare, it can be considered as an embryonic experimentation of a compositional theme she investigated throughout her life: the relationship with the context. Indeed, it is the natural datum that dictates the form of this architecture carved out of tuff and composed of complex and diverse spaces, all technologically advanced.
In the 1950s, he realized masterpieces: his Villa in Via Tasso (1955) [14], Palazzo Della Morte (1957) [15], Villa Grimaldi (1959) and the very interesting Ina Casa neighborhoods in Capodichino (1951) and Agnano (1953) [16]. Also noteworthy is the 1954 project for the arrangement of the Naples Station square with the futuristic parabolic arch bridge-building that crossed the large public space. In the same year, Filo founded a studio with Carlo Chiurazzi and Giorgio di Simone, who had just graduated. This was the period of the experimentation of a highly personal rationalism, of a Mediterranean manner of his own, attentive to the orographic conditions in Naples, which was integrated in a non-mimetic manner into the landscape of the unevenness, in and on the tuff of the city's cliffs. The work that most reflects this design approach is Palazzo Della Morte in corso Vittorio Emanuele in Naples. The entire complex, made up of several buildings of different types, is designed in relation to the orography of the site and the panoramic view: from the staircase that clings to the tufa ridge of the hill, to the courtyard-garden, the true “green heart” of the composition, crossed by an articulated walkway on *pilotis* that fits between tall trees, bushes and flower boxes [17].
Then came the dark years marked by the scandal of the La Cattolica skyscraper, the clashes with colleagues at the university and part of the critics, including Cesare Brandi, Bruno Zevi and Roberto Pane, who accused the project of not fitting into the ancient Neapolitan center. The consequences, as anticipated, were severe and marked its *damnatio memoriae*, which is now being belatedly remedied. Yet the project presented in the 1954 competition, before the Soprintendenza's intervention, was more interesting, more similar in its lozenge shape, steel structure and projecting balconies to the contemporary skyscrapers of Le Corbusier, Gropius, Ponti, Nervi and Danusso [18].
In 1963 with the release of Francesco Rosi's famous film “Le mani sulla città”, when the denunciation of the technical-political system personified by Achille Lauro became a national case, the *Grattacielo*

became its symbol. In the feature film, the builder Edoardo Nottola, alias Mario Ottieri, dominated the city from the top floor of the building where he had made his “headquarters”.
Filo went on to design many houses and *condomini* that still today cover the Neapolitan hills, helping to delineate the skyline of that "middle city", between the center and the suburbs, which exploded in the boom years, where the Neapolitan middle-class went to live. An example of this is the condominium at 141 via Petrarca whose elevation, bent and rotated at 30 degrees, masterfully embraces the Gulf [19] [20]. Also in Posillipo, in via Nevio, are the *palazzine* designed by Francesco Di Salvo and completed by Filo and his collaborators (1956-59). These buildings were also chosen by Rosi for one of his films, “La Sfida” (1958), but here the social criticism fails to cast a shadow over the architectural spaces filmed. Some scenes are filmed in the hall studded with massive *pilotis* covered with mosaics, on the stairs and in the penthouse that the camorrista Vito buys, “the most beautiful and the most expensive in the building”, as the real estate agent advertises. The flat has just been painted white and has deep balconies overlooking the sea, facing the Vesuvius. It is an image that restores to us all the beauty of Stefania Filo Speziale's architecture: modern, precise and rational, and at the same time more than sunny, dazzling [21] [22].

### 1.3 The *palazzina* at the Parco Grifeo in Naples

The itinerary drawn up with Open House included, in addition to Palazzo Della Morte, the La Cattolica skyscraper, the building in via Petrarca 131 and the buildings in via Nevio, also an unseen apartment block at number 45 of Parco Grifeo, not far from Palazzo Della Morte and built in the same years. It is undoubtedly a minor building, but one that nevertheless presents some interesting points.
The history of the park, straddling the Chiaia and Vomero neighborhoods, is marked by the transformations of land that was once agricultural, then owned by the nobility, which was gradually alienated during the 20th century to become the object of property speculation, but also the site of prestigious residences for the rising Neapolitan upper middle-class.
Along its hairpin bends starting from corso Vittorio Emanuele and ending at the Villa Floridiana, the initial nucleus of the urbanization of this part of the hill, as well as a remarkable example of Neoclassical Neapolitan architecture and an “English-style” garden, one encounters important examples of modern architecture. From the numerous works by Lamont Young that dotted the park owned by his family at the end of the 19th century, starting with the "Lamont Castle" (1902) [23] that marks the entrance to the park, to Palazzo Decina, designed by Michele Capobianco and Giulio De Luca after World War II (1956-60) [24] [25].
The building designed by the Studio Filo Speziale is located higher up on the last hairpin bends of the Grifeo Park, bordering the Villa Floridiana. The settlement and compositional principles are similar to that applied in Palazzo Della Morte, also located on the slope of the Vomero hill, a little further east along corso Vittorio Emanuele. Like the latter, although in a much more simplified manner, it is composed of several overlapping volumes arranged to take advantage of the magnificent panorama over the Gulf.
Two autograph graphic designs and some documents compiled between 1955 and 1959 found in Archivio delle Licenze edilizie [Building Licence Archive] of the City of Naples show us its original design. The complex consisted of a building set at a lower, longitudinal level and an upper body to the rear against the retaining wall of the terracing of the Villa Floridiana. The two blocks were joined at roof level by a system of staircases and walkways that crossed the terracing placed at different heights. Between them, a small cloister was inserted at ground level to provide light to the various dwellings in the longitudinal block, which was accessed by two sets of stairs. The upper building, on the other hand, could be reached by means of lifts that descended directly into the flats or onto the terraces.
In order to achieve a rational distribution in such an irregular and steeply sloping plot, Filo resorted to plans composed of broken, non-regular lines. On the elevation, as can be seen in the beautiful project axonometry found in the Archives, the aim was to position the various volumes at such distances that the houses were not deprived of their views of the Gulf. As with Palazzo Della Morte and the best Neapolitan apartment buildings of the time, administrative limits, largely dictated by the need to preserve the landscape, became a design opportunity. The building was in fact subjected to the 1935 Building Regulations for constructions downhill from a scenic route, so the heights were calculated in section according to the 30% slope so as not to occlude the view. But the natural datum, preponderant in Naples, became living matter, mouldable in Filo's architecture, which established a close dialogue with it. The volume above the building was conceived as a true "superimposed villa" of varying height, visible only from the Villa Floridiana. It stood out in front of the tuffaceous ridge marking the boundary of the park, giving the building an unexpected morphological complexity. The functional programme took place eluding any typological classification. The "living machine" was totally embedded in the complex orography, in the interplay of advances and retreats dictated by the site and orientation, ultimately by the presence of the Gulf to the south.
Realized by the firm of engineer Catello, whose name appears in the header of the graphs among the designers, after Filo, Chiurazzi and di Simone, the building today looks different from the project. It

differs mainly in the treatment of the main façade, which was simplified and deprived of the continuous loggia system above the stone-clad basement. Moreover, knowing Filo's decorative care for the common areas of his apartment buildings, from Palazzo Della Morte to the buildings in via Nevio, the lobby area in this apartment building is too bare to think that it has not undergone any changes during construction.
Seen from above, today, the system of terraces joined by walkways and the different volumes at varying heights are barely legible, probably due to tampering with the design, due to the numerous roofs and even a few added bodies. The effect is one of layering, which, if on the one hand is detrimental to the original clarity, on the other hand helps to make evident the interplay of interlocking and overlapping volumes and heights, of interpenetrations with the landscape.

**1.4 Legacy**
The discovery of the drawings of the *palazzina* at the Parco Grifeo offers us the opportunity to reflect once again on the great architectural heritage of post-World War II Naples, to which Filo, in all his production, which also varies depending on the client and the construction companies, has been an illustrious witness; a heritage that remains to be recognized and re-evaluated, especially with regard to private housing. Unfortunately, is still emblematic in Naples the critical process of devaluation to which most of Italy's post-war private dwellings has been subjected, with the recent exceptions already mentioned.
The relationship with the landscape of the bay and the hills can be considered as the element that characterizes the best Neapolitan condominiums by Filo, whereby it is the natural given that dictates the form of the building, adjusting the initial Cartesian geometry in complex, diversified forms and spaces. As the architect herself said in her 1953 book “La casa di abitazione”: «every building, and mainly those [...] destined for man's family nucleus, must be studied in relation to the surrounding external environment constituted by nature or by the artificial one pre-ordained by man» or, again, «the house will constitute with the outside a single organism intended to offer ease and pleasure to the dwelling« [«ogni costruzione, e principalmente quelle […] destinate al nucleo familiare dell’uomo, devono essere studiate in rapporto all’ambiente esterno circostante costituito dalla natura o da quello artificiale preordinato dall’uomo» o, ancora, «la casa costituirà con l’esterno un unico organismo inteso ad offrire agio e piacere all’abitazione»] [26].
Far from the functionalism of the “masters”, Filo's architecture is shaped according to a code which is undoubtedly modern, also due to the use of certain elements such as white plastered concrete, walkways and *pilotis*, but at the same time perfectly integrated into the context through strongly expressive solutions, never dogmatic.
Who knows whether this quest for contextualization and integration of modernity with our Mediterranean landscape might not be a feminine characteristic of Filo's design. The research remains open, as does its critical interpretation, and many buildings by the first female Neapolitan architect are still waiting to be discovered or put into the right perspective.

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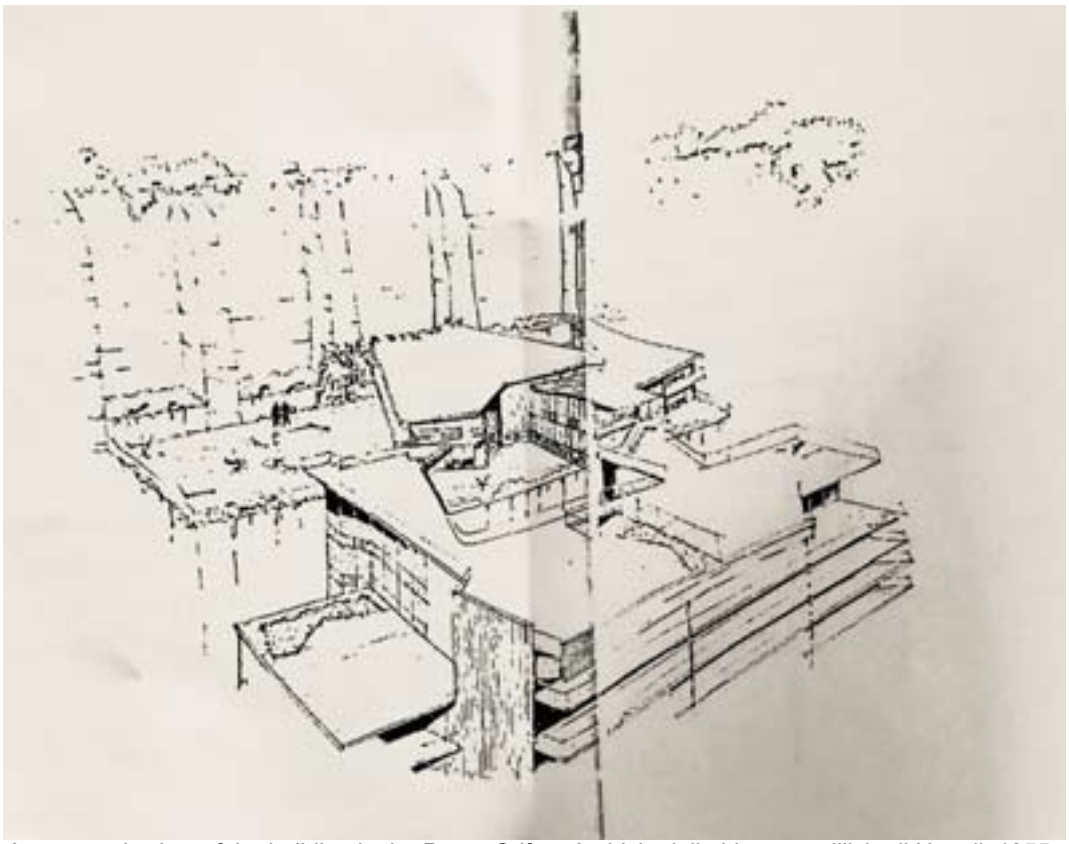

**Fig. 1:** Axonometric view of the building in the Parco Grifeo, Archivio delle Licenze edilizie di Napoli, 1955.

**Fig. 2:** View from the Vomero hill of the roofs of the upper block of the building in the Parco Grifeo today (photo by Chiara Ingrosso).

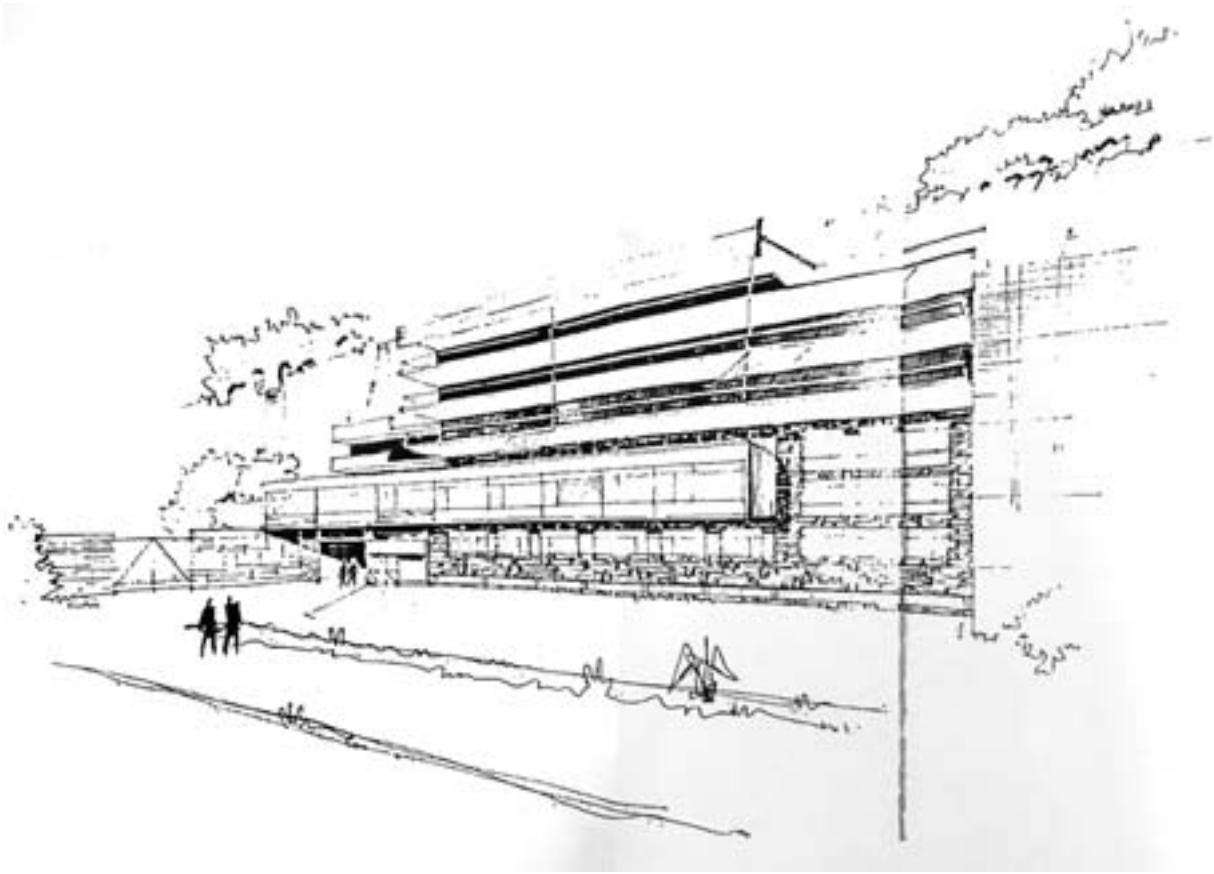

**Fig. 3:** Perspective sketch of the main façade of the building in the Parco Grifeo, Archivio delle Licenze edilizie di Napoli, 1955.

**Fig. 4:** View of the main façade of the building in the Parco Grifeo today (photo by Chiara Ingrosso).

**Fig. 5:** View from the main entrance of the building in the Parco Grifeo towards the Gulf (photo by Chiara Ingrosso)

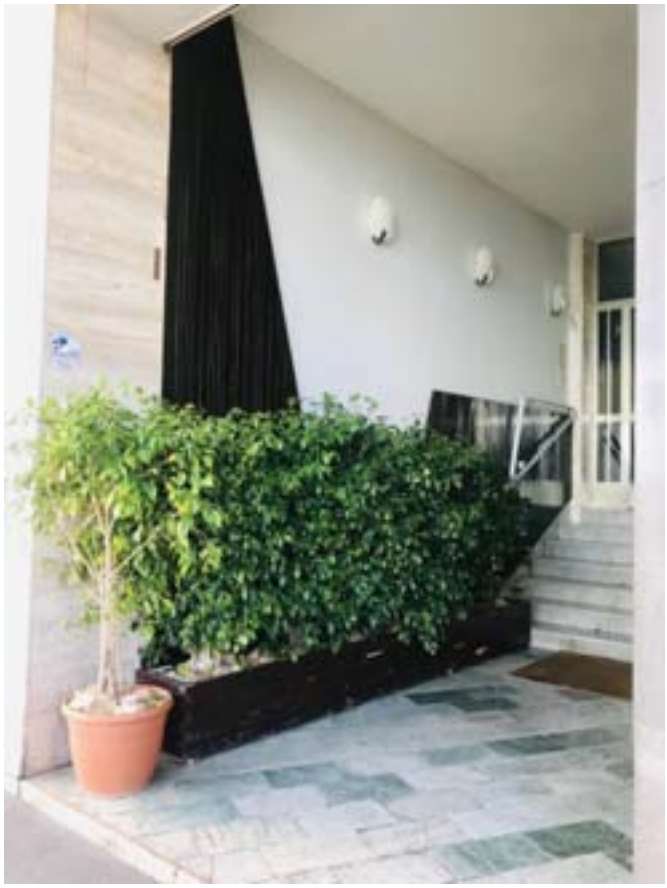

**Fig. 6:** Detail of the entrance of the building in the Parco Grifeo (photo by Chiara Ingrosso).

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# Lost architectural models
# Digital reconstruction of Raphael's Stables in Villa Farnesina

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**Abstract**
In 1506, when the first stone was laid for the new residence of the wealthy banker Agostino Chigi near the Vatican, not enough space was found for the Stables. In 1511, after buying some neighboring land, Chigi commissioned Raphael to build a Stables, overlooking the new Via della Lungara. Chigi promised the pope that those Stables would be the most elegant ever seen, and kept his word. In 1514, work began and in 1518 it was complete with the two main floors if the Stables were the site of a sumptuous banquet that saw Pope Leo X as the protagonist; but the work was completed in 1520 after the death of the artist, Agostino Chigi and his widow Francesca Ordeaschi. What was the appearance of the Stables is difficult to establish, and today little remains of them: part of the perimeter wall on Via della Lungara, demolished up to about half of the lower order. The survey carried out with the lidar techniques, between 2018 and 2020, had as its main purpose the documentation of the architectural asset investigating its current conformation. The criteria of this research and survey activity tend to document and analyze what remains of the architectural organism today. This in order to be able to define – in comparison with the data obtained from the instruments and those of the sixteenth-century surveys – the overall conformation of the Stables, through the construction of a digital model that reflects as much as possible the characteristics that the building organism could have had in the past.

**Keywords:** Cultural Heritage; documentation; survey; digital 3D reconstruction.

## 1. Introduction

This contribution describes the process of digital reconstruction of the Stables, designed by Raphael for the wealthy banker Agostino Chigi (Fig. 1), starting from the analysis of the architectural remains and the data obtained through direct and digital survey and bibliographic and archive research. The intention is to realise the possibility of a virtual tour that combines real images with a virtual reconstruction of the building that restores its original appearance and its relationship with the Villa Farnesina [1], designed by Baldassarre Peruzzi. Our age is characterized by the digital revolution and this involves and transforms procedures, methods and forms of communication and understanding. In particular, architectural reconstruction from archaeological remains [2] is a fairly frequent operation in the field of Cultural Heritage studies and resolves many undefined aspects for the purpose of communication to a wider public. In this field, the study of architecture in a state of ruin or in the process of disappearing is a field open to research using virtual reality, digital modalities and architectural graphic expression. In fact, the representation of disappeared architecture today represents an important challenge for the knowledge of our past history. The investigation and accurate interpretation of data found on site and from archive documents makes it possible to retrieve the information necessary for the knowledge of a

site and to reconstruct the events of its construction but also of its transformation or, in some cases, destruction.
In this research process, digital tools today offer powerful means of documentation, creating the conditions to collect, through digital survey, fundamental and precise data on the actual state of the place under investigation, but also, through 3D modelling [3], to guarantee a scientific reconstruction of the architectural artefact. In fact, the production of virtual models allows a constant verification of interpretative hypotheses, with effective solutions also for the subsequent presentation to the public through graphic rendering images, animation videos, virtual or amplified reality. The degree of graphic realism and its scientific accuracy also allows greater interest to be aroused by the wider, non-specialized public who, also emotionally involved, for example in a virtual tour, are introduced to the themes of cultural heritage conservation. In conclusion, the use of digital modalities constitutes a non-invasive technique and a sustainable and cost-effective way of learning about historical and architectural heritage.

## 2. Historical investigations and the survey

When the first stone was laid in 1506 for the construction of rich banker Agostino Chigi's new residence near the Vatican, it was not possible to find sufficient space for the necessary Stables on the newly acquired land. It had to wait until 1511, when, with the purchase of some neighbouring land, Chigi commissioned Raphael Sanzio, already a talented painter and emerging architect, with the construction of a stable building overlooking the new Via della Lungara.
They would have been the most elegant Stables ever seen, Chigi promised to the Pope, who instead glorified the beauty of the new Riario palace just in front of it, undoubtedly Agostino Chigi kept his word. The construction, begun in 1514, should have already been complete on the two main floors by February 1518, when the Stables were the site of a sumptuous banquet attended by the new pontiff, Leo X; works continued for a couple of years more, than definitively ended in 1520 after the artist's, Chigi's and his widow Francesca Ordeaschi's death. However, which they looked like remains difficult to establish with certainty.

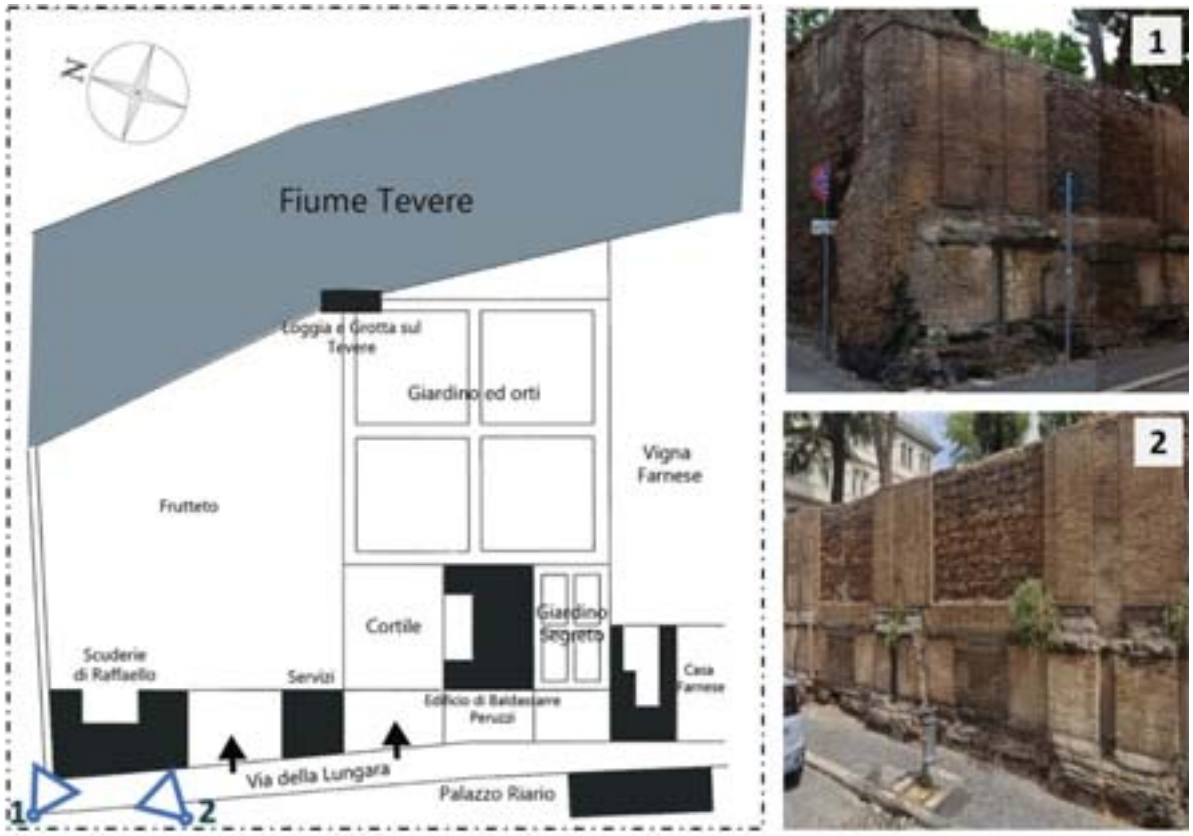


**Fig. 1:** Framing of the Villa Farnesina area, with the original configuration of all the factory service buildings including, to the north-west, the Stables that Raffaello designed for the Chigi.

Indeed, historiographical documents (some 16th-century reliefs, in particular that of an anonymous Franco-Flemish surveyor and that of an anonymous Frenchman) testify to the original configuration (Fig. 2). In order to document the current and original layout of the architectural asset, research was conducted between 2018 and 2020 using integrated surveying techniques (Fig. 3).
Thanks to the historical documentation founded, it was possible to make a comparison with the data acquired by means of the survey: these graphic testimonies provided a rather reliable image of the building since it was demolished in 1808 due to its dilapidated state.
Both 16th-century surveys agreed in demonstrating three levels above ground: the ground floor of Doric order, used as a stable, a first floor of Corinthian order, of a height similar to the level below, but with an uncertain function - Frommel [4], hypothesizes for this level a use as a guest quarters - and an attic that the two designers indicate as being of different height. More attention is instead paid to the design of the details, which are also accurately reproduced in some of Cherubino Alberti's plates.
The drawings by the anonymous French-Flemish artist provided information on the ground plan in which the spaces for the horse Stables are recognizable, on the side elevation with the portal of entry and on the section of the ground floor that shows the vaulted roof of this level.
Ambiguous, both in plan and elevation, is instead the representation of the staircase that led to the upper floors and that also seems to indicate, with the presence of some steps on the side of the rear courtyard, the existence of a basement level of which, however, little information is available: some elements of this level were discovered during an excavation conducted in 1970, documented through drawings and photographs. Nowadays very little remains of the Stables building: part of the perimetral wall on Via della Lungara, demolished, however, up to about half of the lower order. Here it is possible to read the scansion in seven bays of the entire wall with the alternation of paired parastas and squares of blind masonry.
Different types of masonry testify to the presence of plugged windows in the basement plinth, probably originally closed by grilles as reproduced in 16th-century drawings. The construction history of the building was understood through an analytic, scientific, and critical survey of the remaining elements of the building system, also performed through advanced technologies. Indeed, the iterated inspections of the building area have highlighted the peculiarity of particular sectors – such as some remains of some clay models shaped as the pilasters of indoor environments, or connection elements of internal ceiling vaults – and hence the need for rigorous documentation of the morphological aspects that would have been interesting for the comprehension of the history of the building.
Through the use of a diffuse and systematic photogrammetric survey, of great importance was the survey carried out using laser scanner digital recording techniques of the residual wall faces inside and outside the study area.

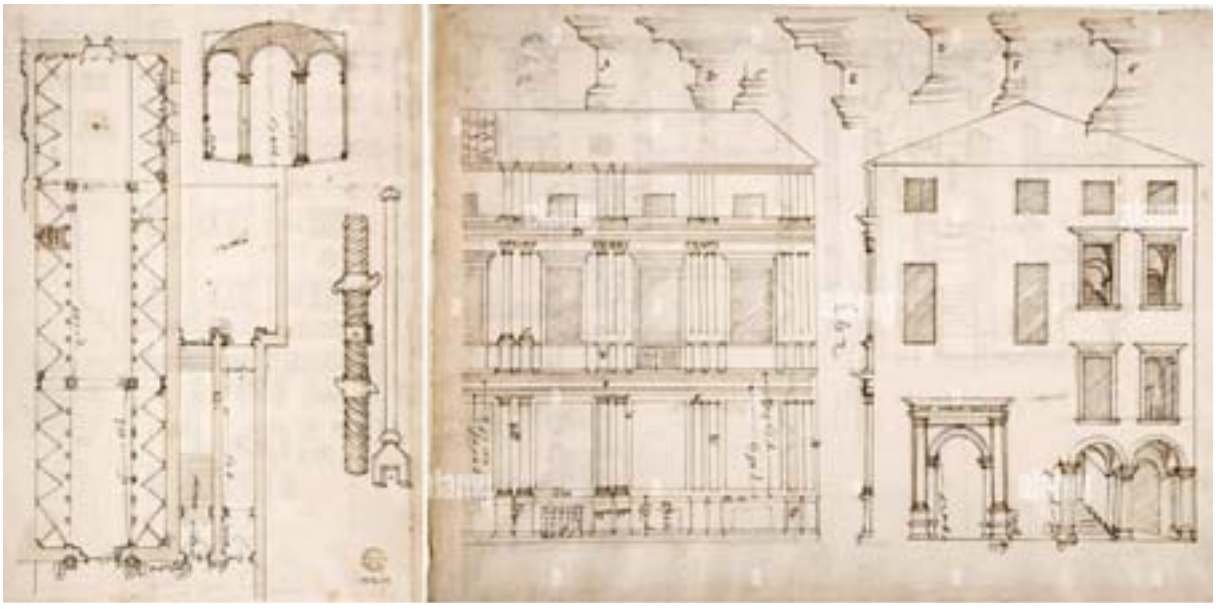

**Fig. 2:** Left, Plan and cross-section of the Stables, anonymous Franco-Flemish, second half of the 16th century, New York, Metropolitan Museum, Inv. 49, 92, 44v; right, Arise from the Stables, anonymous Franco-Flemish, second half of the 16th century, New York, Metropolitan Museum, Inv. 49, 92, 50r.

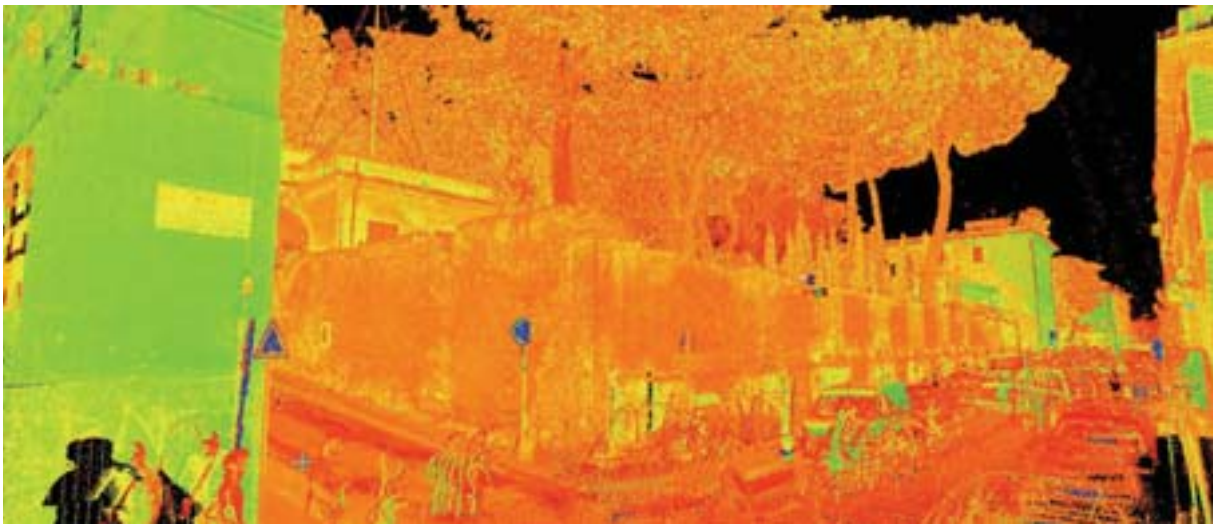

**Fig. 3:** View, along via della Lungara, of the point cloud model obtained by laser scanner acquisition. Observe what remains of Raphael's Stables.

A rich photographic documentation - carried out mainly with a Nikon D3100 Reflex camera - whose data was organized in a topo-photographic archive [6] articulated by orientation inside and outside the site. However, considering the relationship of the Stables with the surrounding urban context and the nearby main body of the Villa, the laser scanning survey – performed with a laser Leica Station C10 – was essential for the documentation and acquisition of the data re-quired for the reconstruction of its original layout. 2D targets were set during the data acquisition phase, to create an out-and-out “close loop” of scans, both outside and inside the area of Villa Farnesina, to achieve the correct ratio between outside and inside data, and facilitate point cloud union in the post-processing phase. Considering the plani-volumetric configuration of the building, which resulted from both the remaining visible architectural elements and the mentioned historical surveys, and the importance to obtain a model for the verification of its historical layout, it was chosen to perform further digital scanning to document it also from different-height observation points for the full coverage of the external surfaces. Hence, additional scanning was performed from Via della Lungara, Salita del Buon Pastore, Lungotevere Farnesina, and Palazzo Corsini. All the obtained scans have allowed realizing an overall point cloud, where the remains of the ancient Stables are also located in the urban context. Following the difficulty of being in front of an almost-disappeared building, the data acquisition phase was articulated into three levels of detail, to merge data from the direct survey, detail photo-grammetric survey, and digital survey. Direct or akin processes (laser distance meter, dual meter laser, etc.) were used for punctual checks and rapid comparisons, and for the survey of detail elements; that is, in situations where the laser scanner could not be used. In this way, following the progressive and overall union of the various point clouds – it was possible to obtain a general model of both walls and residual elements, favoring the successive phase of geometric-morphological analysis and reconstruction of the original configurations of the artifact (Fig. 4), in a continuous interaction between the reinterpretation of historiographic documentation and the verification of layout hypotheses in the 2D and 3D output.

## 3. The digital reconstruction of the original architectural model

The path leading to the virtual reconstruction of the Scuderie's architectural artefact was conducted starting from the results of the digital survey and historiographic acquisition activity. The preliminary analysis of the measurements reported in the 16th-century archive drawings, with respect to the unit expressed in Roman palms, and their comparison with the range-based survey, allowed for the reconstruction of initial outcomes (in plans, elevations and sections) validated through the geometric analysis of the plano-altimetric composition (Fig. 4).

The outcome is a system that in the three-dimensional reconstruction of a critical model [7] reflects the different functions of the Stables, with a basement floor, with ventilation and lighting openings towards the main road; a mezzanine floor, one part of which was intended for Stables, divided into three modules, and the other part for vertical connection; a first floor probably intended for storage, open to the outside by large windows with balconies and balustrade parapets; an attic probably intended for guest quarters. The analysis has led to a precise description first of the external façades such as the one facing the Via della Lungara with eight pilaster strips on pedestals marking out a ground floor of Doric order, an upper floor of Corinthian order and an attic. The façade towards the Villa, to the south-east, was composed differently for the part pertaining to the Stalls and the part enclosing the main staircase; the former was

marked: on the mezzanine floor by an opening delimited by Doric columns leading to the hall; on the upper floor by two large windows; in the attic by two smaller windows.

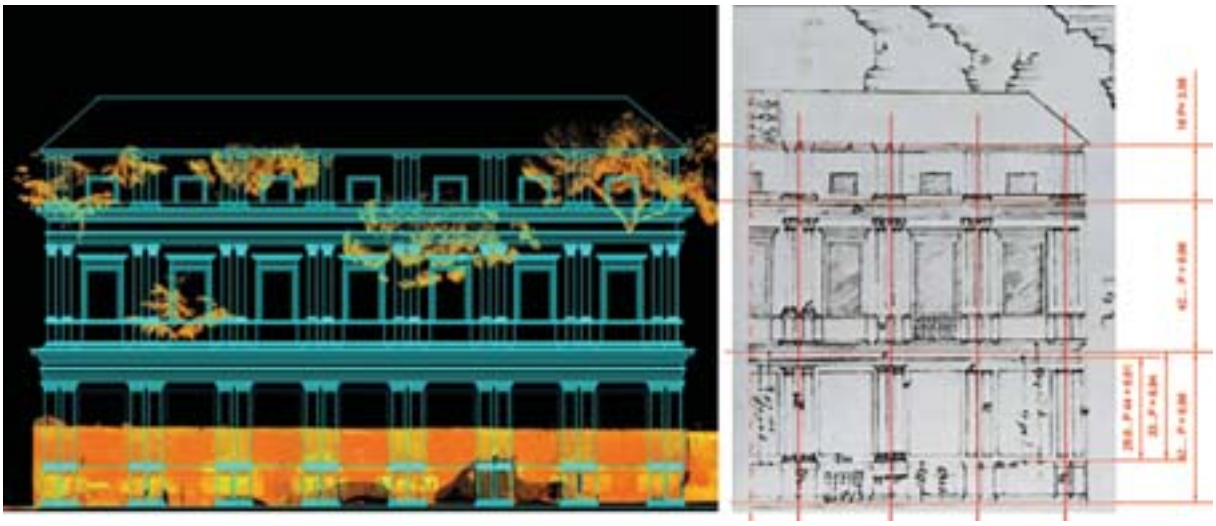

**Fig. 4:** Reconstruction of the original configuration of the façade of the Stables along Via della Lungara, starting from the digital survey and the analysis of archive drawings.

As for the volume housing the staircase, two adjacent openings led respectively to the access corridor and the corridor connecting to the courtyard behind; on the upper floors there were three rows of windows, some of which were blind.
The virtual reconstruction (Fig. 5) guided by the correlation of data, aimed at completing the 16th-century survey, found it necessary to make some hypotheses on the elevation along the Salita del Buon Pastore, which is not documented on the upper floors except through an interpretation of historical views and iconography. For example, from Tempesta's view of 1593, it is easy to ascertain the scansion of the openings along the Salita del Buon Pastore and the architectural orders of the façade on via della Lungara, as well as the constructive relations between the different functional areas of the building.

Fig. 5: view of the digital model, from the south, of the original architectural conformation of Raphael's Stables.

In particular, the Stables building appears to be leaning against another smaller one along the Salita del Buon Pastore, at an angle adjacent to the rear courtyard, probably added later during the 1520 extension works. Thus, the volume of the Stables is characterized by an opening on the mezzanine floor and two rows of windows on the upper floors, re-proposing the composition of the elevation towards the Villa Farnesina.
The elements that have come down to us so far, fewer in number than those that have now disappeared, do not allow for a reliable reconstruction of the internal organisation of the upper floors. Only the functional organisation can be reconstructed for the layout of the mezzanine floor, the Stables and a hypothesis on the spatial organization of the staircase in accordance with contemporary architectural typologies and the perspective representation of the vaults covering the landings indicated in the Franco-Flemish elevation drawing.
The digitization process carried out on the remains of an artefact that has changed radically over the centuries has therefore not been limited to the processing of mere images, but is itself a process [8] to broaden knowledge that makes use of modelling to carry out a precise reflection on the design problems Raphael faced when carrying out this delicate task and the original solutions he adopted.
The quality of what was produced at the end of the reconstruction process then led, again in an almost essentially digital context, to the creation of visitable virtual contexts, and to the on-site enhancement of the perception of the place through virtual reality solutions in order to rethink the dissemination to virtual tourism users who can access the content developed in the research [9]. This in fact led to the need to design a computerization in the immersiveness of the model, in a Interaction between architectural elements and the visitor. towards a system of 'serious games' that sees the focus on the multimedia presentation of the figurative and informative content [10]. If this pushes towards the tourist enhancement of the property, on the other hand it implements a process of cultural dissemination that lays the foundations for new studies and research to broaden the understanding of an architectural space of which few traces remain.

## 4. Conclusions

This research activity, which has finally made it possible to document the condition of the building in its historical *facies*, can be a useful support for recording the results of other future interventions and multidisciplinary studies. The research activity carried out has certainly highlighted the great multifaceted qualities of the artist - Raphael - evidenced in many peculiar features of the building, such as in the masterly organisation of the various spaces e.g. destined for the Stables. The results achieved, moreover, demonstrate that the careful use and critical interpretation of any building survey, must always go back over its most important phases - which can often also be read on the 'skin' of the building - in order to achieve, where possible, full knowledge (*firmitas*-static solidity, *utilitas*-functionality and *venustas*-beauty principles dear to Vitruvius) of a building's history.

## 5. Acknowledgments

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# Built environment, art and strategies for care and maintenance landscape: artist residencies in Massa Lubrense

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## Abstract

The paper shows a Best Practice, based on the topics of beauty, art and landscape, which are the core issues in strengthening the identity of communities. The artist residence: "Art, Landscape and culture of food", in Massa Lubrense was funded by an agreement between the Associazione Ristoratori Lubrensi (ARL), the Department of Architecture (DiARC) of the University of Naples Federico II and the Municipality of Massa Lubrense. It also involves synergy with schools, associations and citizens. In this scenario, artistic production is a driver to rebuild deep links with the tangible and intangible cultural resources of the Historic Urban Landscape (UNESCO, 2011). The strategy implemented, engages the actors on the territory in a path of reading and reinterpreting places, recognized as identity features by the community, in order to share the responsibility of their care and maintenance (EC 2005). The pilot project, carried out in the area of S. Costanzo Mount, is a pilgrimage destination and scenic point that embraces the Gulf of Naples and the Gulf of Salerno in a single view. The project identifies artist residencies as a method to promote awareness processes, triggering a collective dimension of responsibility. To face the disappearance of co-evolutionary dynamics, which for centuries have bound communities and places, art is proposed as an engine for the awareness and cohesion of civil society toward beauty. This to counter the disruptive pressures that alter environmental and architectural heritages.

**Keywords:** Regeneration, reuse, built environment, maintenance, community engagement

## 1. Introduction

In the scenario of global ecological transition, technological and economic challenges are linked to social and cultural issues, which help determine the actions of transformation and preservation of the built environment [1]. In order to accelerate the processes of ecological modernization, it is necessary for architects and institutions to act on the designs of the future while also considering civic values of solidarity, participation and cooperation of communities [2].
Landscape is a prism that allows one to take a human-centered perspective [3], focused on the human dimension. There is no landscape if there is not its perception by a subject, through his different senses. On the other hand, landscape is merely the result of a series of choices made by each subject and community. A society's culture reflects in the landscape because of the way each person stands in relation to others and to nature/environment and culture represents the best human product creation.
Landscape configures itself as a vital/living resource, capable of changing continuously under the impetus of people's needs, interests, hopes, as well as because of the impacts of climate change.
This means re-generating values of trust, inclusiveness, synergy even towards nature and landscape at a rate at least as fast as their consumption [3]. Therefore, the aesthetic dimension of the built environment contributes to this purpose as a generator of an attractive force field for people and

activities [4]. It is configured not only as a source of emotions and well-being, but also as the entry point for the production of interpersonal and ecological values that can be transmitted as operations of care and maintenance of the built environment [5].
The virtuous circuit between the aesthetic dimension, the physical dimension of the built environment and the social dimension - translatable as beautiful, useful and just - are not necessarily in conflict but can be linked together with a view to regenerate through a circular process that tends to feed itself over time. This process is verifiable in the actions of enhancement and shared management of the built environment and the landscape it helps to generate, assuming a common good value characterized by such aesthetic quality [6]. Caring for the commons, on which everyone's well-being depends, is the entry point for regenerating attention to the general interest and questions of meaning/meaning, interpreting it as a mixture of cultural and natural landscapes.
According to circular strategies of the built environment regeneration, the objective of the proposal aims to establish a methodology of participatory care and maintenance through the integration of artistic experimentations to counter the disruptive pressures that alter environmental and architectural heritages. To promote awareness processes, triggering a collective dimension of responsibility and to face the disappearance of co-evolutionary dynamics, which for centuries have bound communities and places, art is proposed as an engine for the awareness and cohesion of civil society toward beauty.
Starting from a best practice, based on the topics of beauty, art and landscape, which are the core issues in strengthening the identity of communities, the research returns the results of a tested practice, the artist residence: "Art, Landscape and culture of food." It was conducted in Massa Lubrense was funded by an agreement between the Associazione Ristoratori Lubrensi (ARL), the Department of Architecture (DiARC) of the University of Naples Federico II and the Municipality of Massa Lubrense. Through a methodological path that promotes a participatory, systemic and synergistic approach to the care of the territories, the outcomes define a transferable strategy based on creative involvement as a fundamental condition for achieving sustainable human development in the care of the built environment.

## 2. Artistic production as a driver of tangible and intangible cultural resources rebuilding in the Historic Urban Landscape

In the international debate for sustainable development, cultural heritage is a driver of transformation of the built environment [5]. The UNESCO Recommendations on Historic Urban Landscape recognize the fundamental role of cultural heritage and cultural landscape for sustainable local development. Representing a broadening of horizons with respect to the object of protection, object-based conservation becomes landscape-based [7] through a systems approach as a result of the historical stratification of cultural and natural values and features [5, art.8]. In particular, the European Landscape Convention [8] considers heritage as living [8], including both the built environment (tangible heritage) and the values attributed by communities to these places (intangible heritage). This broadening of horizons involves a shift to a new view of the relationship between conservation and transformation, in which the latter must be managed and directed, rather than avoided [9]. The European Landscape Convention recognizes landscape as the essential component of people's living context, resulting from the action of natural and/or human factors and their interrelationships [8]. This scenario, landscape regeneration and maintenance actions aim to intervene on phenomena of degradation or anthropogenic aggression in order to identify those transformative actions capable of respecting the collective, historical and physiognomic construction of the identity peculiarities of a specific culture.
The Convention for the Safeguarding of the Intangible Cultural Heritage [10], recognizes intangible cultural heritage as a set of expressions, knowledge, tools, objects, artifacts and the cultural spaces that communities, groups and in some cases individuals attribute to Cultural Heritage as shared identification and development of a sense of belonging [11].
The relationship that, over time, binds a place to a community through actions of mutual transformation and adaptation determines a choral and inseparable production of the built environment between people's identity and genius loci [12]. The latter is the expression of local specificity and uniqueness, a product of the interaction of a community, and thus a culture, with its context.
According to a systemic view of the built environment [13] all technological components and all spatial elements constitute the cultural capital of the landscape, consisting of a tangible part (artistic productions and monuments of local culture) and an intangible part (values, beliefs, memories). Tangible and intangible heritage, related to each other in the concept of landscape define the material culture of places that contributes to the continuity between past and present, extending these concepts to future generations in order to create, build, use and modify heritage and landscape [14]. In this perspective, landscape can be considered as a layered deposit of material and cognitive sediments objectified in landscapes, cultures and knowledge, which are configured as collective heritage. The action of care by communities over time on it develops symbolic, cultural and material processes by experimenting with

forms of participatory landscape regeneration. In this meaning, strategies the management and maintenance become essential to the preservation of existing values and the production of new values through a process of recreating material and immaterial values. The built environment is, therefore, a social construction in that, expressing the diversity of the cultural and natural heritage of each population, it represents its identity foundation [15]. The regeneration actions that can be implemented on it follow a cultural process related to the care of intangible values and the maintenance of tangible values. The recognition of these landscape values determines the need to identify new models of recovery and maintenance of the built environment, considered as a common good [16]. The latter is a complex system of human actions that over time have balanced the relationship between nature and culture, ecology and society [17] facing social and economic dynamics that, in turn, are returned in the landscape. Therefore, the more a landscape is dense with relationships and exchanges, the more cultural heritage will be able to be said to be a common good, representing the real connection between community and built environment [18]. Such relationships affect the quality of life, which implies a civic aesthetics that does not only concern personal enjoyment, but expands to an interpersonal and community dimension. It becomes the tool for transforming citizens into custodians of shared values, letting them able of making creative synthesis between personal interests and general interest, thus contributing to the humanization of the ecological transition processes required today.

To the creative arts is deferred the pervasive role of landscape regeneration [19], promoting the collective dimension of custodianship to rebalance the co-evolutionary vocation that traditionally links heritage, nature and the built environment [20]. Artistic creation is a process capable of not only conveying emotions, meanings and values, but also of promoting the maturation of critical thinking in those who participate in the production of the landscape and the built environment. Artistic production is characterized by a high transformative potential for reconstituting links between citizens, the historic landscape and tangible and intangible cultural resources of the territory. It can activate regeneration processes that, starting with the education of young people and the knowledge sedimented in communities, point the way in the direction of life models marked by cultural sustainability. The synergies between artistic production and regeneration of the developed environment help outline new opportunities in terms of participation, training and future planning. In this sense, the practice of Artist Residency represents a form of cultural production that is capable of being an engine of social, economic and cultural development because of its ability to affect the reactivation of local creativity, the promotion of social cohesion, and the encouragement of commitment to the custodianship and regeneration of the built environment [21]. The practice of Artist Residency has significant consequences for communities and landscapes in terms of both use patterns and architectural qualities of the built environment [22]. Such practice can be one of the means of information exchange, knowledge increase, and creative skill acquisition that individuals and organizations accomplish in using existing resources. In particular, by promoting their participation in cultural practices, artists respond to the need to awaken the creativity of individuals and communities, with the goal of generating collective creativity that is closely interconnected to the regenerative potential of the built environment [23]. The practice of Artist Residency increases social cohesion and quality of life through the stimulation of community creativity, as by making stakeholders confident and imaginative they feel empowered to harness their own potential to maintain and care for the built environment [24].

## 3. Methodology

Having considered landscape as a common good and art as a driver of transformation, the process of recovery and maintenance of the built environment follows a methodological path that must have implications in both the design and operational dimensions [16]. The methodology adopts a systemic view of the built environment [18] in which specific internal potentials affect how it is integrated [22] and the quality of relationships among its components (physical, social, cultural and economic).

The adopted methodological approach, which is circular and iterative, represents a sequence of stages that aim to overcome the limitation of mere preservation of the landscape as a historical testimony connoted only by the aesthetic dimension and devoid of meanings in the contemporary world. Each methodological phase follows a criterion of action necessary to enhance the landscape resource both by stimulating relationships between the community and the built environment and by promoting a new capacity for landscape management and maintenance through the care of the artistic element. Therefore, the methodology is divided into four main phases: Knowledge and awareness acquisition, Experimentation and modelling, Replicability and transferability, and Evaluation and Validation. In the first phase, the action criterion concerns what stakeholders felt the need to enhance their identity places through the guidance of expert knowledge by formalizing an agreement between entrepreneurs, university researchers and local municipality. In the second phase the action criterion is based by issuing a Call for Artists, the creativity entrusts the redevelopment of a beautiful environmental pathway, reinterpreting the right to cultural heritage and the sharing of responsibilities toward education process of sustainability care. In the third phase the criterion for action in contexts marked by disruptive

pressures that alter the qualities settlement and the new users' needs for transformation, the project experiments strategy at the intersection of artistic production and participation. It can bring an acceleration of sustainable regeneration processes. In the fourth phase, the action criterion concerns balancing the instances of innovation with the protection of identities, it is possible to promote strategy by triggering relationships between creativity and environmental sustainability. Focusing on creative potential, stakeholders empower and care for the built environment (Figure 1).

**Fig. 1:** Methodological path: a creative rehabilitation strategy for built environment.

By following the methodological path, cultural values can be transformed into civic values, fostering the composition of the relational dimension between landscape and communities that reinterpret it as a common good. The methodological path activates synergies through the involvement of the community that recognizes in art an opportunity to awaken its potential. This in order to prevent traditions and identity image from disappearing over time. The systemic logic, recognizing the links, relationships and connections between the stages of the methodology allows the regeneration process to be reinterpreted from a circular perspective that, by creatively integrating the built environment and artistic production, promotes synergies among different agents/institutions in a dynamic and proactive manner [21]. The resulting regeneration process stimulates the care and maintenance of specific local cultural resources [24] both spatially and technologically to achieve the improvement of quality of life.

## 4. Discussion and Results

The commitment to invest in culture and tourism in the Sorrento Coast and the metropolitan area of Naples translates into the promotion of creative processes of care and maintenance of the built environment, directed at establishing actions to enhance fragile landscapes. The experimentation, in fact, was conducted in the area of S. Costanzo Mount, a pilgrimage destination and panoramic point that embraces the Gulf of Naples and the Gulf of Salerno in a single glance. The place's poor accessibility has preserved it from the pressures that tourism exerts in the area, making it a symbol of local identity. Entitled "Massa Lubrense art, landscape, food culture," the project to care for the built environment, funded by an agreement between the Associazione Ristoratori Lubrensi (ARL) and the Department of Architecture (DiARC) of the University of Naples Federico II, and the Municipality of Massa Lubrense. The creativity of artists was entrusted with the redevelopment of an extraordinarily beautiful environmental pathway that runs through the site (Figure 2).

**Fig. 2:** Landscape view of S. Costanzo Mount

The right to cultural inheritance and shared responsibility for heritages reshape the coordinates of care and maintenance processes. The experience is conducted through a synergy between the university, the municipality, local entrepreneurs, schools, associations and citizens and identifies artistic production as a driver for rebuilding deep links with the tangible and intangible resources of cultural landscapes. In these contexts, where creativity and beauty represent foundational traits of settlement tradition, artistic production can reinterpret places to preserve their values. The project activated a creative actions of landscape care, accompanying the actors involved in a path of reading and reinterpretation of places recognized as identity elements by the community.

The experience in Massa Lubrense stems mainly from the economic crisis that hit restaurant entrepreneurs during the early stages of the Covid 19 pandemic, prompting them to imagine new trajectories of economic development, based on cohesion even among usually competing entrepreneurial entities and the desire to strengthen the identity of the area. The ARL (Associazione Ristoratori Lubrensi) was founded in 2020 as an association of local restaurateurs driven by a common desire to engage in improving the place where they live and work.

The upheaval of social relations and relations with the territory was perceived by the local population, aggregating them around the deep values capable of being a glue for the population itself. The strong religious tradition of the small Lubrense community takes on a central role in the reconstruction of ties between people, places and knowledge. The Eucharistic symbols become the common thread of an experience that associates people, cultural and landscape assets and local traditions, helping to build a renewed heritage community. In this sense, the project takes on beauty as a driver of sustainability, which regenerates, in turn, creativity, in a context where young artists are invited to re-interpret the identity of places. The filed experience promoted a participatory, systemic and synergistic approach to the care of territories, identifying a transferable strategy of care and maintenance of the built environment, a fundamental condition for achieving sustainable human development. The filed experience, supported by professors, researchers and technicians, accompanied the community in a process of regaining awareness of the need to preserve the past and support the future. The initiative promoted dialogue between expert knowledge, artists, third sector representatives, entrepreneurs, and new generations, reinforcing communities to their role as active custodians of settlement systems. Therefore, the participatory processes and artistic experiments made it possible to establish appropriate

tools to develop the critical capacity of stakeholders and thus improve their presence in public debate initiatives and/or co-design and co-management processes.
The project returned activated collaborative regeneration processes, in areas seemingly distant from contemporary art, focusing on education and social innovation. Faced with the sustainability challenges affecting the built environment today, forced between abandonment, obsolescence and uncontrolled transformations, the community experienced the possibility of regenerating memory and acquiring skills. These made it possible to co-design and co-manage the processes of recovery and maintenance of the built environment. In this perspective, the hosting of the two winning artists of the Artist Residency practice, Virgile Legavre-Jerome and Marjan Fahimi, became one of the stages of a strategy based on human-centered design. A key finding from the questionnaires circulated at the end of the project's experimentation is that the built environment has formed the connective tissue of the local community. The promotion of an ethic of glocal citizenship and shared responsibility emerges as an intangible connective infrastructure for sustainable development. Supported by long-lasting skill specialization processes and funding opportunities, cultural and artistic production has become an engine of regeneration. The project identifies the encounter and cooperation between community and artist as an educational form to activate the reinterpretation of landscape values. In a settlement of exceptional landscape value and maintenance vulnerability, the Artist Residency supports the transfer of innovative solutions for the regeneration of the built environment from research to the field of practice. The artists were assisted by DiARC students and students from the F. Grandi High School of Art in Sorrento in the phases of context exploration, elaboration and realization of the work, and by the community at the stage of identifying the location of the work, respecting the high religious value of the site. In addition, the community participated in the installation or installation operations (Figures 3 and 4).

**Fig. 3 e 4:** Participatory approach during stakeholders shared event on S. Costanzo Mount

During the residency period, formal and informal meetings were organized so that the artists could immerse themselves in local life, with its traditions and vocations. In the face of the disappearance of co-evolutionary dynamics, which for centuries have bound communities and places, art is proposed as an engine for the awareness and cohesion of civil society toward beauty, to counter the disruptive pressures that alter heritages. Noting the processes of uncontrolled transformation that increasingly affect the built environment, the project's approach is based on the idea that hospitality offered to artists is an opportunity to regenerate community awareness and creativity. Proposing balancing conditions between a fragile pre-existing order and citizens' shared values is often a difficult task for public administrations manage the balance between the fragilities of territories of excellence and the legitimate needs of citizens. Creative activities, such as artist residencies, can virtuously regenerate relationships between the community and the landscape by having a positive effect on settlements-promoting sustainable development through relationships between the host context, youth creativity and community cohesion. The project identifies artist residencies as a methodological support tool to

promote awareness processes, triggering a collective dimension of responsibility. The invitation to dialogue was the main theme of the proposal and the artist hosted in the territory formulates it: the artwork is established with the space, the synergies do not come from an ordering element, an artifact, sculpture or architecture, but rather from the community that lives the landscape and contributes to its creation and maintenance. The artist's sensitivity and creative vision awaken the community's need for encounter and cooperation: the artist shares the community's memories and rituals, leaving the traces of a relationship. The project triggers quality processes to induce actions of landscape care, making the site a set of places known through the Grand Tour and, therefore, cultural landmarks in the evolution of European thought. The project is inaugurated in S. Costanzo Mount as it identifies these emblematic places, to which the community attaches value, as the first garrison of material and immaterial qualities (Figure 5).

**Fig. 5:** Community engagement into caring of artworks during its installation

By rediscovering these sites artistically, it once again makes the beauty of place a hub of creative production and community encounter, as well as an educational method for sustainability and custodianship of the beauty of identity landscapes. The project provides a framework for the impacts of civic education on the care and maintenance of landscapes through the collective appropriation of knowledge and memories. This condition is essential for the mitigation of anthropogenic impacts on the built environment. Renewed artistic production with people's attention and fondness for heritage triggers new strategies of caring for the built environment with possibilities for development (Figure 6).

**Fig. 6:** Marjan Fahimi artwork on S.Costanzo Mount, La Finestra, 2022.

## 5. Conclusion

The paper returns the research experience conducted in the context of the project "Massa Lubrense art, landscape, food culture," funded by an agreement between the Associazione Ristoratori Lubrensi (ARL) and the Department of Architecture (DiARC) of the University of Naples Federico II, and the Municipality of Massa Lubrense. It returns a strategy of caring for the built environment by entrusting the creativity of artists with the redevelopment of an environmental path in S. Costanzo Mount. The built environment-art pair increases levels of beauty, meaning and social sustainability through the synergy between artistic creation and the work of art, identifying the latter as an ordering element of a landscape invested by unmatchable transformations. The work of art marks both the processes that precede it and those that are activated because of its existence. In this sense, art is a driver of tangible and intangible cultural resources rebuilding in the Historic Urban Landscape through the experimentation of culture-led regeneration processes. These are based on an approach to landscape redevelopment that emphasizes culture and the local community as key elements of the transformation process. This strategy enhances cultural and creative resources to promote sustainable economic, social and environmental development in which the involvement and participation of stakeholders in care and maintenance processes is necessary at every stage of the process. The transferability of the strategy to other settlements of exceptional landscape value and high vulnerability, Due to abandonment or incompatible transformation through the practice of Artist Residency supports the replicability of innovative solutions for integrated and participatory care and maintenance of the built environment.

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# A new *Museum of the suburbs* in Rome. Architecture for new narrative lexicons in the R5 sector of Tor Bella Monaca.

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## Abstract
On the eastern outskirts of Rome, the boundary between the urban area and the rural landscape is defined by the great redent of Tor Bella Monaca, designed by Pietro Barucci in 1980. Today, this huge modern monument stands as a witness to an ideology that has failed to unravel the tensions between urbs and polis, an emblem of a society that marginalises its edges in pursuit of an idea of perpetual centralisation.
In this context, the Plan promoted by Roma Capitale aims to reinterpret Tor Bella Monaca as a material and cultural heritage to be valorised and transformed, favouring the construction of a new sense of urban community. The think tank coordinated by Orazio Carpenzano has developed a regeneration project to redeem the area physically and functionally, with a focus on the relations between the center and the periphery, as well as on typological and environmental aspects.
The symbol of this desire for rebirth is the project of the RIF - Museo delle Periferie, a museum-lab that develops architecturally in the underground level and emerges into the north courtyard of the complex with three large patios, which rewrite a new sampling of possible uses in the intermediate space between the collective dimension of the city and the domestic dimension of the house. The project recognizes the periphery as the habitat for the birth of a new idea of civic culture: inclusive, collaborative, dialogic, and future-oriented, characterized by the vitalistic charge that defines borderline spaces.

**Keywords:** museum, periphery, heritage, architecture, culture

## 1. Tor Bella Monaca and the outcast legacy of the Modern
The legacy of Modernism has left us with a striking number of masterpieces and a wealth of good architecture, but also some painful testimonies to ideological approaches to urban design that have proved to be failures in the test of history. In the great contemporary discourse on heritage, these problematic legacies urge civil society and political decision-makers to engage in a close debate between the demands for erasure and those for the preservation and regeneration of the material legacy left to us by previous generations.
Architectural culture must take on the not easy task of mediating and, if possible, directing choices towards criteria that allow conscious and sustainable choices to be made, aimed at the construction of new urban tools that include controlled demolition and conscious reconstruction in their vocabulary of possible actions. However, this process is far from over, as the recent chronicles show, with the constant threat of demolition for many buildings that could be recycled and put to new uses. The humanist culture of design is still fighting its own battle against the instances that tend to leave the field open to the barbarity of the erasure [1] of objects that have not had time in this violent world of ours to become ruins and thus offer themselves to that "lost time that art sometimes manages to rediscover" [2].
On the eastern outskirts of Rome, the large building in sector R5 of Tor Bella Monaca, designed in 1980 by Pietro Barucci with Elio Piroddi and a group of architects and engineers, seems to be heading for a happier destiny thanks to the Integrated Plan promoted by Roma Capitale, which envisages making it the subject of a major urban regeneration and transformation project, reinterpreting it as a material and

cultural heritage to be enhanced in order to promote the construction of a new sense of community. The think-tank, coordinated by Orazio Carpenzano, has developed a regeneration project to physically and functionally redeem the area, focusing on the relationship between the centre and the periphery, as well as on typological and environmental aspects.
The symbol of this desire for renewal is the RIF - Museo delle Periferie (Museum of the Suburbs) project, a museum-lab that develops architecturally in the underground level and emerges in the northern courtyard of the complex with three large patios that rewrite a new sampling of possible uses in the intermediate space between the collective dimension of the city and the domestic dimension of the house.

### 1.1 *A great future behind us.* The suburbs as a testing ground for new housing projects for the third millennium

The landscape of the large economic and social housing estates built in Italy since the end of the 1960s is often the grey backdrop to the fixed scene of a society that, in pursuit of an idea of permanent centralisation of urban quality, has ended up marginalising its fringes. In the suburbs of major European cities, housing policies, in an attempt to deal with the housing problems caused by the extraordinary demographic growth of the post-war period, have led to the emergence of neighbourhoods with serious basic problems, which have rapidly become the scene of unresolved tensions, physical decay and social exclusion. Today, these outcast places are experiencing a marginalisation that is less spatial than social [3], often exacerbated by exogenous factors such as the poor quality of public spaces and the urban landscape, difficult access to essential services, and the disconnection of territories in terms of mobility. The pandemic has further increased distances and lack of prospects. At the same time, however, the major environmental, economic, political and health crises that have disrupted the beginning of the new millennium have stimulated and accelerated initiatives for the ecological and infrastructural transformation of cities. Forced to take drastic and urgent measures, politicians are now embarking on a path of sudden change in residential and economic patterns, in order to achieve greater physical and digital accessibility of spaces and services offered to citizens, in a capillary, slow-moving system based on the theme of the '15-minute city', theorised by the Franco-Colombian urban planner Carlos Moreno [4] and now on the political agenda of major Western cities, including Rome: the city of the future will have to be polycentric, promoting social proximity and cultural vibrancy and making it possible to satisfy the different needs of life: living, working, providing, caring, learning and entertaining.
In the cities of the third millennium, the periphery, understood as an urban phenomenon on a global scale, is an unexplored treasure trove of spatial, environmental and social potential, capable of perfectly restoring the image of a city that is finally fair, participatory and inclusive. To be effective, therefore, the project to recover this heavy modern heritage must first of all be translated into a cultural project that aims to identify in the suburbs the forge of new metropolitan identities, the meeting and confrontation place of a fully multicultural society, younger and more dynamic, more open to experimentation, by intervening in the quality of their housing supply and in the reconfiguration potential of the stem spaces [5] that populate and innervate the metropolitan neighbourhoods. The humanistic culture of the project requires us to deal with even the most painful legacies that architecture and politics have consigned to the history of cities, to identify in the spaces of large courtyards such as Tor Bella Monaca the germinating nuclei for a new beginning, to reconcile the categories of controlled demolition and conscious reconstruction, to intervene even in a substantial rewriting of settlement principles that have proved fallacious in the test of time and use. Contemporary lifestyles mix the public and private dimensions of the urban dwelling, which is increasingly transformed into a space that includes places for relating to the outside world, broken up to create units dedicated to hospitality, and articulated to represent or annex working spaces.
Housing is waiting to become an important laboratory of planning and design again, it needs new development processes articulated by different actors, from local and regional administrative realities to proposers and implementers, private, cooperative, public and third sector, it is demanded by residents and new urban users, it implies the sharing of spaces and services to function as a micro-city [6].

### 1.2 *The wall-hive.* The R5 sector of Tor Bella Monaca and the dystopia of inhabiting the multitude

Rome's recent urban history has seen the parts of the newly expanded urban fabric merge together through a process of progressive growth along the main roads, then assaulting and partially consuming the remaining space, with some significant exceptions represented by the large environmental bodies that still connect the city to its founding landscape. Sector R5 of Tor Bella Monaca is one of the episodes that best describes this peculiar relationship that Rome has with its hinterland: the great *redent* bends its footprint on the ground into three large open courtyards, alternating between them with two narrower courtyards facing the road axis of Via dell'Archeologia, in an attempt to establish a strong boundary relationship between the space of the city and that of the countryside, against the open backdrop of the landscape of the Simbruini Mountains carved out by the Aniene riverbed. However, unlike the not so distant experiments carried out by Libera, Muratori and De Renzi in some of the districts of Ina-Casa,

where the theme of urban aggregation is translated into an appropriate hierarchisation of dimensional scales, in Peep Season, of which Tor Bella Monaca is an exemplary manifestation [7], the urban model of the large dimension is taken to the extreme, stiffening it in a set of norms and typological parameters that are not adequately translated into an articulated and coherent system between the various scales of the project [8]. Where neighbourhoods such as Tuscolano II, Valco San Paolo or Ponte Mammolo offer an articulation of the ground floor capable of reconciling relational needs with those of privacy, constructing a new urban identity through the quality of the spaces between houses and the city, the project for Tor Bella Monaca suffers from a misplaced confidence in the ability of the capital's government to create, over time, an adequate territorial network of public policies and effective services to support the settlement weight of 1,200 dwellings and over 4,000 inhabitants enclosed in a single and desolatingly uniform building container [9]. The social problems resulting from a massive 'deportation' of already disadvantaged families, without any public support, immediately proved explosive and resulted in enormous social costs, which ended up creating in the collective imagination the belief that Tor Bella Monaca was one of the most dangerous and unlivable places in the city [10].
Today, the R5 sector of Tor Bella Monaca is still an alien and diseased body, marginalised by the neighbourhood of which it is a part [11], besieged by criminal infiltration and by decades of institutional neglect, which has left the field open for the abusive appropriation of large parts of its cellars and communal spaces.

## 2. Taming the *monstrum*. Regenerative actions and typological reconfigurations in Sapienza's project for Tor Bella Monaca

The impetus for the physical and social rehabilitation of this large building came from the initiative of Roma Capitale, which, through its participation in two different calls for proposals [12], entrusted Sapienza with a task to be developed in the R5 sector with the aim of improving the quality of life. The rehabilitation and valorisation project, coordinated by Orazio Carpenzano and Eliana Cangelli in an interdisciplinary design workshop involving over 30 researchers and professors from the Sapienza University of Rome [13], focuses both on the recovery of the building from the point of view of the typological distribution and energy performance of the apartments, and on rethinking the connection to the ground and the relationship between the base of the building and the open spaces facing it. The public space of the area will be equipped with new community services, new vegetation and an integrated sustainable mobility network to facilitate access to the underground stations and to the Tor Vergata district, with its university and research centre, and to the *Vele di Calatrava* area, where Expo 2030 will be built.

### 2.1 Strategies and interventions for the recovery of the built heritage

The project hypothesis for the recovery of the architectural heritage implements a strategy that distils the qualitative data from the existing and identifies the nodal points at which to intervene, also by means of deliberate demolitions, leaving the field open for implementations, integrations and alterations with a view to a critical reinterpretation of the building. In terms of energy, it is planned to renew the technological systems and work on the building envelope to improve energy efficiency; the roof will be rethought to accommodate communal terraces and redefine the building's plants, with the integration of photovoltaics and the creation of social spaces. However, the most radical typological and functional changes have been made to the building's relationship with the ground, which has always been the most critical element of the original project. Here the entrances to the stairs and lifts along the new urban boulevard of Via dell'Archeologia are reversed, redefining a new relationship between the building, the street and the courtyards. The new entrances become more identifiable, safer and less promiscuous places; the current balconies are transformed into loggias for the apartments and the new services planned on the ground floor, facing the green courtyards. The ground floor connection is rethought and enriched with service spaces facing the street and the courtyard, and is extended by filling the trench that currently allows direct access to the basement, the darkest, most unsafe and dangerous place in the entire complex. The new urban plan finally becomes a freely accessible and usable space. The role of the residential wall is reversed, from an element of break to a hinge of continuity between the boulevard and the inner courtyards, which are restored and prepared to be inhabited by services and spaces open to the whole city: in the south courtyard, a *ColLaboratory of Energies* with meeting rooms, spaces for coworking and training in the field of energy and the environment, and the new home of the toy library "Alice's House", already active in the area to welcome the youngest children; in the north courtyard, the *RIF – Museo delle periferie (Museum of the suburbs)* and the City House.

## 3. The *RIF – Museo delle periferie*. Architecture for new narrative lexicons

Conceived and directed by Giorgio de Finis, the RIF [14] is a project of Roma Capitale and is part of the Polo del Contemporaneo [15] under the auspices of the Azienda Speciale Palaexpo. It is the first museum in Rome outside the Grande Raccordo Anulare. With the sole exception of the Maison de Banlieue in France [16], it can be said to be an unprecedented experiment for a museum whose main

objective is to make the citizens of Rome's suburbs aware of the territory in which they live and to propose keys to interpreting and analysing their environment, also through artistic and performative stimuli, in order to contribute to a greater involvement of civic consciousness in issues related to urban development. The RIF currently operates throughout the territory and is waiting for its headquarters to be built in the north courtyard of the R5 compartment in Tor Bella Monaca, which will, however, confirm its nomadic aspect, its widespread operation throughout the territory and its figurative and rhizomatic nature. The initiative aims to focus on the theme of the suburbs as part of a broader analysis of the urban phenomenon on a global scale, to deepen our knowledge of the metropolis of the third millennium and to imagine a fairer, more participatory and inclusive city. The time of its cultural offer will be extended beyond the limits of its own exercise, according to the principle of *closed when open, open when closed*, as an emblem of an uninterrupted rootedness in the place, starting from the moment of the beginning of the construction site. As de Finis and Carpenzano state, this will be characterised by "a participatory, co-imaginative observation" on the part of the inhabitants themselves, so that the site welcomes the museum like a port welcomes a ship, the herald of a metalanguage capable of making parts of the city that do not know each other talk to each other. A permanent museum-laboratory where the world can be redesigned through the imaginative nature of the artistic process. A difficult museum that gives space to the complexity of the world we live in. A space/machine that, like all museums, does not give answers but helps to produce new questions. A cultural factory based on the idea of the periphery as a space for innovation, capable of producing a culture that is finally collective and open to new generations.

### 3.1 The architecture of the RIF

The RIF project is the result of research deeply rooted in the experiments of the Gruppo Architettura translated into the context of the Roman School by Lello Panella, master and mentor of Orazio Carpenzano. This genealogical line of experimentation leads, in RIF, to an architectural reflection on the theme of inhabiting the urban utopia in a pacified state, with the ability to construct an intermediate space between the city and the residence, where the system of neighbourly relations is reorganised as an autopoietic system of compensation and social control. The project builds an intermediate space between the large dimension of Barucci's Redent and the rural landscape of the Agro Romano towards which it faces, mediating with the domestic scale of the individual dwellings repeated indefinitely to construct a depersonalising and potentially alienating multitude of windows overlooking a city that expropriates the inhabitants' right to identify themselves as *cives*.

Its body is rooted by subtraction in the empty space enclosed by the dwellings, inhabiting their subsoil, from which it emerges in a porous structure made up of craters that form open collective spaces, large mouths through which it receives visitors, but also light and air. A total of 1700 square metres will house exhibition spaces, studios, conference rooms, permanent workshops, libraries, a cinema and the Casa della Città (House of the City). By conquering the chthonic dimension, the museum becomes the root system of the houses and places, side by side with the figure of the beehive of living cells designed by Barucci, that of a perpetually functioning anthill, teeming with vitality and a place of delivery for the external multitudes, neatly free and disorderly structured. In its rhythms of functional and spatial opening and closing, the RIF urges the public and private dimensions of being together to trigger a happy interference between closings and openings. This hidden insertion takes on the characteristics of a new foundation for the site: its amalgamation of nature and artifice is a pulsating umbilical space that activates a process of renaturation for the public ground, in which the craters become low gardens, an empty space of decantation between the rhythms of the built area, whose paths of accessibility and exchange with the surroundings are rewritten by the project.

The austere figure of the great inhabited wall of the Bella Monaca gate is dissolved in the horizontal dimension of its plane of attachment to the ground, duplicated by the project in a system of hypogean inhabited spaces from which, through the three low gardens, air frames emerge: spaces made of air that, like fragments among other fragments, interact with the metamorphic nature of the vegetal presences that populate the garden of the northern courtyard, manifesting the presence of the museum, otherwise invisible, in the space rediscovered for new collective uses.

In their union, the ground floor and the underground space form a thickness that goes beyond the sum of the two dimensions. This thickness determines new views between things, becomes a space built to manage conflicts, to bind and hold together houses and services, individuals and communities. A new, mobile and creative 'archaeological' dimension.

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[1] In the latest chronicle, architects, intellectuals and scholars from the Italian academic community are involved in the defence of Nardò's Gerontocomio, a work by Raffaele Panella that is in danger of being demolished due to the blunt will of the city council. This is the latest episode, in chronological order, in a long series of painful losses for the modern architectural heritage, which has not yet been adequately

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[5] PORQUEDDU, Luca. *L'architettura degli spazi staminali*. Melfi: Libria, 2019.

[6] An important moment of reflection on the theme of contemporary living is the annual conference 'Per una Nuova Casa Italiana' (For a New Italian House), promoted by the homonymous research laboratory of the University of Pisa in collaboration with the IUAV University of Venice. On the subject of Rome's micro-cities, the following essay is noteworthy: BELLICINI, Lorenzo. *Le 'microcittà' di Roma e il nuovo piano regolatore*. "Urbanistica", n. 116, 2001, p. 198–199.

[7] Tor Bella Monaca is a public housing estate built at the beginning of the 1980s on the basis of Law 167/62, which introduced in Italy the so-called Economic and Popular Housing Plans, or more simply Area Plans, whose main purpose was to allow the public authorities to promote interventions in the field of housing policy while at the same time directly managing the territory. Included in the first PEEP of Rome, it was mainly designed to accommodate a population from very disadvantaged backgrounds, linked both to precarious housing conditions and to economic and social weakness. Like other neighbourhoods of the same type built in those years, it was located in an isolated area, far from the urban reference area, and the planning intentions would have made it autonomous from the rest of the city in terms of the provision of all services. FABBRI, Marcello. *Le ideologie degli urbanisti nel dopoguerra*. Bari: De Donato, 1975.

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[9] Barucci himself describes the experience as a 'battle lost at the start, to reduce the discomfort of those who would have been lucky enough to live in R5'. Web: http://www.pietrobarucci.it/volumi/vol_4.html

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[12] The first is the PinQua call, the National Innovative Programme for Housing Quality, which in 2020 financed urban renewal and public housing projects presented by regions, municipalities and metropolitan areas for a total value of 2.82 billion euros. Through the PinQua call for proposals, and with the contribution of the Municipality of Rome, approximately €29 million has been allocated for the rehabilitation of the central courtyard and the apartments overlooking it. Participation in the PinQua competition and collaboration with the Sapienza, Roma Tre and LUISS Universities of Rome were promoted by the then Councillor for Town Planning, Luca Montuori. Subsequently, in 2021, the funds available under the PNRR enabled the completion of the project on the north and south courtyards of the great building, thanks to the funding for the development and implementation of the Tor Vergata-Tor Bella Monaca Integrated Urban Plan, which includes a sustainable mobility system linking Tor Bella Monaca with Tor Vergata and the city. The activities for the development of Rome's Integrated Urban Plans have been promoted by the Councillor for Urban Planning of Roma Capitale, Maurizio Veloccia.

[13] The Sapienza University of Rome research group was composed as follows. Scientific responsibility and general co-ordination: Orazio Carpenzano; Design co-ordination: Eliana Cangelli; Architectural design of the museum and service spaces in the courtyards: Orazio Carpenzano, Fabio Balducci, Paolo Marcoaldi, with Andrea Parisella, Fabrizio Marzilli; Typological, Technological and Environmental design

of the R5 buildings: Eliana Cangelli, Spartaco Paris, Michele Conteduca, with Valerio Fonti, Carlo Vannini, Mariangela Zagaria, Matteo Macchi; Open Spaces and Landscape Design: Fabio Di Carlo, Wei Chen, Maria Chiara Libreri; Plant and Energy Design: Fabrizio Cumo with Filippo Beretta, Lorenzo Villani; Structural Design: Francesco Romeo, Edoardo Currà with Andrea Lucchini; Urban Planning and Third Sector: Carlo Cellamare with Fran-cesco Montillo; Cost Estimation: Francesco Tajani with Rossana Ranieri.

[14] The name RIF, according to its creator Giorgio de Finis, means the re-foundation of the city beyond the boundaries of the centre, as well as being the central part of the word 'periferia' (periphery).

[15] The Contemporary Pole includes, in addition to the RIF, the Palazzo delle Esposizioni, the Mattatoio and the MACRO. Web: https://www.palaexpo.it/

[16] Web: https://www.maisondebanlieue.fr/

**Fig. 1**: Tor Bella Monaca: the R5 sector - *Photo © google earth*

**Fig. 2**: Images of the R5 sector in the 1980s at the end of construction - *Photo © Pietro Barucci*

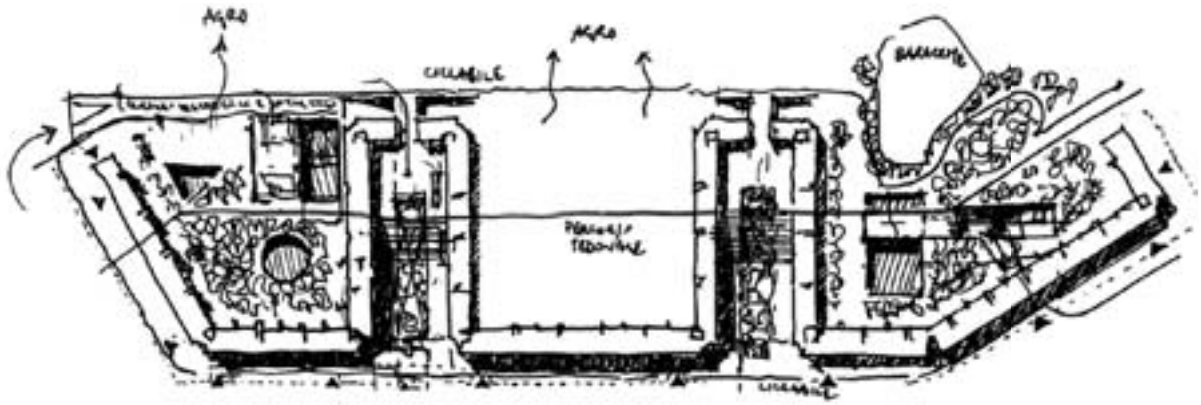

**Fig. 3**: R5 sector - Study for the general layout of open spaces © *Fabio Balducci*


**Fig. 4**: Piano integrato Tor Bella Monaca – Tor Vergata: General plan with the interventions on the open spaces of the R5 compartment and on Viale dell'Archeologia transformed into an urban boulevard

**Fig. 5**: Building front on Via dell'Archeologia: ante / post-operam comparison

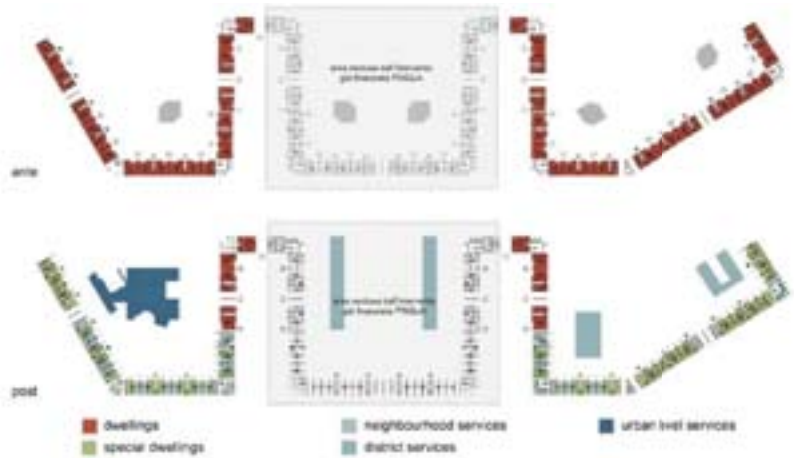


**Fig. 6**: Use of the ground floor of the building: ante / post-operam comparison

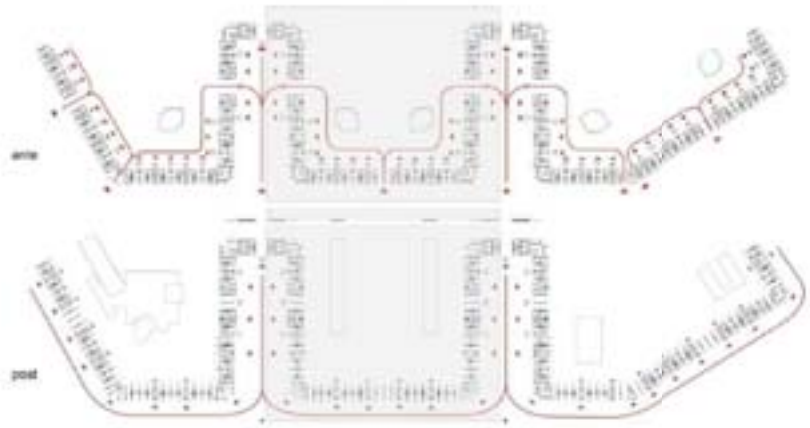


**Fig. 7**: Access paths to condominium hallways, staircases and lifts: ante / post-operam comparison

**Fig. 8**: Prefiguration of the new ground floor towards Via dell'Archeologia

**Fig. 9**: View of the new configuration of the south courtyard

**Fig. 10**: View of the new configuration of the north courtyard

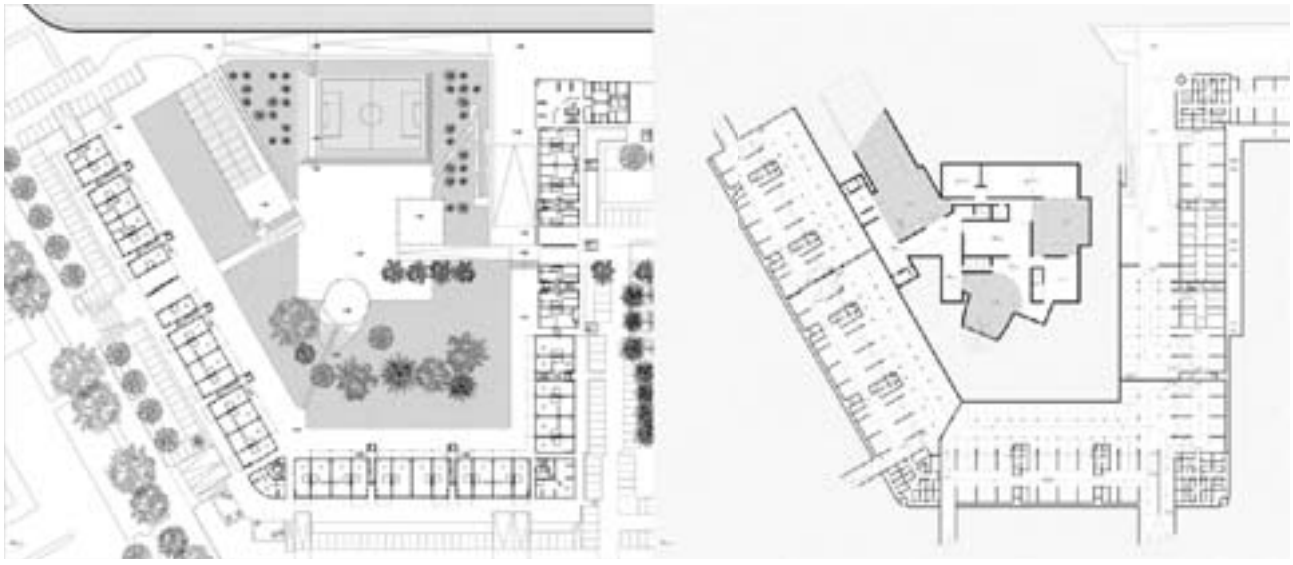

**Fig. 11**: RIF Museo delle Periferie: Ground floor (left) and basement floor (right) in the north courtyard

**Fig. 12**: Longitudinal section of the north courtyard at the main entrance to the RIF

**Fig. 13**: Prefigurations of the three RIF air frames that emerge from the museum craters in the north court

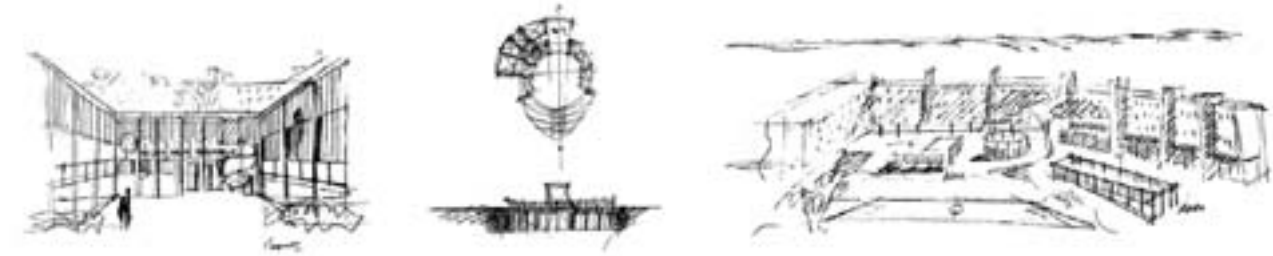

**Fig. 14**: Studies for craters in the north court © *Orazio Carpenzano*

**Fig. 15**: Prefiguration of the main entrance to the RIF

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# The reuse of *Lilong* in Shanghai

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## Abstract
The paper aims to explore and analyse the processes ongoing in contemporary metropolis of Shanghai, with reference to the emergent phenomenon of architectural reuse of the *lilong* (lane neighbourhoods), a type of social house developed in Shanghai in the 19th century, which has so characterized the city as to be considered an architectural icon. Stylistically, it is a hybrid of Western architectural languages and spatial organization, typical of Chinese tradition. The main aim is to understand how reuse is contributing to a more historically and culturally conscious design and how these places have influenced the city not only architecturally, but above all from a social point of view, an aspect that also typifies the conservation projects that have affected them. Re-use projects will, also, be analysed with reference to the legislative system governing the valorisation and protection of cultural Heritage in China to deeply understand the elements that led to the decision to conserve through re-functionalization and re-use projects these parts of the city. This architectural type represents an important historical moment in the transformation of China into a Republic, and through the spatial and social relations generated in its spaces, it allows us to understand certain peculiarities of Chinese culture, which is rich in symbols that remain stable in form. In Chinese philosophy, in fact, every reality is whole: everything in the universe is like the universe.

**Keywords:** Cultural Heritage, *lilong*, China, Shanghai

## 1. Deciphered the hidden secrets: *lilong*
“Decipher the hidden secret” is the locution French semiotician Roland Barthes uses to describe Chinese philosophy, recalling a concept already expressed by Marcel Granet in his text *La pensée chinoise*, published in Paris in 1939 [10].
“Decipher the hidden secret” means colliding with the contradictions that characterize this country suspended, often, between the sign values typical of tradition and an overwhelming thrust toward modernization [2]. This duality creates an extremely complex sign overlap that is sometimes difficult to decipher, which can also be perceived in the conservation and reuse interventions implemented in the last few years in Shanghai, which have particularly focused on the historic districts of the *lilong Shikumen* (里弄石库门] [33].

### 1.1 The Hidden Secret of *Lilong Shikumen*
Among the most fascinating hidden secrets to be decoded, a preeminent position is to be assigned to the neighbourhoods composed of the settlements, known as *lilong*, a clear representation of sign overlapping, in which the tangible signifier, represented by the building structure, corresponds an intangible meaning, related to the social aspects’ characteristic of these settlements. Thus, we move - through a sign referral - from a tangible visible level to an imaginative one [13].
Also, the value of this housing typology at the historical level is also connected to its own being one of the earliest examples of social housing in China [29], in the *Shikumen* (石库门), "stone gateway" style that developed only in Shanghai.

The term *lilong* is composed of two ideograms Li (里) neighbourhood or block of dwellings and Long (弄), alleys; also translated as alley house indicated not only, as already pointed out, a spatial meaning, but, also, how these places were small urban communities, full of a social vitality typical of the harbour city of Shanghai. The first examples of this typology occur in the 1870s in connection with the city's population boom, partly related to the economic fervour generated by the first English and then French commercial colonization [5]. This situation persisted throughout the last three decades of the 19th century, in which there was a mass migration of populations from neighbouring villages; a direct consequence of the constant population increase was a growing demand for low-cost housing. This set in as a result a massive process of building wooden barracks, fostered by English and French traders, who needed cheap local manpower. It is estimated that in 1876 there were about 105 wooden-framed collective houses in the foreign concessions, called Li (里) [29] [30]. «The boggy ground on the outskirts of the Chinese city, which had been allocated to the British and French consuls and which their nationals had begun to occupy, war transformed into a potential “gold mine”. Land real-estate speculation took hold; very quickly, all the parcels were occupied. The Western Landowners in the concessions divided their land into lots and hastily built wood housing to be rented to refugees. According to official agreements, it was forbidden for Chinese to live in the concessions; given the profit for some and the interest of others this directive was circumvented and neither consuls nor the Chinese authorities did anything to respect their original commitments» [29].
These temporary structures, built by adapting the spatial pattern of English tenements, turn out to be the prototype of brick *lilong*. According to scholars Wang Shaozhou and Chen Zhimin, this housing pattern is among the earliest examples of hybridization between Chinese and Western architecture - the so-called *Shikumen* style [30] - as well as being a hallmark of Shanghai's urban [9] and sociocultural landscape [16]; in 1949 tenements covered about 60-70% of the city centre.
The brick-and-timber *lilong* have been built since the late 19th century [22]; they are two - or three-story townhouses characterized by a private property area on the main front and a service area at the back. The repetitive juxtaposition of social housing units thus goes to design an organized complex with a series of main streets, used as primary circulation, accessible from commercial streets, overlooked by side alleys leading to each housing unit [6].

**Fig. 1:** A typical *lilong* branch lane.

These settlements appear as self-managed neighbourhoods inside the city, small villages, accessed through gateways; enclosed on themselves, they present a clear and rational structure that gives them a high level of security and peacefulness [24]. These are protected environments that set themselves against the noisy urban environment that surrounds them; this dichotomy is also emphasized by the commercial function allocated precisely to the building units, placed along the perimeter of the settlement [27]. Small businesses are also located inside so that they can provide daily services to the entire community.
The front door usually features an arch on which the name of the settlement is indicated. Each neighbourhood is organized internally with a residents' committee.
Due precisely to their characteristics from the architectural, urban, and social points of view, the *lilong* represent the first prototype of collective housing before Liberation [31].
They are usually classified according to five different types:
1) The old *Shikumen lilong*: they are the earliest two-story masonry and wooden structures developed from the late 19th century until about 1915. The wooden prototype introduced in 1870 is modified to improve housing conditions and for fireproof purposes. These are courtyard houses, which partly reproduce the spatial composition of rural houses of the Jiangnan region. Such spatial conformation was adapted to the social structure of traditional extended families, typical at that time in Chinese culture.
2) The new *Shikumen lilong*: this typology developed in the early years of World War I to respond to the uncontrolled population increase that led Shanghai to reach 2,000,000. The population from neighbouring areas is largely employed in the manufactures - which spring up in this period inside foreign concessions - and which usually present adjacent housing areas for workers: *lilong*. By the end of the 19th century, *lilong* became the most popular housing type in Shanghai, in fact constituting nearly 50 percent of the total built-up area [11]. The new *lilong Shikumen* maintain the spatial composition of courtyard houses built in rows, even as spaces are reduced to suit the needs of small, low-income households. Interior comfort standards are also lower.
3) The new-type *lilong*: with the end of the War a radical transformation takes place in the city, especially in the central areas, with the extension of the network of facilities and the infrastructure system throughout. New *lilong* are established at that period to provide compact, yet fully equipped housing for middle-class families; the latest building technologies are adopted in these units; special attention is also paid to interior finishes. Decreasing, on the other hand, are the spaces designated as courtyards.
4) The garden *lilong*: these are developed between the 1920s and 1940s. They reproduce the layout of the new-type *lilong* but are endowed with large gardens inside or at the back and designed for the upper-middle class of society. They are usually built of brick, or with a mixed structure-brick and concrete. Such houses often occupied large lots in prestigious locations.
5) *lilong* apartments: made of reinforced concrete, they were introduced in the early part of the 1930s due to continued economic growth [19]. Each building has a common lobby with stairs and elevator, and each unit consists of a living room with kitchen, two bedrooms, and a bathroom. Different from previous types, in which the housing unit is arranged on several levels, in the case of *lilong* -apartments the spaces are all distributed on one floor.
This type of housing was located particularly in the areas between the International Settlement and the French Concession, the current centre of the city, and in the northern part of the International Concession, near the current West Station, as shown on the 1936 map [20].

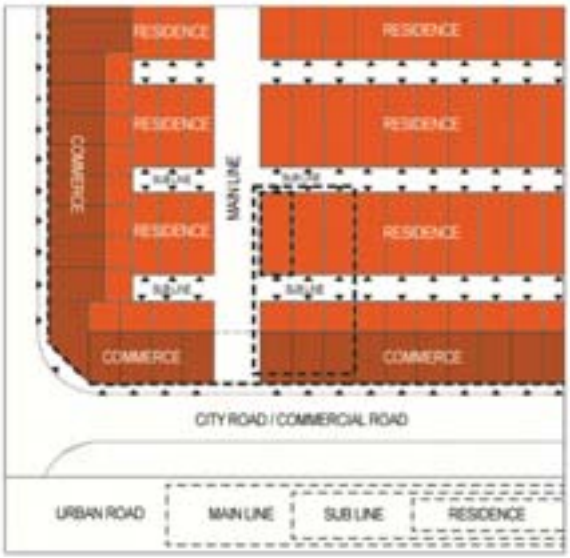

**Fig. 2:** Hierarchical Structure of *lilong* Block.

### 1.2 From obsolete model to protagonist

*Lilong* construction ended around 1941, when the city fell under Japanese control during the Sino-Japanese War. Their construction would not resume even after the National Liberation in 1949 because they were unsuitable for the new housing standards and too tied to the previous socio-political system [21].

The interest in this housing type was rekindled in the 1990s with the initiation of several urban redevelopment projects in which the *lilong* played a leading role [17]. The concept that seems to guide these projects is that of "adaptive reuse," in which elements of tradition and modernity coexist through a constant overlapping of signs. Thus, only certain elements of tradition are preserved, often emptying them of their cultural and social values to regenerate entire neighborhoods of underutilized areas and structures [7].

Among the most important urban preservation and redevelopment projects [1] - realized in the last few years in Shanghai - is the one that in 1997 focused on the former Taipingqiao area - consisting of 23 neighborhoods, inhabited by about seventy thousand people.

The project - financially supported by Hong Kong's Shui On Group and the Luwan district - was designed by American architects Wood and Zapata and named "365 Scheme", because the design aim was to give back 365 hectares of urban areas to the citizens of Shanghai, with the consequent reallocation of 5750 families to other city zones [35].

The main aim of the project was to establish a new commercial area: Xintiandi [新天地], the new world. The master plan was designed through the interconnection of two zones: the southern block designated entirely for new construction, and the northern block characterized by the renovation of traditional housing - *lilong* Shikumen, for where three different methods of intervention were planned:

1. Total conservation applied to a single building, memento of the spatial composition of the *lilong* Shikumen. The choice also falls on the presence of the building where the First National Congress of the Chinese Communist Party was held.
2. The preservation of the exterior, regarded only as façade, through a process of "skin preservation".
3. The total reconstruction (Shanghai Xintiandi's *Shikumen* Wulixiang museum) [40].

Arch. Ben Wood justified these design choices by saying that everything changes and buildings are lifeless and exist only in the moment they are lived in, the intervention therefore did not create fakes, but had as aim the restitution to the city of a cultural typology and archetype [39].

«I do not subscribe to the strict dogma of preservation. Everything changes. Life changes, Building changes. The biggest problem with preservation is that they want to set some magic date that it was meant, that day or that year. Culture is a living thing. They try to make artifacts of cultural things. Buildings do not live they are kind of inanimate and they need people to animate them. […] But Xintiandi is not fake. These buildings were all here. Didn't move anything, took some out» [35].

The dark, steam-filled alleys-as they appear in many of the historical images - have been completely changed to house new commercial activities, to become again an integral part of the "upper quarters" (shangshi jiao) of the French Concession [23].


**Fig. 3:** Wood & Zapata: Sketch manuscript of Wood's urban design in Taipingqiao area, and in this redeveloping process, residents could not be involved.

This pronounced aesthetic need - which guides the project - is called by Goldberg a "festival marketplace" [41] a decontextualized representation of time and space, in which the sign value is delegated only to the imaginative process. It is a transformation from a historic district to an iconic Walt-Disney-style neighbourhood, virtual reality for tourists. Indeed, the intervention tends toward the commodification of history through an iconic promotion of place [18] and seems to be moved by the process of cultural globalization and rhetoric that characterizes many of China's cities [3] [8].
During this regeneration process [3] [33], residents were left alone, unable to voice their demands and their rights and interests. Although the intervention has promoted a total redevelopment of the historic neighbourhoods, giving back to the city an area more in keeping with current housing and welfare standards, it has, however, erased the social value proper to these places and generated a feeling of mistrust among citizens towards the *lilong* redevelopment processes [40], which have been transformed into worthless sign elements, theatrical backdrops, that thanks to the media system pride themselves with historical authenticity [4] [17] [33] . Despite such critical issues, the project is described on the city's official page as an intervention that succeeded in giving an «answer for preserving the old architecture of Shanghai that would be representative of its historical and cultural heritage [...] the blocks of *Shikumen* buildings, with their preserved original walls and tiles, give tourists a unique feel of walking the bustling Shanghai streets of the 1920s and 30s» [34]. and was awarded the ULI (Urban Land Institute) Award for Excellent and the AIA Citation for Heritage in 2003.

**Fig. 4:** Xintiandi *lilong* branch lane.

### 1.3 Tianzifang: born of the bottom-up power

The concepts of "adaptive reuse" were also adopted in the intervention for Taikang Rd, a minor road only 420 m. long, connecting the RuijinErLu and SiNanLu commercial roads in the central Luwan district within the French Concession [12] [33]. The area was later renamed Tianzifang [田子坊] by contemporary painter Huang Yongyu [33].

This project is part of the architectural heritage protection policies, but with a different matrix from the one in Xintiandi. In fact, it was originally born in 1998 from a direct effort by the head of the Street Office - Mr. Rong Fa Zheng - in charge of managing local neighbourhoods and providing basic services to communities. Mr. Rong Fa Zheng in collaboration with some local artists and supported by the executive chief of Tianzifang, Mr. Mei Sen Wu developed a project - originally aimed at a plan to redevelop some abandoned industrial areas- which was then extended in 2000 to *lilong* to safeguard historic buildings and keep the social value that characterized these urban neighbourhoods alive. The 2000 project contrasted with a private speculation plan, called the Xin Xin Li Planning Project, which aimed to demolish historic heritage to build modern skyscrapers.

In the regeneration of the area starting in 2003 [14], the College of Architecture and Urban Planning of Tongji University [36] was also involved for organizing historical research to identify the transformation processes of the area [37]. In this project, in addition to the collaboration with the University, the support of residents, especially during the regeneration of area and protection of *lilong* [9], also appeared crucial. Unfortunately, in 2005, conflict processes began to be triggered that led to the exclusion of residents from the decision-making. In 2008, the final phase of the project began, characterised by an uncontrolled transformation of the area, with the almost total reconstruction of the *lilong* and the decision to allocate the ground floors to commercial activities and art studios.


**Fig. 5:** Tianzifang *lilong* branch lane.

The regeneration, which arose spontaneously, has preserved many of the characteristics of the *lilong* Shikumen. Tianzifang, in fact, still presents itself as a tangle of labyrinthine alleys, where electric cables create webs connecting the different buildings together and noises and smells fill all the spaces in the neighbourhood at any time [15].
Even in this project, Western principles of preservation have not been applied because many of the buildings have been modified according to new needs, both residential and commercial, and few buildings maintain original architectural elements.
Undoubted and distinctive, however, is the attempt at non-Westernization that characterizes Xintiandi instead. In the design for Tianzifang, preservation was understood as a collage in which discordant elements of each other were adapted to make a new reality, more in keeping with the artists' idea of the place. However, the intangible value of these neighbourhoods is erased, and the words of director Shu Haolun ring in the mind. In the introduction to her 2006 documentary film Nostalgia, she describes the change in the historic districts as follows: «One day grandma called me. She told me that the newspaper said Neighbourhood Da Zhong Li has been sold to Hong Kong [developer] by district government, [and] soon it will be demolished. In the city Shanghai where I lives, the whole neighbourhood's demolishment and relocation is a quite common thing. When I heard this news, I can't feel it common anymore, because it hits home. Our old house is in Da Zhong Li. Da Zhong Li will be 'quite commonly' demolished, later it'll becomes those shining skyscrapers. Now what I could do is that I take my camera to Da Zhong Li, which hasn't become skyscraper yet. I want to 'write' my nostalgia through lens» [43].

### 1.4 The Hongkou model Project

The case study of the Hongkou district is particularly interesting because it was selected as the area for a model project, promoted directly by the central State government, called "conservation before renovation and demolition".
The area characterized by a significant number of *lilong* preserves inside it a building, built in 1930 by the Shanghai Land Investment Company, which is notable for its typical *Shikumen* architectural features. In addition. because of the proximity of Hongkou harbor, the residents of this community were mostly urban migrants employed in the port trade in the northern bund. It is therefore an area of outstanding historical significance, a place that narrates the past through its architectural heritage and its inhabitants.
Due specifically to the high historical and cultural value, the Government decided to develop a participatory project in which experts from the administration worked closely with residents. The operation was supported financially by the central Government, which considers the *lilong*, social housing facilities, for low-income residents, who cannot contribute, therefore, to the regeneration of the architectural heritage [32]. The project-which has been in place for 10 years-follows UNESCO's Recommendations on the Historic Urban Landscape Recommendation (HUL - UNESCO 2016: 26-28) [38], and involves not only the renovation of housing units, but also the construction of new facilities and infrastructure to improve the well-being of residents, as well as the demolition of all structures now in an advanced state of disrepair. In this neighbourhood yet «the day typically» begins «with the 'Cantata of the Alley, [...]. Then the first vendors would arrive, selling hand-wrapped won tons, fried bean curd and fresh green olives, often delivered in baskets lowered from upper-floor windows» [28]. These are the *lilong*, places always full of activity and people, dense with smells and chaotic living. [33].

**Fig. 6:** *Lilong* branch lane.

## 2. Conclusion

The characteristic, which links these three projects together, seems to be a process of altering the existent through the extension or reduction of its semantic field, to generate new values.

Linguistically, we would speak of a process of affixation, a morphological derivative process of formally and semantically changing a lexical base through the addition of morphological elements, by means of a distributional criterion and a functional one, which allows the needs of contemporary society to be satisfied [25] [26]. Regeneration projects turn out to be, therefore, always balanced in this oxymoron, which transforms buildings in an empty shell of the symbol, "products," severed signs of the referential alibi [37]. The property is understood as an image, narrating through a sign overlap, different tales in an endless succession of influences full of charm and magic, in a country in dialectical contrast between tradition and modernity [41]. These are tales that are built ad hoc, projects whose aim is to tell a story that never really existed.

Renata Pisu [in the preface to Roland Barthes' China Travel Carnet] writes: «[...] China is not an intimate affair, it is China, always China, even today, some forty years later it is still the great engaging theme that in every age recurs [...]» [42] and in this hidden secret that is difficult to decipher, the *lilong* are an important document to the historical, social and economic processes that characterized Shanghai.

They changed as social and economic conditions evolved, from working-class housing to housing for the upper-middle class. The preservation efforts that have characterized them since the since the 1990s seem to have only partially understood the historical and social value of these properties.

Residents seem to have been overwhelmed by these projects, often passive spectators of a drama in which they were unwitting protagonists.

It would be desirable for residents themselves to promote their direct participation in the processes of redevelopment and protection of urban and architectural heritage, emphasizing the need to safeguard the tangible as well as the intangible cultural value. Indeed, from the cases studied, it appears that the socio-cultural value of *lilong* is impoverished when residents are not considered part of the intangible cultural heritage.

We remain, however, suspended, and unable to give an answer to the question by Barthes: *Alors, la Chine?*. This country remains a reality full of questions, which always fascinates and arouses controversial feelings.

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# Bim and blockchain a possible contribution for the security of building heritage system

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## Abstract
Blockchain technology originates with the creation of Bitcoin and technically indicates a sequence of data divided into blocks connected in a chain. This chain is immutable and each block is linked to the previous one and to the following one thanks to a system of hash codes, developed to prevent fraudulent actions. This technology has aroused great interest mainly for its interaction model based on a distributed trust system, characterized by the absence of a "trusted" third party. Due to the great security of the data stored in the blockchain, many companies that produce products subject to counterfeiting, have adopted this technology to protect their final product. If well designed and implemented, the blockchain can be exploited in various digital fields, including BIM which has revolutionized the construction world, creating a strong collaboration between all the players involved in the design process. Implementing BIM with blockchain would solve the problems of intellectual property of a project, privacy and improve trust between those who sign a contract. This paper describes the main critical issues of BIM and how the blockchain could make them strengths, provided that this technology is technically and legally implemented to allow for the development of Smart Contracts, contracts written in computer language and made secure thanks to the of the blockchain.

**Keywords:** BIM; Blockchain; Smart Contract; Consent; Trust;

## 1. The BIM taday
In this paper we will not talk at length on describing how BIM technology works but will focus on some aspects of the software which, if integrated with the blockchain, can expand its use. Design based on BIM model allows sharing and exchanging all project information through a single digital layout, which becomes a peer-to-peer data exchange environment, in which each actor in the process contributes according to their skills to enrich global information making it immutable thanks to the blockchain.
Today we use BIM to model our project using the parametric components that the software makes available to us. All project components have metadata on their characteristics and acquire others when they are included in the BIM project, such as their position in the structure during the project phase. The BIM processes this data by creating a database which is the true wealth of this technology.
Given the way BIM is structured, these data, if well analyzed and processed, facilitate the sharing of the project with all the designers who participate in it.
Unfortunately, BIM is still used only as a parametric CAD, without exploiting all the metadata which is the real strength of this technology [1].
With the union of BIM and blockchain, it would be possible to collect, store, update and archive all the information contained in the project model in an incorruptible, reliable and transparent database [2]. Being able to accurately record even the smallest changes to the model would help to better define copyright and intellectual property rights as well as greater liability for the participants in the event of disputes.

## 2. What is Blockchain?
The road taken by Satoshi Nakatomo, the pseudonym behind which the anonymous inventor of the blockchain technology is hidden like all the most enlightened inventors, has not created anything from

nothing, but has transformed a system into digital form that allows to re-propose something that already existed, but that could only be realized in the material world: the transfer of value[2].
The blockchain originates with the birth of Bitcoin and technically the term indicates a technology consisting of a sequence of data divided into blocks connected to each other in an immutable chain, organized in chronological order [6]. Therefore, each block containing information is connected to the previous and to the following so as not to be broken or modified by means of hash codes.
In order to be able to carry out a transfer of value in a completely digital way, via the Internet, a method was needed which made it very difficult to frustrate the immutability of the transactions, which was as immune as possible from an external attack aimed at altering the properties of the technology used for validate the exchange of value between two players, and which could guarantee all this in the absence of direct fiduciary control [5].
The blockchain is this: a digital system that digitally re-proposes the exchange of assets, whereby asset we mean any material or immaterial entity susceptible to economic evaluation, for a certain subject, preventing the risk of replication of the asset, transparent and traceable.
The solidity of this process lies in the blocks that compose it, connected to each other and in the impossibility of modifying the data present in a block when it was added to the blockchain, as it is protected by cryptography, which is very expensive and difficult to break.
This technology was implemented to enable cryptocurrency transactions, so it is very robust, having to protect something that has value but is immaterial at the same time. This intrinsic characteristic of the blockchain has aroused great interest mainly for its interaction model based on a distributed trust system, characterized by the absence of a trusted third party and for the great security that the data processed with this technology have.
Many companies producing goods subject to counterfeiting have adopted blockchain-based technology to crystallize the data relating to their products, making it impossible for them to be counterfeited and giving greater security to those who buy them. Some supercar manufacturers, such as Ferrari and Lamborghini, have implemented a blockchain in which to insert the data of each car created, both historical and newly produced, to crystallize all the components of the car and prevent improper manipulation.
If well designed, the blockchain can be exploited in various digital fields, including BIM which has revolutionized the construction world, creating a strong collaboration between all those involved in the design process.

## 3. Pros and cons of the blockchain

Now let's see what the strengths and weaknesses of this technology are. Traceability, immutability, and security are the main characteristics that characterize the blockchain. More generally, we can say that this technology makes it possible to use a system that allows the establishment of trust relationships between subjects who do not know each other, drastically reducing the vulnerabilities typical of a system that involves a central entity or a third-party intermediary [7]. Exploiting this technology, which manages to reproduce and transfer the value of a tangible or intangible asset in the digital world, to guarantee the subjects who sign a contract would have great advantages.
Among the development opportunities of this technology, there is certainly that linked to identity, understood as the possibility of improving the process of identifying users which becomes fundamental for signing a contract.
In the Bitcoin blockchain, access to the network and the ability to write and read the transaction register, the ledger, does not occur by identifying and verifying the owner of the Bitcoins. In other words, network participants are only referenced by their public keys, but have no way of guaranteeing their identity.
There is no central authority that can authenticate access to the blockchain. For this reason, a blockchain responsible for signing a contract in which the participants must be identified requires an

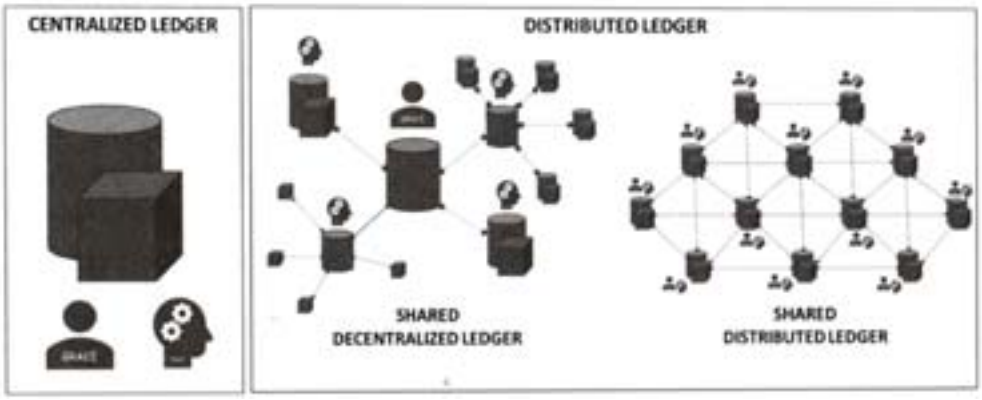


**Fig. 1**: Comparison between Centralized Ledger and Distributed Ledger

"IDENTITY PROVIDER", subjects authorized pursuant to EU Regulation n.910/2014 to issue an interoperable digital identity at community level. In Italy we have the SPID, Public Digital Identity System, to identify subjects who subscribe to or access a digital service by providing access keys, in this way the process would no longer be anonymous but linked to an identity certified by the Identity Provider [6]. Each blockchain is based on a shared and distributed ledger technology (DLT) which can be differentiated according to some characteristics, including access to the network, the identity of those who create the assets (miners) and the presence of a third entity that can pre-select participants.
The characteristics of this technology, together with the systems that support it, make it very useful in all those cases in which one wishes to obtain a guarantee of the immutability of a transaction and of the correct execution of a computer code which must produce an irrefutable result. It can be very useful to exploit a technology of this type to offer evidence that a transaction has taken place, for example the sale of land, or an intangible asset such as a copyright or a patent.

## 4. IoT, BIM and blockchain: The glass of water theory

IoT (internet of things) and blockchain can be integrated with the BIM methodology for the benefit of the entire building process. Let's see how these three technologies can be linked throughout the life cycle of building products. The possibility of digitizing the entire process, from the design phase with the adoption of BIM, integrated with the blockchain, would give birth to a transparent process with monitoring of the conduct and responsibility of stakeholders, with a consequent reduction of variants in progress Opera.
A study carried out by the Department of Architecture and Built Environment of the University of Nottingham Ningbo China has tried to define a theory, the "glass of water theory" [4], to explain how the technology of BIM, the Internet of Things (IoT) and the Blockchain works. The Chinese research group developed this model to clearly illustrate the interaction of these three technologies and how they interlock in the building process. BIM, IoT and Blockchain are complementary and their integration in the construction industry makes it possible to transform it into a digitized and computerized sector, in a safe and highly efficient environment. The vector, entity and flow of information can be compared to a glass of water. The water constitutes the data while the glass represents the method by which this data is stored, transmitted and shared.

- BIM (base of the glass): the basis of the digitization process of the AEC sector is formed by the management of digital information for the entire life cycle of the building.
- Blockchain (walls of the glass): redefines the method of storing information. It constitutes a decentralized registry database. It has excellent results in terms of updates, archiving and data protection.
- IoT (water): is a network that allows the collection of data and the exchange of real objects supported by the Internet. IoT can be used to transmit data collected by building components and transmit it over the network. Building management can therefore be optimized as materials, equipment and other objects can be tracked.

In the absence of BIM, information and data cannot be stored and managed. Without IoT the glass is empty, the system is not real. Without blockchain, data and information cannot be stored and managed in a secure, transparent and convenient environment. The combination of these three ingredients represents the future of the construction sector.

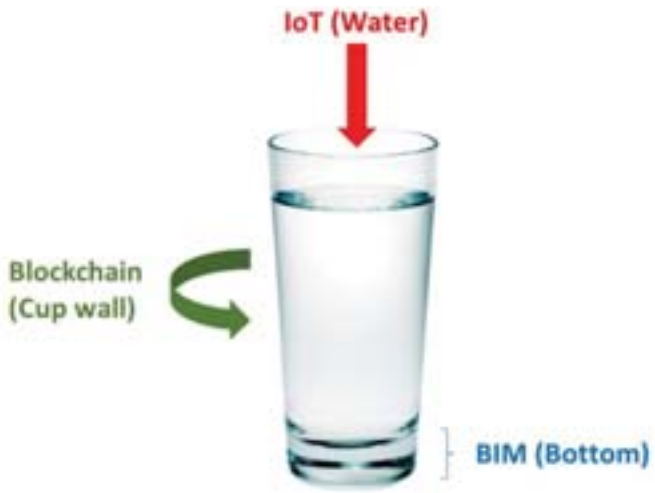


**Fig. 2**: glass of water theory

BIM, IoT and Blockchain have been developed in different fields. BIM digitizes building information, IoT connects realistic objects with the internet (through sensors, etc.) and the blockchain transmits data in

a decentralized network. The interaction between the different technologies can lead to improving the field of AEC, with unique digital sources. The improvements deriving from the interactions between BIM, Blockchain and IoT can be [4]:
1. BIM and Blockchain: contractual improvements, supplies and timely changes to projects.
2. IoT and BIM: development of smart construction, construction site safety and e-commerce.
3. Blockchain and IoT: Decentralized IoT database, privacy, external collaboration.
4. BIM, IoT and Blockchain: they contribute to technical and managerial innovation throughout the life cycle of the products.

## 5. Blockchain and Smart Contract

We can imagine the evolution of the blockchain on three levels, at level 1 the blockchain is used for transactions with cryptocurrencies, guaranteeing the uniqueness of the transactions and their immutability, while preventing the validation of fictitious transactions that could add itself to the block chain and to change what happened previously. By leveling up with the algorithms on which the blockchain is based, it is possible to enable the execution of Smart Contracts [10].
The regulatory definition of "SMART CONTRACT" by the 2019 Simplification Decree, later converted into "Law 11 February 2019 n.12" is the following: "It is a computer program that operates on technologies based on distributed registers and whose execution binds automatically two or more parts based on predefined effects from them. It satisfies the requirement of the written form after electronic identification of the interested parties, through a process having the requirements set by the Agency for Digital Italy".
At the top of the pyramid, associating the meaning of "Internet of Value" with the blockchain, we have the network of nodes that transfer the value exchanged with the Smart Contract.
This occurs in the absence of an external figure who certifies the transaction from one subject to another, through a system of algorithms and cryptographic rules such as to allow the writing of the transaction carried out in a single distributed register which keeps track of the transfers of value, through assets unique digital. In this way it is not difficult to foresee the use of this technology in fields that are also very different from that of cryptocurrencies. If we assume that the various phases of a building construction contract and the related payments are exchanged on the blockchain, instead of exchanging Bitcoin, we obtain a sort of potentially inviolable accounting register, which keeps track of all the transactions carried out and already envisaged by the plan of construction elaborated with the BIM [5].
A shared and distributed ledger (DLT) understood in this way would allow the transfer of ownership of "digital tokens" or Tokens to which various goods and rights can be associated in the outside world.
The use of BIM will certainly progress to a level where all project participants will theoretically be able to work on a single unified model (BIM Level 3) [3].
There is therefore no reason to limit the use of this software to 3D model generation only when it would be possible to record all information and documentation of a project, including change orders, billing and payments. If stakeholders are to make BIM an effective collaboration tool and fully exploit its vast potential, the information that is recorded in the program must be secure and certain. It is therefore necessary to set up a security system, to ensure continuous monitoring of the evolution of the BIM model and of the data published in it.
Blockchain technology, therefore, is an excellent ally for protecting access and verifying the nature, author and timing of any changes made.

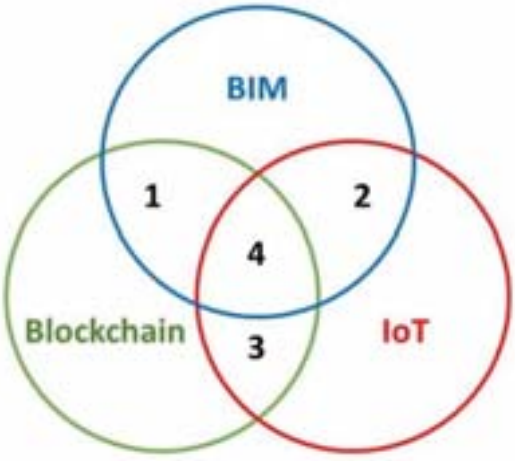


**Fig. 3:** combination of BIM, blockchain and IoT

While blockchain could solve some of the problems that arise with the use of BIM, smart contracts have the potential to revolutionize outdated contract procedures.
Many processes that normally rely on the interactions and decisions of multiple stakeholders would be automated thanks to Smart Contracts. For example, payment request procedures would be very fast, using automated processes made possible by Smart Contracts embedded in the BIM software. Thus, the payment process for a project could be fully integrated into the corresponding BIM model.
Specifically, if the supplier is ready to ship a component to the construction site, they will record the information in the BIM model. The Smart Contract linked to the BIM and bank account to finance the project, verified the availability of funds to pay for the supply and would confirm this to the supplier, the project manager would confirm that he has received the component within the BIM and, automatically, the funds would be transferred from the project account to the interested parties. The exchange of invoices and supplementary documentation supporting a payment request could also be completed automatically.
The project participants will obviously have to "trust" the Smart Contract and be sure that the information it contains and the actions it takes are recorded in a secure and unalterable way. In the case of BIM, implementing the smart contract within the blockchain architecture could solve many recurring problems in the real world, allowing the "smart contracts" to carry out all the transactions and the blockchain to certify the inalterability and security of the data.

## 6. BIM + blockchain possible usage scenarios.

Applying blockchain to construction processes would unlock a whole new world to the construction industry; this is because there would be no need to place trust and expectations towards anyone, in fact there would be automatically verified and digitized transactions, all in the same way, in an encrypted digital register. With the use of a BIM model implemented with the blockchain, both parties, client and executor of the work, would no longer be exposed to scams, legal disputes, lengthy decision-making times, costs for using trusted third parties who can verify the fairness of transactions.
Among the numerous advantages that the use of the blockchain would bring to BIM design, there are: the introduction of Smart Contracts, guarantee and protection of intellectual property, correct attribution of responsibilities, automated management of supplies, guaranteed management of financial transactions, digital management of the audit for the verification of budgets and procedures, both during construction and once the work has been completed, cost reduction and improvement of productivity.
In a process that manages transactions involving a value, information security consists of three components: confidentiality, integrity and accessibility [8]. Confidentiality protects against unauthorized disclosure of information. Integrity involves protecting data from unauthorized changes by preventing the addition, deletion, or modification of archived digital records. This means that the data cannot be changed without authorization or that the information must be correct and complete. The most important aspect of maintaining integrity is user authentication or identity verification to ensure that only authorized people can change data in the system. The information must not be modified accidentally or by user error or by the system. When handling sensitive information, it is necessary to provide a highly secure environment that reduces the possibility of both intentional and accidental changes. Accessibility means that data is always available to authorized users when needed [5].

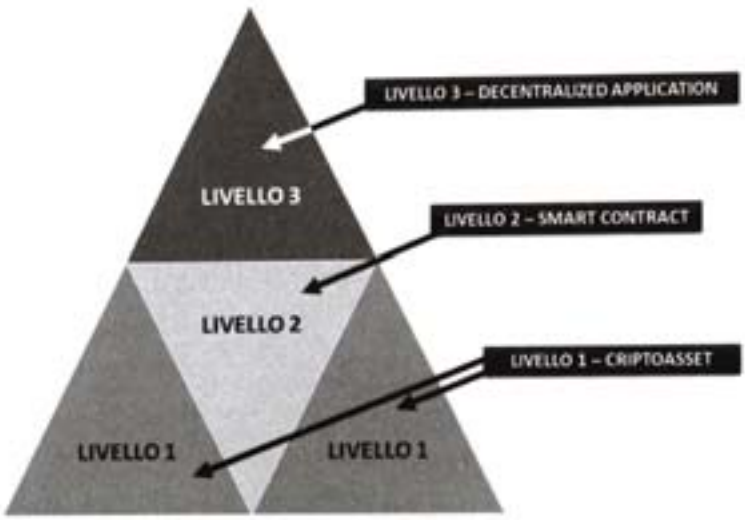

Fig. 4: The Blockchain evolution.

## 7. Conclusion

The use of BIM in design is expanding significantly; at the same time, there is a convergence towards the creation of a unified project model within which all the designers participate for the pertinent aspects, using the graphics engine of the software both for the building and plant engineering or safety aspects. At the same time, those who look after the legal aspects have to migrate to the digital environment where construction projects are planned.

It seems realistic to assume that the construction contract will be significantly affected by these technological developments. It will therefore be necessary to develop new contractual methods and processes by borrowing from technologies already applied to contracts that exchange digital assets such as cryptocurrencies.

All currently implemented contracts are structured on the premise that the rights, obligations and responsibilities of one party to the contract are the flip side of the other party. This binary architecture can be disrupted by the collaborative process managed by BIM. As the use of BIM becomes more widespread, participation in design will be increasingly integrated into software and contractual provisions that were previously based on clear, easily verifiable lines of responsibility will become increasingly difficult to enforce.

Therefore, by combining blockchain technology and BIM, a clear, reliable and transparent process would be obtained, creating a close collaboration, based on the exchange of data and trust between the actors involved, even in the absence of a third party acting as guarantor.

In conclusion, it can be said that blockchain technology will be the new paradigm for digital, but the technology needs to be improved, both from a technological point of view and from a legal point of view. The real challenge of the construction sector will be, first of all, to bring BIM to global use, this is possible if the entire production chain believes in this collaborative technology as a second step it will be necessary to implement BIM technology with the blockchain to bring the process to a level of efficiency that was impossible to imagine until a few years ago.

The best blockchain to implement in BIM with Smart Contracts is of the hybrid type "Public and Permitted Blockchain" and will have an impact not only technical, but also legal having probative value of information for the privacy of data and processed information [9].

This type of blockchain makes it possible to balance the benefits of this technology with the fundamental ones of a legal nature. But it alone is not enough to create an authoritative system, the use of the digital signature is important to identify those who operate within the blockchain [5].

Through the blockchain, BIM increases its digital potential, making every single step traceable, irrefutable and certified. Implementing the blockchain in the construction world through BIM means not only reducing the times for issuing authorisations, giving the process certainty of each authorization step, but also the automatic disinvestment of financial resources, eliminating downtime in procedures. The real goal of digitization is to create a collaborative supply chain, based on the exchange of data and trust between the actors involved, even in the absence of a third party acting as guarantor.

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# Study for Improvement of Evacuation Safety of Cul-de-sacs Roads in Historic Streets - A Study on the Installation of Emergency Evacuation Doors in Kamigyo-ward, Kyoto Japan -

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## Abstract
Kyoto City, the site of this study, has several densely wooded urban areas, among which are cul-de-sacs where buildings cannot legally be reconstructed, which may pose problems for evacuation and rescue operations in the event of a disaster. To combat this problem, a road designation system is currently being implemented in Kyoto City. However, this system is based on the premise that buildings must be rebuilt and cul-de-sacs expanded, due to which cultural values cannot be sustained. To address this urgent issue, it is necessary to study evacuation plans and methods to eliminate cul-de-sacs without the need to rebuild. This study targets Kamigyo-ward in Kyoto City and aims to improve evacuation safety by examining a substantial evacuation plan for cul-de-sacs infeasible for two-way evacuation and a method for eliminating cul-de-sacs while preserving the historical townscape. The current status and characteristics of cul-de-sacs were clarified through field surveys in the Seishin and Demizu school districts, which are the most dangerous of the two. Furthermore, an evacuation was simulated to evaluate the effect of improving accessibility to evacuation centers by envisaging evacuation doors on walls and fences along the cul-de-sacs and anticipating the road closure rate. Residents and others, who have emergency evacuation doors installed, were also interviewed to identify the factors necessary to improve the number of emergency evacuation doors installed. Based on the results, we evaluated the effectiveness of emergency evacuation doors and have made substantial recommendations regarding their installation..

**Keywords:** Cul-de-sacs Roads, Blind Alleys, Densely Built-up Wooden Area, Evacuation Simulation, Emergency Evacuation Door

## 1. Introduction

### (1) Background and Objectives of the Study

Being a historical city, Kyoto city has extensive dense expanses of built-up wooden urban areas and copious narrow streets, with old town layouts remaining mainly in the city center and its periphery. These densely built-up wooden urban areas and narrow streets pose a major urban disaster prevention problem, as they hinder evacuation and rescue efforts during earthquakes and other disasters, including the easy spread of fires. In particular, cul-de-sacs in densely built-up wooden urban areas that cannot be reconstructed may pose problems in evacuation and rescue operations in the event of a disaster. And although Kyoto City is currently implementing a road designation system, this system is based on the premise of building reconstruction and the expansion of cul-de-sacs and will not be effective immediately. Therefore, it is necessary to eliminate the cul-de-sac without rebuilding. Hence, a new evacuation plan and method of eliminating cul-de-sacs need to be

considered.

In Kamigyo Ward, the primary site of this study, there are 1,288 narrow streets, 69.4% of which are cul-de-sacs. According to the 2012 guidelines for narrow street measures, Kamigyo Ward has a very high percentage of cul-de-sacs, compared to 33% of cul-de-sacs in the entire city's urban planning area. The purpose of this study is to improve evacuation safety by conducting research on cul-de-sacs and studying practical evacuation plans for cul-de-sacs, considered inaccessible for two-way evacuation, and methods to eliminate cul-de-sacs while preserving the townscape.

### (2) Positioning of this study

In a study of densely built-up wooden urban areas, Murakami et al.[2)] experimented with the use of a Geographic Information System (GIS) to develop a system that comprehensively supports the planning process for a disaster-resistant city to mitigate earthquake and fire damage from an urban planning perspective. Also, many reports on disaster-resistant city planning in densely built-up wooden urban areas are based on risk assessment of road blockages and wide-area simulations. In addition to evaluating disaster prevention performance and maintenance effectiveness in densely built-up wooden areas using not only physical indicators such as building collapse risk and burnout potential but also evacuation difficulty rates, Osaragi et al.[3)] have independently proposed the construction of roads that shorten the distance between intersections. However, no real space verification or consideration of the proposed information space is currently available. In addition, Munemoto et al.[4)] tested a methodology to conduct planning that is highly consistent with real space while reducing the time by using GIS to conduct the complete process of discovering dangerous cul-de-sacs to evacuation route planning measures. However, many differences exist between information space simulations and real space, and identifying evacuation routes that correspond to the surrounding environment is challenging. This study methodology's novelty lies in determining the distribution of fences and walls along the cul-de-sac through field surveys and installing emergency evacuation doors to secure evacuation routes while reducing building renewal to the greatest extent.

## 2. Methods and subjects of the study

### (1) Overview of the subject area

In the "Report on the Study for the Maintenance and Preservation of Beautiful Narrow Streets in Historic Cities in Relation to the Survey for the Comprehensive Attractiveness Improvement of Historic Cities Centered on Kyoto," it has been stated that Kamigyo Ward in Kyoto City has 1288 narrow streets, 894 of which are cul-de-sacs, which account for 69.4% of the total number of narrow streets in the whole city. The ratio of cul-de-sacs to narrow streets is the largest in the city. The average number of sites facing a cul-de-sac is also the largest in the city, with an average of 4.8 sites per cul-de-sac[5)]. Thus, Kamigyo Ward is considered to be one of the most populated wards making it most likely for residents to experience evacuation difficulties. In addition, Kyoto City has the largest number of districts selected as "Priority Districts for Disaster-resistant City Planning" in its announced policy[6)] of measures to be taken in dense urban areas, and four of the six school districts are concentrated in these districts. This study focuses on four of these school districts. However, given the significant number of cul-de-sacs in these four school districts alone, we narrowed down the list to half and focused only on two school districts. Referring to the disaster-resistant city planning map for each school district, we counted the number of cul-de-sacs with a building at the end, the number of cul-de-sacs with a fence or wall at the end, and the number of cul-de-sacs with an emergency evacuation door or private door at the end to allow passage in the event of an emergency. Table 1 and Figure 1 show the results of the survey.

**Table 1**: Number and percentage of each cul-de-sac

| | Cul-de-sac (building) | Cul-de-sac (fences and walls) | Cul-de-sac (door) | Total cul-de-sacs |
|---|---|---|---|---|
| Shoran School District[7)] | 35 (45.4%) | 19 (24.7%) | 23 (29.9%) | 77 |
| Ninna School District[8)] | 95 (61.3%) | 31 (20.0%) | 29 (18.7%) | 155 |
| Seishin School District[9)] | 33 (70.2%) | 11 (23.4%) | **3 (6.4%)** | 47 |
| Demizu School District[10)] | 85 (73.3%) | 26 (22.4%) | **5 (4.3%)** | 116 |

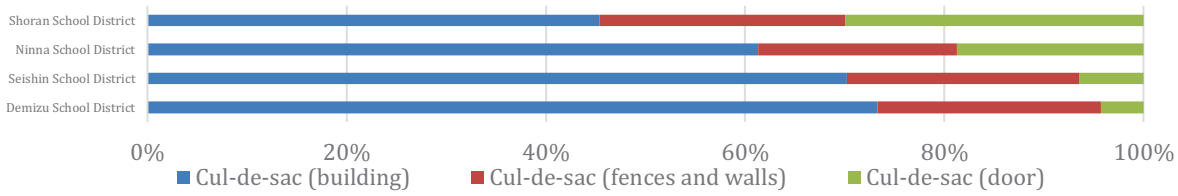


**Figure 1**: Percentage of cul-de-sacs by type

It is evident from the data shown in Table 1 and Figure 1 that the percentage of emergency evacuation doors or privately owned doors at the end of the street is extremely low in the Seishin School District and Demizu School District, and we could conclude that the cul-de-sac measures have not progressed very well and need to be addressed immediately. Therefore, we focused on only these two school districts in our study.

## (2) Research Methods

The study's methodology can be described in the following key points:

[1] Conducting a literature survey and field survey of cul-de-sacs in Seishin School District and Demizu School District in Kamigyo Ward to determine their current status.

[2] Conducting building collapse simulation as a prerequisite for evacuation simulation to designated evacuation centers in the event of an earthquake. Creating a road closure model based on the simulation results.

[3] Performing evacuation simulations for four different scenarios, described below.

(1) Simulation of an evacuation to the designated evacuation centers under normal circumstances.

(2) Simulation of an evacuation to the designated evacuation centers considering road closures.

(3) Simulation of an evacuation considering road closures when using the existing emergency evacuation doors and privately-owned doors.

(4) Simulation of an evacuation considering road closures when using the installed emergency evacuation doors and private doors by assuming new addition of evacuation doors in walls and fences along cul-de-sacs or blind alleys of cul-de-sacs.

Using the results of this simulation to evaluate changes in accessibility to the evacuation centers and the effectiveness of evacuation doors.

[4] Conducting interviews with the administration and residents residing along the cul-de-sac to investigate the reasons for the lack of progress in cul-de-sac safety measures.

[5] Making proposals for improvement of the safety of cul-de-sacs based on the results of the effectiveness of evacuation doors and the outcomes of interviews.

## (3) Building collapse simulation

A necessary aspect in considering the building collapse phenomenon is the manner of the spread of the debris generated by the collapse, but the relationship between the phenomena of building collapse and debris generation for a given seismic motion has not yet been fully elucidated. Therefore, for any seismic input, the debris would spread in all directions, and the debris flow width is determined by referring to previous studies dealing with building collapses.

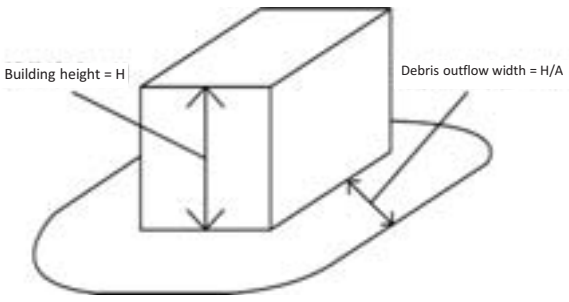


**Figure 2**: Image of debris flow

Referring to the study conducted by Kamei et al.[11], we estimated the debris flow width in this study by dividing the building height H by the parameter A as shown in Figure 2. Regarding the debris flow width, a study conducted by Hasegawa et al.[12]demonstrated that the

road closure rate by road width for parameter A = 2 was closest to the actual situation[13] in Rokkomichi, Kobe City, at the time of the Great Hanshin-Awaji Earthquake. Hence, the parameter A = 2 was also used in this study. Therefore, the debris flow width is assumed to extend in all directions of the building by the distance obtained by dividing the building height H by 2. The building height was referred from the study by Ichikawa et al.[14], where the average floor height was uniformly set at 3 m, and multiplied by the number of floors in the building.

### (4) Road closure model

Since this study aimed to analyze evacuation routes, we assumed that people would travel on foot in the event of a disaster. Also, we considered roads completely covered by debris as road closures (Figure 3). Road and building polygons were generated by the CAD software (Vectorworks) by using the basic map information provided by the Geospatial Information Authority of Japan (GSI). The road was considered to be in a blockage situation if buffers, assumed as debris flow, were generated from the building polygons, and if they divided the road polygons. According to a study by Tsukaguchi et al.[15], in Nada Ward, Kobe City, which was severely damaged during the Great Hanshin-Awaji Earthquake, the road closure rate was about 10% for 8 to 10 m wide roads and was 5% for 10 to 12 m wide roads. To facilitate the simulation, the road was not considered closed, or blocked, if the width of the road exceeded 10 m.


**Figure 3**: Road closures caused by collapsed buildings

### (5) Conditions used to simulate building collapse

This study targets the "Hanaore Fault Earthquake" that is assumed[16] to cause the most extensive damage in Kamigyo Ward. Further, since the assumed seismic intensity of the Demizu School District and Seishin School District in Kamigyo Ward is 6-upper on the Japanese scale, this study also assumed an earthquake of 6-upper on the Japanese scale. For this analysis, the total collapse rate of non-wooden buildings was not handled, but the total collapse rate of wooden buildings was calculated and put into a Monte Carlo simulation. Table 2 shows the estimated damage to houses in Kamigyo Ward. In this study, Based on a previous simulation of evacuation from along the cul-de-sac to the designated evacuation center, buildings facing roads that are considered impassable and newly constructed buildings assumed to be noncollapsable, and based on Google Street View, collapse simulation was omitted for the buildings that were found to be less than 10 years old. Assuming that all the buildings that got entirely demolished were wooden, the **building total collapse rate** was calculated to be (1900 + 9200) ÷ 37347 = **29.7 (%)**

| No. of wooden houses | Completely destroyed | |
|---|---|---|
| | D5 (Layer destruction) | D4 |
| 37, 347 | 1, 900 | 9, 200 |

**Table 2**: Estimated damage due to Hanaore Fault Earthquake[17]

Using Monte Carlo simulations, we predicted whether a building would "collapse" or "not collapse" in the event of an earthquake based on this total collapse rate. To identify the cases with the highest number of collapsed buildings, 10,000 simulations were run for Seishin School District and Demizu School District each, and for analyzing the road closure conditions, we selected the top five cases from each with the highest number of collapsed buildings.

## 3. Field Survey Results

For the Seishin School District and Demizu School District, the distribution status of cul-de-sacs, the number of cul-de-sacs by width, the number of cul-de-sacs eliminated (calculated by comparing the number

of cul-de-sacs in the disaster-resistant city planning maps of 2018 for the Seishin School District and that of 2017 for the Demizu school district to present day cul-de-sacs of each), the number of sites along cul-de-sacs, fences, and walls along cul-de-sacs, the distribution status of privately-owned doors, and other distribution conditions such as the road end, were surveyed. Table 3 shows the distance and percentage of road extensions by width in the Seishin School District and Demizu School District, measured using the basic map information.

**Table 3**: Distance and Percentage of Road Extensions by Width in the Seishin and Demizu (Unit: m)

| Seishin School District | | | Demizu School District | | |
|---|---|---|---|---|---|
| Width less than 4 m | Width not less than 4 m | Total distance of extension | Width less than 4 m | Width not less than 4 m | Total distance of extension |
| 4,137 (58%) | 2,997 (42%) | 7,134 | 6,768 (42%) | 9,328 (58%) | 16,096 |

### (1) Current status of cul-de-sacs

The number of cul-de-sacs by width and the number of cul-de-sacs eliminated are shown in Table 4.

**Table 4**: Number of Cul-de-sacs by Width and Number of Cul-de-sacs Eliminated

| | Width less than 1.8 m | Width 1.8 to 4.0 m | Total number of cul-de-sacs | Number of cul-de-sacs eliminated |
|---|---|---|---|---|
| Seishin School District | 24 [52.2%] | 22 [47.8%] | 46 | 1 |
| Demizu School District | 69 [67.6%] | 33 [32.4%] | 102 | 9 |

### (2) Number of sites along cul-de-sacs and number of residents

The average number of persons per household in the **Seishin School District** (from the October 2020 census) was calculated as:

$$Population\ 4222(people) \div 2412(household) \fallingdotseq 1.75(people)$$

The average number of persons per household in the **Demizu School District** (from the October 2020 census) was calculated as:

$$Population\ 8615\ (people) \div 4557(household) \fallingdotseq 1.89(people)$$

The number of persons living along the cul-de-sac was determined assuming that 2 persons resided per household, as per the round-off average. The estimated number of residents residing along the cul-de-sac was 368 and 786 in the Seishin School District and Demizu School District, respectively.

## 4. Results of collapse simulation

The number of buildings that contributed to road closures in the Seishin School District and Demizu School District are tabulated in Table 5.

**Table 5**: Top Five Cases with the Highest Number of Collapsed Buildings and Highest Number of Buildings Contributing to Road Closures in Seishin School District and Demizu School District

| Ranking of number of buildings collapsed | Seishin School District Number of buildings collapsed (cases) | Number of buildings contributing to road closures in Seishin School District (cases) | Demizu School District Number of buildings collapsed (cases) | Number of buildings contributing to road closures in Demizu School District (cases) |
|---|---|---|---|---|
| 1 | 220 | 149 (67.7%) | 375 | 186 (49.6%) |
| 2 | 211 | 147 (69.7%) | 372 | 203 (54.6%) |
| 3 | 210 | 144 (68.6%) | 371 | 189 (50.9%) |
| 4 | 206 | 140 (68.0%) | 369 | 203 (55.0%) |
| 5 | 204 | 134 (65.7%) | 368 | 204 (55.4%) |

Average of the ratio (percentage) of the number of buildings that contributed to road closures to the number of buildings that collapsed in the top five ranks of Seishin School District was 67.9%, indicating that

approximately 70% of the collapsed buildings contributed to road closures in the district. The aforementioned ratio (percentage) in the top five ranks of Demizu School District was 53.1%, indicating that approximately 50% of the collapsed buildings contributed to road closures in this district. A comparison of the two school districts, as shown in Table 3, demonstrates that the higher closure rate in the Seishin School District can be attributed to the higher percentage of narrow streets in the Seishin School District, which in turn may have increased the likelihood of road blockages.

## 5. Evacuation simulation results in the Seishin School District

### (1) Evacuation simulation under normal circumstances

Omitted due to space limitations.

### (2) Evacuation simulation considering road closures

Omitted due to space limitations.

### (3) Evacuation simulation considering road closures when using evacuation doors, etc.

This experiment simulated walking from each cul-de-sac to the designated evacuation center, taking into account the existing emergency evacuation doors and the road closures when using privately-owned doors. We identified eight areas that could be made passable using existing emergency evacuation doors and privately-owned doors, which are considered effective for evacuation. The average and percentage of the number of persons evacuated without using existing doors and by using existing doors are shown in Table 6.

**Table 6**: Average and Percentage of the Number of Persons Evacuated Without Using Existing Doors and With Using Existing Doors

| Total number of residents residing along cul-de-sacs with installed doors, etc. | When proposed and pre-installed doors, etc. are not used | When proposed and pre-installed doors, etc. are used |
|---|---|---|
| 76 persons | 9.2 persons (12.1%) | 20.4 persons (26.8%) |

The average percentage of those who were able to reach the designated evacuation increased from 12.1% to 26.8%, indicating a 14.7% increase in safe evacuation.

### (4) Evacuation simulation considering road closures when a new evacuation door is installed

This simulation was based on the assumption that the walls and fences along the cul-de-sacs or at the end of the blind alleys have been renovated as evacuation doors and were used along with the existing emergency evacuation doors and privately-owned doors to simulate walking from each cul-de-sac to the designated evacuation site, considering road blockage. We identified nine areas where installation would be possible and that could be made passable by installing new emergency evacuation doors. The average and percentage of the number of persons evacuated without installing evacuation doors and by using newly installed evacuation doors are shown in Table 7.

**Table 7**: Average and Percentage of the Number of Persons Evacuated Without Installation of Evacuation Doors and With the Use of Newly Installed Evacuation Doors

| Total number of residents residing along cul-de-sacs with newly installed evacuation doors | Without installation of evacuation doors | With installation of new evacuation doors |
|---|---|---|
| 110 persons | 22 persons (20.0%) | 53.2 persons (48.4%) |

In this case, the average percentage of those who were able to reach the designated evacuation centers increased from 20.0% to 48.4%, indicating a more favorable increase of 28.4% in evacuating during a disaster.

### (5) Considerations based on the percentage of those who completed the overall evacuation

The percentages of the number of persons evacuated in the following three cases are shown in Table 8, the number of persons evacuated without taking any measures in case of road closures, the number of persons evacuated by using the existing emergency evacuation doors and privately-owned doors, and the number of persons evacuated by prospective evacuation doors, newly installed in walls and fences along cul-de-sacs or at the end of blind alleys, and by also using the existing emergency evacuation doors and privately-owned doors.

**Table 8**: Percentage of Number of Persons Evacuated in Evacuation Simulation Considering Closure of Each Road

* Percentages given in parentheses ( ) are the values compared to the case without measures

| Ranking of number of buildings collapsed | Without measures | Using existing doors | Using newly installed doors |
|---|---|---|---|
| 1 (220 cases) | 18.5% | 23.9% (+ 5.4%) | 32.1% (+ 13.6%) |
| 2 (211 cases) | 14.7% | 17.9% (+ 3.2%) | 26.6% (+ 11.9%) |
| 3 (210 cases) | 11.4% | 12.5% (+ 1.1%) | 21.2% (+ 9.8%) |
| 4 (206 cases) | 21.2% | 25.5% (+ 4.3%) | 37.0% (+ 15.8%) |
| 5 (204 cases) | 18.5% | 20.1% (+ 1.6%) | 27.2% (+ 9.7%) |
| Average percentage of number of persons evacuated | 16.8% | 20.0% (+ 3.2%) | 28.8% (+ 12.0%) |

A comparison of the number of evacuated people with no countermeasures taken to the number of evacuated people that when the existing doors and newly installed were used, there was a 12% increase in the average percentage of those who were able to reach the designated evacuation center from 16.8% to 28.8%. The reason for the low increase in the overall number of persons evacuated from cul-de-sacs may be due to the high rate of road closures and the fact that areas with dense sites along cul-de-sacs are often isolated.

## 6. Evacuation simulation results in the Demizu School District

### (1) Evacuation simulation under normal circumstances

Omitted due to space limitations.

### (2) Evacuation simulation considering road closures

Omitted due to space limitations.

### (3) Evacuation simulation considering road closures when using evacuation doors, etc.

This simulation mimicked the situation of walking from each cul-de-sac to the designated evacuation center, taking into account the existing emergency evacuation doors and the road closures when using privately-owned doors. We identified eleven areas that could be made passable using existing emergency evacuation doors and privately-owned doors. The average and percentage of the number of persons evacuated without using existing doors and with using existing doors are shown in Table 9.

**Table 9**: Average and Percentage of the Number of Persons Evacuated Without Using Existing Doors and With Using Existing Doors

| Total number of residents residing along cul-de-sacs with installed doors, etc. | When proposed and pre-installed doors, etc. are not used | When proposed and pre-installed doors, etc. are used |
|---|---|---|
| 158 persons | 45.6 persons (28.9%) | 76.8 persons (48.6%) |

The average percentage of those who were able to reach the designated evacuation centers increased from 28.9% to 48.6%, indicating a 19.7% increase.

### (4) Evacuation simulation considering road closures when a new evacuation door is installed

This simulation assumed that the walls and fences along the cul-de-sacs or at the end of the blind alleys had been renovated to be used as evacuation doors and that the existing emergency evacuation doors and privately-owned doors can also be used to simulate walking from each cul-de-sac to the designated evacuation site, also considering road blockage. We identified fourteen prospective installation areas that could be made passable by installing new emergency evacuation doors. The average and percentage of the number of persons evacuated without newly installed evacuation doors and with the use of newly installed evacuation doors are shown in Table 10.

**Table 10**: Average and Percentage of the Number of Persons Evacuated Without Installation of Evacuation Doors and With the Use of Newly Installed Evacuation Doors

| Total number of residents residing along cul-de-sacs with newly installed evacuation doors | Without installation of evacuation doors | With installation of new evacuation doors |
|---|---|---|
| 148 persons | 30.8 persons (20.8%) | 64 persons (43.2%) |

The average percentage of those who were able to reach the designated evacuation centers increased from 20.8% to 43.2%, indicating a 22.4% increase in evacuation scope.

### (5) Considerations based on the percentage of those who completed the overall evacuation

The percentages of the number of persons evacuated in the three different situations are shown in Table 11. The number of persons evacuated in the absence of countermeasures in case of road closures, the number of persons evacuated by using the existing emergency evacuation doors and privately-owned doors, and the number of persons evacuated by proposed evacuation doors newly installed in walls and fences along cul-de-sacs or at the end of blind alleys and the existing emergency evacuation doors and privately-owned doors.

**Table 11**: Percentage of Number of Persons Evacuated in Evacuation Simulation Considering Closure of Each Road

* Percentages given in parentheses ( ) are the values compared to the case without measures

| Ranking of number of buildings collapsed | Without measures | Using existing doors | Using newly installed doors |
|---|---|---|---|
| 1 (375 cases) | 32.8% | 34.9% (+ 2.1%) | 38.7% (+ 5.9%) |
| 2 (372 cases) | 31.6% | 35.6% (+ 4.0%) | 40.6% (+ 9.0%) |
| 3 (371 cases) | 28.8% | 36.4% (+ 7.6%) | 39.2% (+ 10.4%) |
| 4 (369 cases) | 29.5% | 33.3% (+ 3.8%) | 38.9% (+ 9.4%) |
| 5 (368 cases) | 34.9% | 37.7% (+ 2.8%) | 41.8% (+ 6.7%) |
| Average percentage of number of persons evacuated | 31.5% | 35.6% (+ 4.1%) | 39.7% (+ 8.2%) |

When the value obtained when no measures were taken is compared with that when the existing doors and proposed newly installed doors were used, there was an 8.2% increase in the average percentage of those who were able to reach the designated evacuation center from 31.5% to 39.7%. The reason for the low increase in the overall number of persons evacuated from cul-de-sacs may be due to the small number of places where evacuation doors can be installed relative to the total number of cul-de-sacs in the Demizu School District. The following can be considered as the aspects of places at which emergency exits cannot be installed; there are no fences or walls along cul-de-sacs lined with buildings. Or because of the high density of buildings, evacuation doors cannot be installed in many cases where there are buildings beyond the walls or fences.

## 7. Interview survey

### (1) Overview of the interview survey

Intending to improve the number of evacuation doors installed, we conducted an interview survey to identify the factors and problems involved in evacuation door installations. Tables 12 and 13 provide a summary of each interview survey.

**Table 12**: Summary of Interviews with Town Renewal, Creation Promotion Office, Kyoto City

| | |
|---|---|
| **Survey date and time** | November 17, 2021 (Wednesday) |
| **Investigator** | Person in charge, Town Renewal, Creation Promotion Office, Kyoto City |
| **Details** | We conducted the interview to understand the current status and issues on the installation of emergency evacuation route doors. |
| **Survey items** | 1. Installation status of emergency evacuation route doors in Kamigyo Ward.<br>2. The kind of persons who are installing the emergency evacuation route doors.<br>3. The reasons for the seeming lack of progress in the installation status of Seishin School District and Demizu School District.<br>4. Systemic problems or issues related to the emergency evacuation route development project.<br>5. The activities are being implemented to raise awareness of the emergency evacuation route development project. |

**Table 13**: Summary of Interviews with the Applicants of Emergency Evacuation Route Development Project

| | |
|---|---|
| **Survey date and time** | December 2 (Thursday), 13 (Monday), and 16 (Thursday), 2021 |
| **Investigator** | Residents of Kyoto City, Applicants of Emergency Evacuation Route Development Project, Mr. O, Mr. B, and Mr. T<br>Person in charge, Town Renewal, Creation Promotion Office, Kyoto City |
| **Details** | The questions were mainly about the sequence of events pertaining to the installation or management status of the emergency evacuation route doors. |
| **Survey items** | 1. The sequence of events leading to awareness about the emergency evacuation route development project system.<br>2. The sequence of events leading to the decision to install evacuation doors.<br>3. The management status of evacuation doors.<br>4. The cost of installation of evacuation doors.<br>5. Problems related to the installation.<br>6. About disaster prevention town walking. |

### (2) Results and discussion of the interview survey

[1] The installation status of emergency evacuation doors installed in Kamigyo Ward is overwhelmingly lagging as is evident from only 15 emergency exits present in the 894 cul-de-sacs existing here.

[2] The most significant limitation in installing emergency evacuation doors is consensus building. Security is one of the factors that can easily become an obstacle to consensus building. To improve the installation status, it is necessary to change the awareness of this security aspect and to improve the security of evacuation doors, which will be a future challenge.

[3] One of the factors that can improve the installation of emergency evacuation doors is “Disaster Prevention Town Walking” involving the town residents, mainly disaster prevention associations, etc., or disaster prevention experts in Kyoto City.

## 8. Conclusion

### (1) Results

The average percentage of those who were able to reach the designated evacuation center in the 5 cases was 16.8% for Seishin School District and 31.5% for Demizu School District when the cul-de-sac measures were not considered. Immediate action for appropriate measures is imperative in both school districts.

When looking at the number of people evacuated from cul-de-sacs with proposed emergency evacuation doors installed, increased the average percentage of those who were able to reach the designated evacuation centers from 20.0% to 48.4% in the Seishin School District. In the Demizu School District, the percentage increased from 20.8% to 43.2%. From the perspective of cul-de-sacs equipped with newly installed evacuation doors, it can be said that the evacuation doors are effective against road closures. However, as there were many cases in which the evacuation doors were installed but could not be used because buildings near the evacuation doors collapsed, measures related to this aspect are also necessary.

### (2) Future challenges

In this study, interview surveys were conducted with three users of the emergency evacuation route development project. However, the interview survey needs to be more extensive to apprehend new problems and factors contributing to the increase in the number of installations. In addition, an interview survey of the persons residing along the cul-de-sacs in which the emergency evacuation doors are not installed should also be considered.

Building collapse simulations conducted in this study applied a uniform total collapse rate since it was not possible to obtain data on the age of each building. If building collapse simulations could be conducted taking into account the age of the buildings, the accuracy of the road closure distribution will be further improved. Therefore, obtaining the data on building ages and conducting building collapse simulations by considering this data is a future challenge.

Although the installation of evacuation doors has an immediate effect as a cul-de-sac measure, the number of places where new evacuation doors can be installed is currently very limited. To solve this problem, an evacuation door is installed at the end of a ladder that scales the difference in elevation at the end of the passage in a cul-de-sac, as shown in Figure 4. Since the width of evacuation routes would be increased by implementing cul-de-sac measures that consider such differences in elevations, it is necessary to consider evacuation routes not only in planar terms but also in three dimensional perspectives.


**Figure 4**: Example of a Three-dimensional Evacuation Route

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# Maintaining the built environment through community engagement tools and strategies: playground as experimentation platform.

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## Abstract
The proposed research investigates community engagement processes in built and urban heritage care strategies, aiming to control the built environment quality with a view to users' involvement, awareness, and education.
Focusing on places intended for school-age users, the research experiments with methods and tools for transferring a shared monitoring strategy, where parents and children experience tools to detect information about the quality of the playground system and its sub-systems (UNI EN 1177; UNI EN 1176-1; UNI 11123). These tools, designed according to the specific abilities and skills of the users, enable knowledge of their changing needs over the playground's life cycle, guiding managers in planning maintenance and rehabilitation activities.
Through the analysis of two selected case studies, located in settlement systems within the municipality of Naples different for physical, social, and economic characteristics, strategies for the activation of training workshops for playground maintenance and rehabilitation are outlined.
Built environment is assumed in the research as enabler and maintenance as driver for the connection with the community: the user becomes an actor within the maintenance process capable of having an influence on the activities and their scheduling.

**Keywords:** Playground, Shared maintenance, Community engagement

## 1. Introduction
European policies emphasise the importance of involving communities in the regeneration of neighbourhoods and toward a sustainable development [1-2-3-4-5]. The international community also recognizes that protecting physical, cultural, economic, and social values is essential to promote human development [6-7-8-9]. Particularly, two main issues are debated in international documents: extending the life cycle of heritages and active stakeholder involvement [4-10-11-12].
The community-centred vision for the care and enhancement of cultural heritage calls into question younger people's responsibility, to let them learn to be custodians of sedimented qualities [13].
The Convention on the Rights of the Child [14], in Article 29, declares the need to educate children to be responsible within the society and to respect the environment. In Art. 31, moreover, play is recognized as an "inalienable right," not only for the physical growth, but also for the social, emotional, and intellectual development of the child. It also becomes a developmentally supportive tool: indeed, numerous research studies have shown that children who have been denied the right to play exhibit socially aggressive and emotionally repressed atypical behaviours [15-16-17-18]. Psychologist Friedrich Frobel recommended playgrounds for children as tools to support psycho-physical development and teach good manners [19].

The article focuses on the enabling processes intended for the care of the built environment, through edutainment activities and tools, aimed at young users and their educators. Playgrounds are the subject of the study, as public spaces designed to develop users' imagination and creativity through play [13]. The work originality consists of the shift from an occasional and discontinuous conception of stakeholder involvement, to one that makes the participation process constant and supported by tools appropriately designed for young users.
The research is structured around the theme of monitoring urban playgrounds' performances. This continuous process over time has the aim, on the one hand, to detect the evolution and changes in the users' needs, and, on the other hand, to ensure the extension of the useful life of these urban presidia. This process has the broader goal of generating in the citizens of tomorrow a fondness and care for the built environment.
The paper is organised as follows: (a) a brief state of the art on the preservation of the built heritage and community engagement, with particular reference to younger people, is provided; (b) the built environment maintenance process as a tool for community engagement is introduced; (c) two case studies of playgrounds are analysed for which to test tools for involving younger people in maintenance activities; (d) an hypothesis of strategies and tools for collaborative maintenance of playgrounds is defined.

## 2. Built heritage and community engagement: toward the inclusion of children and youth in care processes

Reactivating the symbiosis between built heritage [9] and communities [10] is now a shared commitment to the conservation and transmission of built heritage [20]. International policies and documents are directed toward symbiosis between sites and communities: developing, on one side, issues related to the value system embedded in heritage and, on the other, transformation processes; moreover, they promote the idea of built heritage as [13]: (a) record of historical development and way of life, connecting capital between community and context [10]; (b) representation of creative capacities and man work, support toward community engagement and empowerment [9]; (c) driving force for growth [21].
In Europe, since 2005 with the Faro Convention [9], and still today with initiatives such as The Faro Way [22], the Europe for Citizens Program [23], the enhancement and preservation of built heritage is promoted through community participation in its governance.
The interest in the participation of the youngest, so that they can learn to be custodians of sedimented qualities [13], arose mainly because of the UN Convention on the Rights of the Child [14]. Today it is recognized that their participation is relevant to a broader global interest and could benefit community engagement policies and practices [24].
The Convention on the Rights of the Child [12] is reinforced in 2002 by the report A World Fit for Children [25] where it reported (pp. 66-67) that States need to promote and protect the rights of children by: ensuring their safety; building a world fit for children, where sustainable human development takes their interests into account; and leveraging the issue of listening to children, ensuring their participation.
There are numerous initiatives internationally aimed at creating "child-friendly" cities [26]. In addition, in many countries around the world, and in different ways, children and youth are enthusiastically involved in building cities:

- in Belarus, 2007, the Child Friendly Cities initiative was aimed to create an environment conducive to children's development through the meaningful participation of children and youth in decision-making processes [27];
- in France, the National Committee organises an annual broad consultation with children on their perceptions of their lives and ability to exercise their rights [28];
- in Nepal, July 2011, the Government of Nepal approved the national strategy on Child Friendly Local Governance (CFLG). One of the main CFLG mechanisms for child participation is the mobilisation of child clubs. Through child clubs, about 80,000 children participate in various local governance structures and processes [29].

Planning, design, monitoring, and management of the physical environment are ideal areas for the practice of child participation: "it turns out to be clearer, to them, the vision and understanding of social problems" [30]. Moreover, as emerges from the literature review addressed by [31], it is important that children feel genuinely involved in these processes and that their involvement can make a difference.

## 3. Planned playground maintenance: a community engagement tool.

Planned maintenance is the combination of activities, conducted according to a predetermined and continuous plan, through which it is intended to maintain the quality levels of the built environment in order to perform the required functions [32-33-34-35-36-37-38]. Since maintenance can be conducted through planned activities exercised for preventive and corrective purposes, it requires an adequate monitoring of the built system [39]. Thanks to the new opportunities offered by digitalization, some phases of the maintenance process, usually under the responsibility of technicians and construction workers, can now be carried out by different expertise [40]. In fact, if the planned maintenance activity

is supported by adequate tools for dialogue with different categories of users, these can be included in the processes of knowledge, diagnosis, control, and monitoring [41]. In this sense, maintenance activity, in addition to providing tangible benefits to communities, in terms of safety and quality of the urban system, can be considered an effective engagement tool and agent of connection between built heritage and community.
The cultural coordinates of maintenance activity, even at the urban scale, have been marked by the overcoming of the role of the user as an outsider to information and decision-making procedures [36-20]. Participatory maintenance processes are not new-found; experimentation with numerous operational practices has shown how such strategies succeed in improving the degree of user satisfaction and the effectiveness of the maintenance process [42]. This is especially recognized when the benefits are perceived in a tangible way, generating a fondness for the asset not only because of the function they perform, but also because of the value attached to it [43].
If properly supported, users, citizens and tourists can be co-responsible actors in the maintenance process, implementing simple maintenance operations and learning to recognize anomalies in the system. Shared maintenance processes foster users' affection and prevent them from engaging in improper behaviours [44].
At the base of participatory maintenance processes there is the need for collaboration and information sharing among different actors [45-46].
Scientific and technological developments have recently produced digital tools for dialogue with citizens to report failures or malfunctions of the urban system to area managers (e.g., through a photo and a comment), following a registration to the mobile application or web platform. These are intended for an adult audience that is responsible and more sensitive to such issues and feature a lack of scientific approach [47].
The purpose of this research is to develop devices that trigger and facilitate interaction and information sharing between area managers and younger age groups. In this way, the latter can become responsible and sensitive to the care of the spaces they enjoy, and active citizens in building a sustainable environment for their future.
To this end, the object of the proposed experimentation are playgrounds, as devices to garrison settlement culture [13] capable of contributing to the children's growth, through the creation of bonds of affection and responsibility in the territory where they grow up.
Therefore, the research proposes to develop, through the initiation of an experimentation on two playgrounds case studies, hypotheses for the implementation of tools to support participation strategies: involving children and youth, with their tutors, in the process of playground care and maintenance.

### 3.1 Playground: privileged educational platform for urban space care. Two Neapolitan cases

Since its creation, the playground has been a tool for urban redevelopment of residual or underutilised spaces in the city. In the years after World War II, in fact, the interstitial, leftover spaces of cities began to be reused as places for children to use for entertainment and leisure activities [48].
Today, open spaces are recognized as playing an increasingly important role within the urban fabric both for their identity characteristics and for the psychophysical benefits they convey to the communities that enjoy them [9]. These spaces are to be considered as structuring elements of the city, with a strong balancing attitude that is also social in nature [49].
In this context, playgrounds become an intended use for public spaces that, through play, has the potential to stimulate the community dimension of custodianship involving and educating young people in the empowerment of public space [50]. Playgrounds stand, therefore, as an ideal platform for experimenting with innovative strategies of participatory maintenance of public open spaces. An opportunity to establish a dialogue between children and adults.
"Experience indicates that the construction process can begin in different ways: top-down - with a mayoral decree or formally adopted government decision, actively coordinated to reach all levels of administration and all corners of the city. Or from the bottom up-from a small neighbourhood initiative, an initiative led by children claiming their right to play and move around the city safely, demonstrating the potential for citywide outreach. In most cases it is a combination of different approaches" [26].
Diversity of approaches is one of the distinguishing features of the Neapolitan cases analysed (Figure 1): (a) the playground designed by Dominique Perrault Architecture, in Piazza Garibaldi, Naples, 2nd Municipality; (b) the Corto Maltese Park, in Via Hugo Pratt, Naples, Scampia, 8thMunicipality.
The playground in Piazza Garibaldi, product of an urban regeneration project by Dominique Perrault's studio, is part of a large urban area that also hosts green and leisure spaces, with soccer and basketball fields. It can be understood as a top-down regeneration effort; in 2004, Metropolitana di Napoli Spa commissioned Dominique Perrault to design the Line 1 subway station and the square in front of the central train station. Moreover, the project is in the public funds "Patto per lo Sviluppo della Regione Campania." The design choices are developed from the needs to redevelop a complex urban area. Piazza Garibaldi is not only a vast area (it covers about 65 thousand square metres), but it is also one of the most important and frequented squares in the city - since 1866 the Napoli Centrale station has

overlooked it - and it is also an area characterised by crime events, as attested by the news reported in local and national newspapers.
The space in front of the central station, built in the second half of the twentieth century following the demolition of the passenger building of the nineteenth-century station, appeared as an urban void interrupted by streets crowded with cars, buses and pedestrians. Dominique Perrault reorganised the open space by dividing it, through the central driveway, into two parts: on the south side the semi-hypogean plaza was designed and built, which includes a shopping arcade and leads to the entrances of the Line 1 subway, and local and national rail lines; on the north side at the same elevation of the street, a multifunctional area has been designed and built, containing a playground, sports space, a green area with gazebos and an amphitheatre, which in addition to leading to the entrances of the Line 1 subway can host musical and cultural events.
The playground is, therefore, located in the northern part of the square close to Vasto district, covering an area of about 5,000 square metres.
The maintenance, cleaning and waste management of the area is entrusted to the company "Asia Napoli," while the maintenance of sports and playground equipment is entrusted to the relevant Municipality. This is also the place of confluence of any reports of breakdown and tampering of the facilities, received by telephone. The reports received are forwarded to an external company that is entrusted to carry out the interventions.
The classification of the environmental and technological system of the playgrounds is proposed in Table 1 to define the types of users and technical elements to be maintained.

**Table 1**: Analytical sheet of the environmental, functional, and technological systems of the Garibaldi Square playgrounds.

| **Giardini di Piazza Garibaldi** | | |
|---|---|---|
| **Analysis of spaces and functions** | | |
| **Function** | playground; outdoor sports; leisure; crossing | |
| **Type of space** | **Spatial domain** | **Users** |
| *Open spaces* | Pedestrian transit area | Children*, adolescent**, families,seniors, commuters, tourists |
| | Green area | Children*, adolescent **, families,seniors, commuters, tourists |
| | Cycle track area | Children, children, families, tourists,commuters |
| | Play/sport area | Children, adolescent, families |
| | Performance and event area (Amphitheatre) | Children, adolescent, families, elderly,commuters, tourists |
| **Technological system** | | |
| **Technology Unit** | **Technical elements class** | **Technical Elements** |
| Lower horizontal closure | Floor/ground/ roadway | Pavement |
| | | Flooring |
| | | Cycle path |
| | | Surface for playing football and |
| Vertical external partition | Protection elements | Walls |
| | | Railings |
| | Separating elements | Bollards |
| Inclined external partitions | Stairs and Ramps | Cordonate |
| | | Gradonate |
| | | Ramps and inclined planes |
| Collective outdoor furniture | Game equipment | Swings |
| | | Slides |
| | | Net and climbing frame |
| | | Football goals |
| | | Basketball baskets |
| | | Swings |
| | Leisure Equipment | Benches |
| | | Waste containers |
| | Green System | Trees |
| Installations and service provision | Lighting installations | Streetlights |
| Notes: *Children, between 5 and 11 years old; **adolescents, between 11 and 17 years old | | |

Corto Maltese Park is in the metropolitan city of Naples, in the Scampia neighbourhood, between Hugo Pratt, Attilio Micheluzzi and Andrea Pazienza streets. It is a bottom-up regeneration project in that it was born from the intentions of the non-profit association "The Green Thumbs", formed in 2012 by a section of residents. The Park represents a project to rehabilitate an abandoned urban area that had become an unauthorised waste dump and the scene of criminal actions.
The association's goal was to improve the quality of the area through the creation of multipurpose spaces for outdoor activities and social integration. These activities have increased the safety and well-

being of the community, returning a space that was now the preserve of crime. The project was funded by the community itself and continues to this day to be so by benefiting from 5x1000 donations.
Corto Maltese Park occupies an area of about 10,000 square metres, and consists of an area designated for sports: a basketball court, a soccer field and a tennis court; and an area for the entertainment and play of children, families, and animals: a dog walking area, an educational garden and a children's play area.
Prefabricated toys and games self-made by the community itself were placed in the children's play areas. Murals were created on the boundary walls, by the association members themselves. Various tree species have been planted in the green areas, benches and waste baskets installed. It is the scene of various events to raise awareness for respecting and caring for the environment, and to combat social marginalisation. Currently, the care, management and maintenance of the areas is carried out by the association "Pollici Verdi" [51], which, as it emerged from the interview conducted with one of the members, is responsible for redevelopment works (such as the installation of new games) and maintenance of technical components, while waste disposal is entrusted to the company "Asia Napoli."
For this playground, an analysis of spatial, functional, and technological systems was carried out, aimed at identifying user categories and building shared maintenance strategies (Table 2).

**Table 2**: Analytical sheet of the environmental, functional and technological systems of the Corto Maltese Park playgrounds.

| **Parco Corto Maltese** | | |
|---|---|---|
| **Analysis of spaces and functions** | | |
| **Function** | Playground; Pedestrian transit; Resting.. | |
| **Type of space** | **Spatial scope** | **Users** |
| *Open spaces* | Pedestrian transit area | Children*, adolescents**, families, seniorcitizens, associations |
| | Green area (park) | Children*, adolescents**, families, seniorcitizens, associations |
| | Play/sport area | Children*, adolescents**, families, seniorcitizens, associations |
| | Kitchen garden area | Children*, adolescents**, families, seniorcitizens, associations, farmers |
| | Dog area | Adolescents**, families |
| **Technological system** | | |
| **Technology Unit** | **Technical elements class** | **Technical Elements** |
| Lower horizontal closure | Floor slab o Floor o roadway | Vegetation |
| | | Garden |
| | | Pavement |
| | | Flooring |
| | | Playing field surface |
| Vertical external partition | Protection elements | Wooden fences |
| | | Green fences |
| | Separating elements | Fence walls |
| | | Gates |
| | | Railings |
| Inclined external partitions | Stairs and Ramps | Cordonate |
| | | Gradonate |
| | | Ramps and inclined planes |
| Collective outdoor furniture | Game equipment | Swings |
| | | Slides |
| | | Tennis court |
| | | Basketball court |
| | | Football pitch |
| | Leisure Equipment | Benches |
| | | Waste containers |
| | Green equipment | Trees |
| Installations and service provision | Lighting system | Streetlights |
| Notes: *Children, between 5 and 11 years old; **adolescents, between 11 and 17 years old | | |

### 3.1 Digital technologies to support shared maintenance strategies for playgrounds

Based on the systemic knowledge of the user categories of the playgrounds analysed, the decomposition of the environmental, functional, and technological system - according to the UNI 8290 [52] standard- and the literature of some examples of shared maintenance, the research proposes the hypothesis of designing digital tools and applications to monitor the performance of playgrounds, as engagement tools.
In both case studies highlighted in the previous paragraph, the user categories were identified: children (5-11), adolescents (11-17), and tutors, with a substantial difference related to the design and implementation process: the Corto Maltese Park was born from a so-called bottom-up process, desired, supported and funded by the community; while the Garibaldi Square playground from a top-down process, commissioned by the company Metropolitana di Napoli Spa and financed with public funds.


Map of Naples, localization of case studies: 1. Giardini of Piazza Garibaldi, 2. Parco Corto Maltese

Giardini of Piazza Garibaldi. Photos by the authors.

Parco Corto Maltese. Photos by the authors.

**Fig. 1**: The image depicts the framing of the case studies, within the city of Naples, and some detailed photos.

This difference does not determine significant distinctions in the identification of the system's components, nor of the requirements and performances [53-54-55] but it is to be considered when defining engagement strategies and tools. They could be different according to the categories of users and their degree of involvement and participation in the activities to be proposed.
Specifically, the proposal discussed here involves the design of digital tools and mobile applications for surveying the needs of playground users, designed ad hoc for each identified category. The intent of providing both tools and a mobile application is dictated by the different abilities and skills of the identified user categories. Moreover, in the case of the mobile application, the advancement over previous research[1] and existing applications on the market are related to the construction of a digital pathway measured to the needs of young users. In fact, the following are envisaged: (a) interactive tools, for play, intended for children, to detect their needs in relation to the comfort and safety of the playground; (b) a mobile application for reporting failures and malfunctions, and for monitoring the playground quality over time, connected to a platform intended for the management of the reports received.
Specifically, the mobile application will have interfaces tailored to the age differences, with gamification tools, reward systems, and edutainment mechanisms that will entice users to use it.
Reports from the mobile application intended for children and parents are characterised by a series of information in support of the visual inspection, equipped with photos, labels and comments, useful to the manager in establishing a pre-diagnosis of the built system [56-57-58-59]. The manager can, in addition, through push notifications sent by the web management platform, ask users in the target area who have installed the application, for control of specific elements or areas within the playground. In this way, it is reported an increase in resources useful to the manager for the monitoring.
For what has already been pointed out, it is also necessary to think of ways and strategies for the promotion and dissemination of tools, differentially in relation to the two cases. Within Corto Maltese Park, the process of engagement with the community is already active and the dialogue between users and managers of the area is constant; in the case of Garibaldi Square, it is necessary for the municipal entity to activate channels, or use existing ones, so that, with the tools hypothesised, it is possible to activate processes of engagement with the settled community.
At this point, the continued use of the tools and their success depend in part on the ability of the manager to respond to the users' needs. In both cases users feel responsible for the process of caring for the playground, reducing the phenomena of vandalization and increasing respect for common goods.
To this end, in relation to the types of users identified, the proposed engagement in playground maintenance activities provides that: (a) tutors are reminded of the use of the application through infographics distributed in the area. They have a direct interest in the use of digital monitoring tools because of the need for safety towards their children using the playgrounds; (b) adolescents are engaged through user-friendly interfaces and gamification strategies. Educational infographics around the behaviours to be maintained for the care of public spaces, are provided; (c) children are engaged interactively through the design of totems, as play tools. These tools will be designed to interact with young users using easy questions about the quality of their experience.
The research plans to test the hypothesised tools on the reported case studies. As mentioned above, it will be interesting to assess the dynamics resulting from their use in the two different cases, in relation to bottom-up and top-down processes. It is expected, in fact, that the level of diffusion and use of the applications will be higher in the case of bottom-up practices, where the sense of belonging to the place and responsibility towards the care of such spaces is stronger; in the case of top-down practices, more difficulties are expected in the use of these tools. Above all in socially challenging backgrounds, such as Piazza Garibaldi, where the guarantee of acceptance and use could be mainly related to the ability of the managing bodies to offer a timely and adequate response to the users' needs, as emerges from several experiments of participatory maintenance [42].
The tools hypothesised influence the formation of responsible citizens in the care of the places they live, and positively affect the scheduling of maintenance and potential renovation. The questions around the quality of children's experience makes it possible to continuously monitor their changing needs, ensuring that managers can design and plan appropriate activities and interventions.
In this participatory approach, the achievement of built environment quality objectives depends on the dialogue that users activate with expert knowledge. The latter has to guarantee: relating building technologies, failures and lowering of the performance levels; detecting changing needs; outlining maintenance strategies; organising and monitoring the service provided.

[1] Applications designed for mobile devices, geared toward the conduct of inspections by the common user, have shown positive feedback as revealed by studies carried out earlier by the study group, related to Maintenance Urban Sharing Tool mobile application to support the monitoring of the built system, the subject of two subsequent developments: the first following the METRICS project [46], which had seen apartment buildings in some areas of the city of Naples engaged in the process of diagnosis for the detection of anomalies found on the facades of apartment buildings, in the courtyard and street areas; the second conducted within the doctoral research [60] built on the project of Start Up MUST Srl, which extended the experimentation to the urban system, building an ad hoc digital pathway for users of urban space and heritage.

In addition, through the constant questioning constructed to obtain children's and adolescents' opinions on the quality of the spaces they live in, the manager succeeds in guaranteeing the main rights of children, in line with what is reported in the text "Building Child Friendly City. A framework Action" [26]: (a) "Express their opinion on the city they want," (b) "Walk safely in the streets on their own," (c) "Live in an unpolluted environment."

## 4. Conclusion

With a view to the sustainable use and management of available resources [11], strategies for building and urban shared maintenance foster participation and complementarity among multiple skills and actors, including non-experts, toward the efficient maintenance of built capital.

In particular, the participation of young people groups incorporates the goals of the sustainable development strategy as defined in the World Commission on Environment and Development 1987 Brundtland report "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Children and adolescents are active players in building a sustainable environment for their future, while gaining awareness of the need for care of the spaces they themselves enjoy.

Starting with young age groups means investing in responsible and active citizens in the development of cities. Education for the care of places, starting with the residents of communities, should be radically reconsidered so that it becomes a priority agent for achieving sustainable development. "The residents of any community know best what many of the environmental priorities and problems of their community are" [30].

By expanding the range of informal and formal spaces for participation, more people could participate, responsibility is shared more broadly, with less reliance on "experienced citizens" [61]. This increases the number of channels through which communication can flow within and between communities and partnerships, avoiding the "bottleneck" of a formal structure or key person [62].

Participation must involve collaboration and dialogue between youth and adults and between communities and government to enable joint projects to explore, understand and respond to community problems as part of a community development process [62].

Today, open spaces for collective enjoyment are recognized as having a driving role in community cultural growth. This research develops the theme of shared maintenance by exploring playgrounds as an ideal platform for experimenting with innovative strategies, which through play can stimulate the community dimension of custodianship based on the involvement and education in the empowerment of public space [50] of an educated-age audience.

Digitization contributes to tailoring the management process, to the specific needs of use of the built heritage, indicated by the users themselves. Thanks to the digital tools hypothesised, the user is transformed into an actor, able to have an influence on the scheduling of maintenance activities and management, to orient the process according to his or her own priorities.

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# Architectural design and biomechanical theatre

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**Abstract**
The execution is the only way to fully understand the method, this is a cornerstone of Mejerchol'd theatrical theory, as well as of making architecture. The workshop activity included in the architecture courses is the only useful way to experiment, make mistakes, understand and, in this way, train as designers.
Therefore, some works by the students of the fourth-year architectural design laboratories are proposed, these are part of the continuous research activity on teaching and on design. In recent years, students have had the opportunity to deal with the consolidated fabric of the city of Rome, a fabric overflowing and rich in historical stratifications, therefore with a fragile balance. They were urged to produce projects for the community that had a relationship with the places close to them and with the aura of the Eternal City. The outcome were projects with different approaches, recalling the past, its forms, and materials; of relationship with the contemporary, national, and international, and of projection towards the future which together contains the two previous ones and gets rid of them. These approaches relate to the three moments that make up movement in biomechanics: intention, balance, execution. This proves that there is parallelism between all the arts because every form of art whether it is painting, music, theatre or architecture shares the same values.

E.P.

**Keywords:** Methods, teaching, approach.

## 1. The phases of knowledge within an architectural design laboratory

During an architectural design laboratory, different moments follow one another for the student. The first is the "rational perception of the task received" [1], when he understands the design theme entrusted to him. This moment usually comes after an initial phase of explanation of the topic and analysis of the documents provided. This is followed by the realization of the project, that is, the cycle of processes that are put in place to complete the work. Finally, "the decrease of the volitional reflex […] in conjunction with the preparation for the reception of a new purpose" [2] or, the moment in which the student, having concluded the project of the given theme and established his skills, is ready to a new work. [3]
The three moments that the student goes through during the period of laboratory activity can be traced back to the three moments that for Vsevolod Mejerchol'd [4] make up the acting of the biomechanical actor: the intention, the realization, and the reaction. In fact, just as for the Russian actor and director, the actor's training is the preparation for the moment of acting, so for the student, the design experimentation, during the laboratories, is the preparation for the moment of real planning.
With this in mind, we present some of the works of the students of the IV Architectural Design laboratories of the single-cycle study course in architecture, for the academic years 2020/2021 and 2022/2023. The topics given were respectively the Polo Civico Flaminio design competition, announced in 2020, requesting the conversion of some abandoned spaces of the former Electronic and Precision Materials Military Establishment into a library and neighborhood house - a multifunctional space at the service of the community; and the Il grande MAXXI ideas competition, announced in 2022, requesting

a multifunctional building to serve the MAXXI museum on an area facing it, together with the design of the green area connecting the two. Both areas are in the northern sector of the Flaminio district in Rome. Therefore, the students' works deal with the consolidated fabric of one of the Roman districts which in recent years has had the greatest development from a cultural point of view thanks to the creation of museums and theaters.

B.B.

## 2. Otkaz as a reference to the past

The intention is the prelude to every action and no intention does not draw upon past reflections. Mejerchol'd explains the intention to carry out an action as the perception of the task received and represents it, in preparation for the gesture to be performed with a retreat: the oktas, in English the refusal. Here, if you want to walk forward, you will first nod a step backward; if you want to throw a stone, your arm will move away from the point where your mind wants to throw it. A reference to the past to run into the future.

It is precisely in this way that some of the students responded to the given topic. The projects that follow - the great MAXXI competition of ideas - refer to materials and workmanship of Roman architecture.

In the first case – fig. 1 and 2 - a reinterpretation of the use of Roman brick is given which in the project is used as a cladding. The students, Davide Bonacci and Giuseppe Mignogna, by imagining that the brick is laid in different directions, rotating it 90 degrees in its larger sizes, create a formal score capable of generating a dynamic facade. During the day, the flattening or lengthening of the shadows gives a new look to the building, transforming it into an enormous sundial. Furthermore, the use of travertine for the wall that marks the entrance underlines the concept of base, the foundation of classical Italian architecture. This wall acts as a filter, it does not isolate the building from the city, but it intrigues the entrance by not completely revealing the building behind it until you pass it.

**Fig. 1:** Rendered view of the exterior, showing the entrance wall that appears as a base and the brick cladding.

**Fig. 2:** Succession of plans, from the ground floor to the top floor. Note the three parts joined by the connective spaces.

**Fig. 3:** Succession of plans, from the ground floor to the roof plan. The central atrium with the skylight characterized by the same design as the stained-glass windows of the Basilica and the other impluvia that cover the terraces are visible.

**Fig. 4:** Left. Photo of the model. You can see how the atrium is illuminated by the polychrome glass of the skylight. Photo by Barbara Bonanno.
**Fig. 5:** Right. Rendered view of the outside from which you can see the color of the plaster.

The project features a well-organized plan, which divides the building into three blocks. Three misaligned slats that from the outside give an organic appearance to the volumes while inside they contribute to the proper functioning of the building, differentiating the activities it contains. In the spaces between the three slats, the connecting elements such as stairs and elevators are placed.
In the second proposed project – fig. 3, 4 and 5, by students Angela and Michele, references to the past are to be found in the composition of the entire building. The rooms develop around a central atrium surmounted by a large skylight which refers to the impluvium of Roman houses, this feature is replicated in a reduced form for other settings, especially for the terraces. Some of these locks on all sides are open only to the sky, recreating en plein air rooms. The large central skylight also condenses another typical feature. The stained-glass windows are designed with reference to the nearby Basilica of Santa Croce al Flaminio, the use of polychrome lass reates plays of light in the atrium that animate the spaces. Finally, the students chose to use, or the exterior finish, a plaster containing brick dust inside, giving the building its typical red colour.

B.B.

## 3. Posil as realization of the movement/project

Posil, in English "sending", is the real test bench, the moment in which we get involved, we experiment, we make mistakes, we correct ourselves: the realization of the action.
In this context, a project is proposed that draws on the contemporary as a reference for the execution of a new building.
As part of the urban regeneration required by the Polo Civico Flaminio design competition, the student Daniele Di Franco presents a monolithic building – fig. 6, 7 and 8, introverted compared to its surroundings. This introspection favours the development of a visitor's journey through the places, as if following an imaginary thread of Ariadne. The student imagines that the visitor starts by going down to the hypogeum; here, a game of staggered partitions leads to a large, multi-height atrium crossed by a staircase which leads to the rooms above where the building's activities take place.

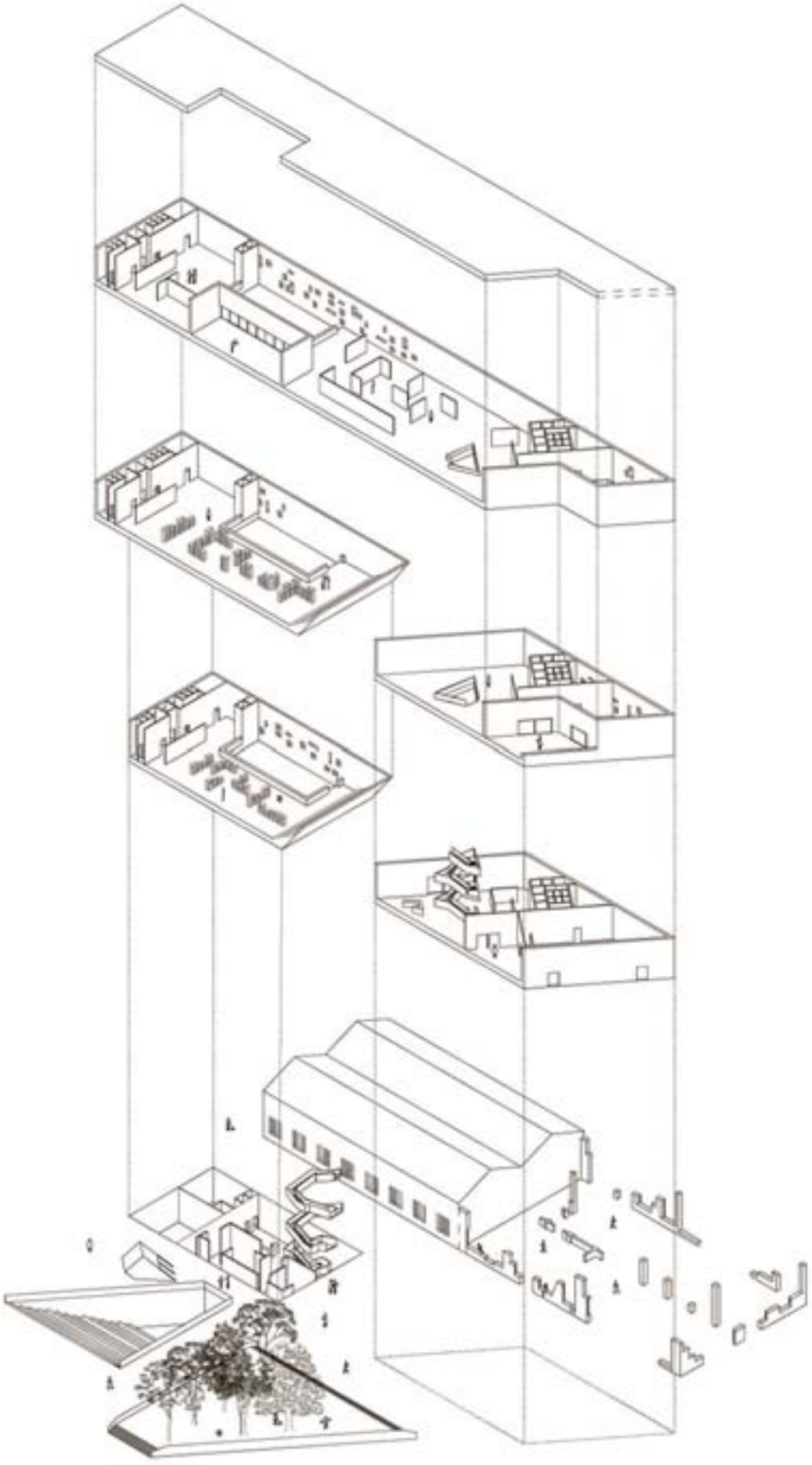

**Fig 6:** Axonometric exploded view.

The spaces are linked to one another in a succession that amplifies the visitor experience by moving

**Fig. 7:** Rendered view of the outside.

**Fig. 8:** Model photo. It is possible to see the opening that creates a connection between the city and the ruins of the barracks behind the building. Photo by Daniele Di Franco.

from the bottom to the top and then back down again. Seen from the outside, the monolith opens only in one point; a choice that serves to connect the city physically and ideally to what remains of the barracks, kept in the form of ruins.

D.D.F.

## 4. Tochka as a projection into the future

Tochka, in English "position", is the dynamic fixation at the end of a movement, it contains within itself the propulsive thrust of the action that has just concluded and the possibility of extending even further. A project that is identified with the tochka is a project capable of condensing the two past moments – otkaz and posìl – and looking towards the future.
In the following design exercise, the student, Giuseppe Ceravolo, exacerbates the static structure of the building, making it distinctive, in extreme contrast with the context of the Flaminio district – fig. 9 and 10.

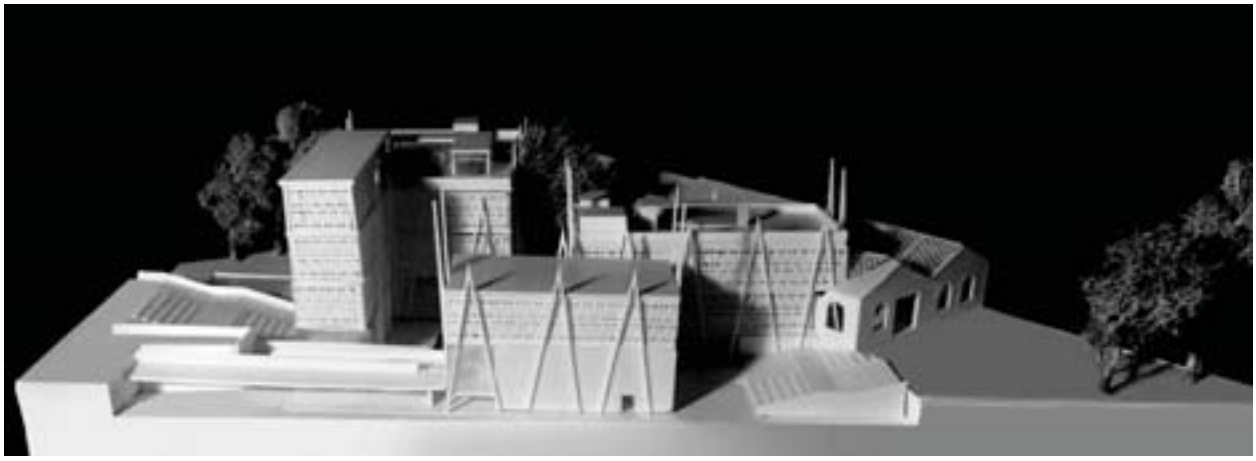

**Fig. 9:** Model photo. Photo by Giuseppe Ceravolo.

**Fig. 10:** Section of the building. It is possible to see the inside of the auditorium and in the background the facade with the brick sunscreens.

**Fig. 11:** Model photo. Photo by Maria Festinese.

Several distinct bodies are gathered around an empty space that compares them in their typical function - library, neighbourhood house and auditorium - and, together, unites them.
The solar shading system draws on the past with the unusual use of bricks mounted on automated mobile systems, adjustable according to solar incidence.
Even the project by the students, Maria Festinese and Giovanna Del Prete, for the shapes and the choice of structural elements, appears futurist compared to the context in which it is inserted - Polo Flaminio competition, fig. 11 and 12. A grid of truss beams left exposed supports two blind blocks which at the top open up to the surrounding area, hosting two terraces that can be used as a theater for open-

air performances. The bodies appear floating on a transparent plane in which the only distinguishable elements are, precisely, the beams. For the cladding of the lower floors, the students choose to use a semi-transparent material so that by night the building is transformed into a huge city-scale lamp.

B.B.

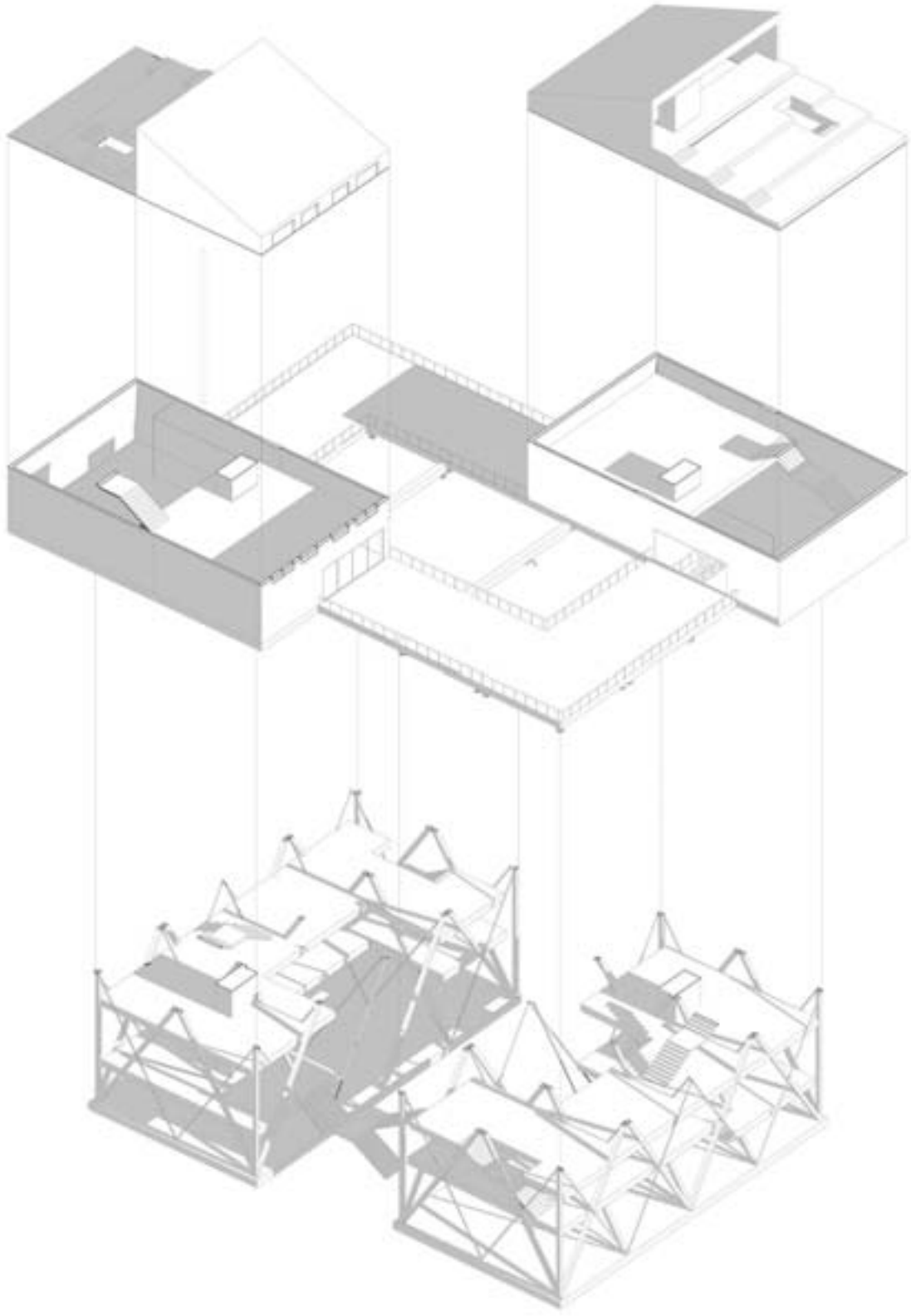

**Fig. 12:** Axonometric exploded view. It is possible to understand how the structure of the building was conceived. The trusses below with light closures and the two blind wall blocks on top.

## 5. Learning by doing

As can be deduced from what has been written up to now, the re-reading of Mejerchol'd's theatrical method in the laboratory setting is various. From the comparison of design approaches to the actor's movements, up to the learning path, the entire period of student work can in fact be represented in an otkaz. Preparation for action is the moment in which the actor's body, as well as the student's mind, pick up the energy necessary for action; they hold them in the balance until the moment they perceive the right moment to put them into practice.
The knowledge, acquired by doing, is ready to resurface for future projects, the preparation, the actor/student's training ground, is over.

B.B.

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[1] Malcovati, Fausto. L'attore biomeccanico. Imola: Cue Press, 2019. ISBN 9788899737177, p.85

[2] Ibid.

[3] Intention as rational perception of the task received, realization as cycle of mimetic and vocal volitional processes and reaction as diminution of the volitional reflex at the moment of realization of mimetic and vocal reflexes concurrently with preparation for receiving a new purpose, are the three obligatory moments for acting according to Meyerhold's theories.Intenzione come percezione razionale del compito ricevuto, realizzazione come ciclo dei processi volitivi mimici e vocali e reazione come diminuzione del riflesso volitivo nel momento della realizzazione dei riflessi mimetici e vocali in concomitanza con la preparazione alla ricezione di un nuovo proposito, sono i tre momenti obbligatori per la recitazione secondo le teorie di Mejerchol'd.

[4] Mejercol'd is a Russian actor, director, and pedagogue who, together with other protagonists of the Russian theatrical avant-garde, revolutionized the way of doing theatre. He operates between the late nineteenth and early twentieth centuries contributing to bring innovations regarding the entire scenic space, the use of music, texts, and the movement of the actor. He devises a form of training for the actor, which is defined as Biomechanics, based on the belief that a good stage performance starts from the physical training of the actor. He was persecuted by the Soviet regime for his avant-garde ideas, arrested in 1939 and subsequently sentenced to death by firing squad.

[5] https://eprints.hud.ac.uk/id/eprint/34449/1/FINAL%20THESIS%20-%20Beale.pdf

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# Dwelling the spaces below the road
# Urban design strategies in the wake of the circular economy

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## Abstract
This paper aims to provide some possible urban design strategies for the upcycling of infrastructure residual pockets, in line with the principles of the circular economy applied to urban design.
In the building of specialized infrastructure, the functional efficiency of the connections and the safety of the users prevail over the architectural quality of the urban space generated below them. This condition generates the paradox that the "above", responding to the criteria of functionality and safety, contrasts with a "below" in which it is difficult and dangerous to move, characterized by urban fragments whose connections have been severed by insurmountable infrastructural barriers, difficult social conditions, degradation, and crime.
The upcycling of these residual spaces, which cannot exclude an interdisciplinary approach, would make it possible to return considerable reserves of urban space to the community and face the phenomenon of land consumption. In this scenario, the urban design has the task of identifying the ways in which the residual spaces of the infrastructures can be used, occupied, transformed, and the way in which it is possible to create physical or perceptive connections between the urban fragments divided by the infrastructural strips, recovering the signs of the roads and urban fabrics.
The case study on which this contribution is based is the eastern area of Naples, a former industrial area and an important Italian logistics hub, marked by roads, railways, and pipelines.

**Keywords:** Keywords, no more than five (Arial – 10 pt – Lower case letters – Justified)

## 1. Space-infra-structure. The road as starting point for the contemporary city transformation [L.S.]
The linear mobility infrastructures – roads, highways, railway lines and all the elements that compose them – are commonly considered, partly rightly, as one of the main causes of landscape fragmentation and its consequences in terms of a bad distribution of space. We know that the fragmentation, from the ecological point of view, produce a damage of the biodiversity: the greater is the fragmentation of the landscape, the lesser is the possibility of the biodiversity to increase or extend, or even only its conservation.
But the fragmentation characterizes the landscape also for the organization of the human life, the possibility to move along the space and to better organize the transformation of the city and the landscape. The linear infrastructures produce a peculiar division of space, becoming the support for the new settlements, which are arranged following a network of closed or semi-closed areas, and oriented lines, and produce several consequences.
The effects of the infrastructure presence in the landscape takes place in different forms, depending on the landscapes crossed, on the elements that characterize and on the orography that supports them. The consequences of fragmentation differ according to a large number of factors: for example, in orographically complex territories (such as the mountain landscape) or the flat ones (such as the Po

valley) the mobility infrastructures take on particular shapes and positions and they are articulated according to different settlement conditions, agricultural, industrial, infrastructural [1].
However, there is a characteristic that, even if in several forms and ways, seems to be common to all conditions of landscape fragmentation: the production of residual spaces along the linear infrastructures, without a project, "white" [2] not used, or waiting for a use that over time takes place only in an improper, informal, spontaneous and unplanned way. From time to time, these spaces become more or less permanent deposits or landfills, areas available for informal use, hidden places where receptacle of rubbish, or frequented by the less integrated fringes of society, who find a home there and reorganize them for their own use [3].
Those spaces are formed due to an intrinsic factor, consequent to the construction or the presence of the infrastructure – as for example in the case of areas used as construction sites or materials storages, necessary for the physical construction of the road, but also in the case of the areas enclosed in the junctions, or of areas that, consequently to a cut, take a shape or a dimension not useful to restore the previous function – or as a product of the presence of the infrastructure in a settled area, which determines a repelling, unattractive, worthless and completely unusable area along its edges.
We can consider the unused areas along the roads together with those elements produced by the transformation of the city, which take on the character of waste, theoretically comparable to the waste of an industrial production or, in more properly geometric terms, to the swarf necessary for the realization of a finished product. In terms of space, they are linked to contemporary literature through expressions such as *drosscape* [4], *junkspace* [5], *délaisseé* [6] or *terrain vague* [7], more in general, to the studies carried out in between the 19$^{th}$ and 20$^{th}$ centuries on the contemporary landscape and on the abandonment phenomena consequent to the changing of the space conditions, and which re-consider peaches or fragments of landscape without function or project as a potential for a new transformation of the landscape.
While the theoretical terms reflecting the physiological phenomenon of the disposal of spaces in fragments consequent to the infrastructural production are clear, it seems to be necessary today, on the one hand, a specification of the phenomenon also through a classification of its characters and its potentialities, and on the other, a more constant design experimentation both in terms of guidelines and in terms of application on paradigmatic case studies.
The characteristics of the residual spaces along the infrastructures are different also according to the settlement conditions of the landscapes crossed by the infrastructures. The most compact city, for example, produces interstitial places that can be traced back to the phenomenon of the "in between space" [8], that are spaces crushed between elements close each other, which offer a potential because they are empty spaces central to the settlements, with clear opportunities of re-use and re-immissioning in the life cycle of the city.
We can find examples between the "Urban soils in the shadow of viaducts" [9], spaces covered by the decks of the urban viaducts, subject in the recent years of an extensive reflection, a design experimentation. The project to reuse and intensify the spaces below the Genoa Viaduct, by M. Solà Morales (1998), but also the most recent project to convert the space below the viaduct along the A8 to Koog An Der Zaan, in the Netherlands (NL Architects, 2003-2008), clearly show the interest to exploit the potential of a physiological phenomenon of the urban infrastructure.
However, it is in the most recent city, characterized by a rarefaction of the landscape elements and a more informal structure, that the "fragments of space along the roads" [10] take on less recognizable and not well-defined characters. Where the structure of the city becomes more undefined, where the elements that compose the landscape are mixed in a seemingly random way, not identifiable with the traditional classifications of the historical city, where we still have difficult to define the shape of the city, and we try to describe the spaces through new analytical tools, also the potential of the empty spaces along the roads seems more difficult to exploit.
In the most compact urban contexts, the possibility for the city to expand itself within each interstitial space sometimes represent a forced need, that require to rethink the abandoned areas, the marginal bands of roads, the spaces below bridges and viaducts. But along the contemporary city, as we have tried to describe it, this urgency appears in practice weaker, the need less pressing, less instinctive. Along the roads there are a multitude of spaces without not only a defined function, strategic or even only stable and consistent with the adjacent activities, but, following a logic more related to the project, completely devoid of a role in the arrangement of elements, or spaces, of the settlements and marginal parts of the city. Nevertheless, in the contemporary city more than in any other place, there is a need to a founding structure, to a supporting texture, to lines and spaces of connection between heterogeneous elements, which are often completely devoid of them.
The infrastructures that cross the contemporary city are often used as reassuring limits, able to define closed areas, which give the back to the unconsolidated urban “magma” [11], and which refer to themselves with an organization often invented *ex novo,* that often appears the way to take the distances from the seemingly incomprehensible landscape that surrounds us.

In this sense, it is clear that the linear infrastructure should be considered no longer the cause of an inexorable fragmentation of the landscape: the problem is rather the lack of a comprehensive vision of the structure of the contemporary city, and the role of all the elements that define it.
Today – following the sensitivity of land management policies towards the problem of land consumption – we could too easily link the theme of fragments of space along the roads to the need to exploit the resources in terms quantity of areas compromised, in order to preserve the agricultural fields or the wooded areas. However, this would be a too straightforward and immediate simplification. Certainly, the areas along the roads are compromised, often subtracted from the sedentary use because they are too close to the flow of traffic, characterized by noise and air pollution, and therefore suitable to support photovoltaic fields, lamination basins, to be re-natured. Some areas more available can accommodate more defined functions, reducing the land consumption in more open and intact areas, such as agriculture, today at risk of consumption and fragmentation. However, the spaces along the infrastructure are, in the logic we propose here, a resource according to a different order: not so much a quantity of space available to the pressures of expansion of the city interior spaces (as happens more naturally in the compact city), as an intrinsic character of linear infrastructure, which makes them more available to be incorporated into the continuous system of a city that does not evolve by parts but through the mutual interaction between elements also very different from each other.
The infrastructure – in the etymological sense of the term, as an element that takes place among the things and becomes complementary to them –, endowed with spaces placed close to its physical body, becomes available for the non-secondary function of meeting place, rather than the element that define the subdivision or separation of single parts of the city; of foundational part, rather than of perimeter; of space rather than line.
In the B-Road research, which we will illustrate below, this principle takes shape in a first structured experimentation.

## 2. B-Road research project and the case study of eastern Naples [R.S.]

The urban design research project named B-Road, which stands for Below the Road [12], focuses on the upcycling of infrastructural residual spaces, matching the themes of urban mining and circular economy. It aims to define intervention methodologies and produce pilot scenarios of residual spaces of urban infrastructures, converting them from waste to resource for the community. Generally, these spaces coincide with the *below* of infrastructure, but they might be also interstitial or lateral spaces. The study area of the research is the eastern part of Naples, an important logistic hub, an industrial hub in the process of decommissioning, and an expansion area for the city, fragmented by strategic infrastructural lines. It is a perfect synthesis of the post-industrial city that seeks redemption among the heavy legacies left by a linear urban consumption model and the opportunities, but also the difficulties, imposed by the current green awareness, inspired by sustainable living models.
From a geographical point of view, the area is a plain located between the hills of Naples, to the west, and the volcanic cone of Somma-Vesuvius, to the east. Originally, it was swampy and crossed by various watercourses in a northeast-southwest direction, which influenced the layout of the first road systems, agricultural lots, canals, and urban fabrics. Later, the expansion of the city towards the east entailed the construction of a series of facilities placed on the edge of the consolidated city, such as the slaughterhouse, the prison, and the cemetery, whose planimetric configuration still followed the morphology of the places [13]. The construction of new neighbourhoods, from the Risanamento onwards, the industrialization of the area, with the construction of refineries and tanks for the storage of hydrocarbons, have introduced a design of the territory, with orthogonal meshes, which has largely cancelled the previous one, dictated from the hydrographic network and orography. Important logistics poles are in the study area: the airport, to the north, the port, to the south, several terminals for ship containers, the Naples Central railway station, to the west, near which the Centro Direzionale (the business district designed by Kenzo Tange) stands and from which two high-speed train lines branch off. Such an accumulation of logistics and service poles has determined the overlapping of different urban visions and infrastructural layers, such as the pipeline, the viaducts SS162 dir, which connects the city centre with the outskirts; the so-called Tangenziale, which is an orbital road, which passes through the city, sometimes piercing the hills, sometimes passing over the urban fabric; the railways for the transportation of people and freight. Each of the infrastructures listed above follows its logic, has its junctions, its supports, and its fences, often without any evident coordination with the others and, above all, without any attention to the urban space they generate. This accumulation of urban objects has led to the high fragmentation of the territory, particularly evident in the phenomena of circumscription and unification, between the infrastructural lines, of heterogeneous areas and the cutting of pre-existing communication routes [14]. This situation has led to the paradox whereby, despite the significant presence of connecting infrastructures, the pieces of territory bordered by the infrastructural lines are badly connected.

Moreover, the overlapping infrastructural strips represent optical barriers that determine the loss of urban and landscape references, accentuating the phenomena of fragmentation and isolation. Finally, the perimeter of the spaces under the viaducts prohibits access to the public but does not prevent illegal occupation, illegal waste disposal, degradation, and abandonment.
The B-Road Research project has mapped many “urban events” classifiable as B-Road spaces within the study area, roughly coinciding with the industrial district (Fig.1). They often have the following characteristics:
- they are delimited by the projection on the ground of the limits of the infrastructure that runs above them, but they do not have a particular function related to it;
- the spaces bounded by the infrastructures follow the geometries (routes and buildings) of the urban surroundings, but their urban transformation process is "blocked" by the constraints imposed as a result of the perimeter of the infrastructural lines.
- residual spaces are left without any kind of accommodation or destination. At most, they are fenced not to define a property, but to prohibit access to a place, which, in this way, is implicitly defined as "external" to urban use.

On the basis of the above considerations, the potentially recoverable surfaces to be returned to the community were estimated, as shown in figure 1, for a total of approximately 25 hectares. They exclusively concern the spaces under the infrastructures or their interstitial spaces, located, in particular, along the SS162 dir and between via Argine and the A3 motorway. However, it is reasonable to expect a greater benefit by means of architectural and urban design. Indeed, the urban design does not consider the objects of study in their stiff physical perimeter and bailiwick, but in connection with urban elements that can be related in some ways. Moreover, the architectural design, whose focus is the quality of the space it produces, searches for spatial and disciplinary connections, defines the extension of the intervention area, intercepts other specialist knowledge and questions them, systematises multiple instances, classifies spaces, defines possible methods of intervention, proposes visions, recognizes spatial qualities beyond the forms of prejudice typically associated with words in dichotomous opposition (for example concrete/green, old/new). In this way, the architectural and urban design could give a valid contribution in contrasting the phenomena of fragmentation of the territory.

**Fig. 1:** Map of recorded B-Road spaces and potentially recoverable areas (in red).

### 2.1. Classification of B-Road spaces

Since the aim of the research consists in the upcycling of the residual spaces of the infrastructure through the architectural-urban project, the B-Road spaces identified have been classified, taking into account, above all, their architectural characteristics (materials, lights, colors, shapes, etc.). Moreover, the critical aspects of B-Road spaces, often more or less summarily connected to the categories in the dichotomous opposition listed above, which are confused with ethical principles (concrete-bad/green-good), are not their intrinsic properties. They depend on the managing, or the contingent events, such as political, urban, and historical ones, or on a perceptive question, for which there is a tendency to associate the residual space of the infrastructures with the "technical room" of the inhabited space, where the lack of architectural care is implicitly admitted and common use is prohibited. Actually, the "back" of the infrastructures, such as the ceiling of viaducts, contributes to the configuration of public or potentially public spaces, such as roads, sidewalks, and green areas. So, the classification of B-Road

spaces made during the research has been articulated according to characters capable of expressing their architectural quality, but not necessarily in quantitative terms. Therefore, the classification criteria concern those parameters that are significant for the spatial perception of a hypothetical user moving through the B-Road space (Fig. 2).

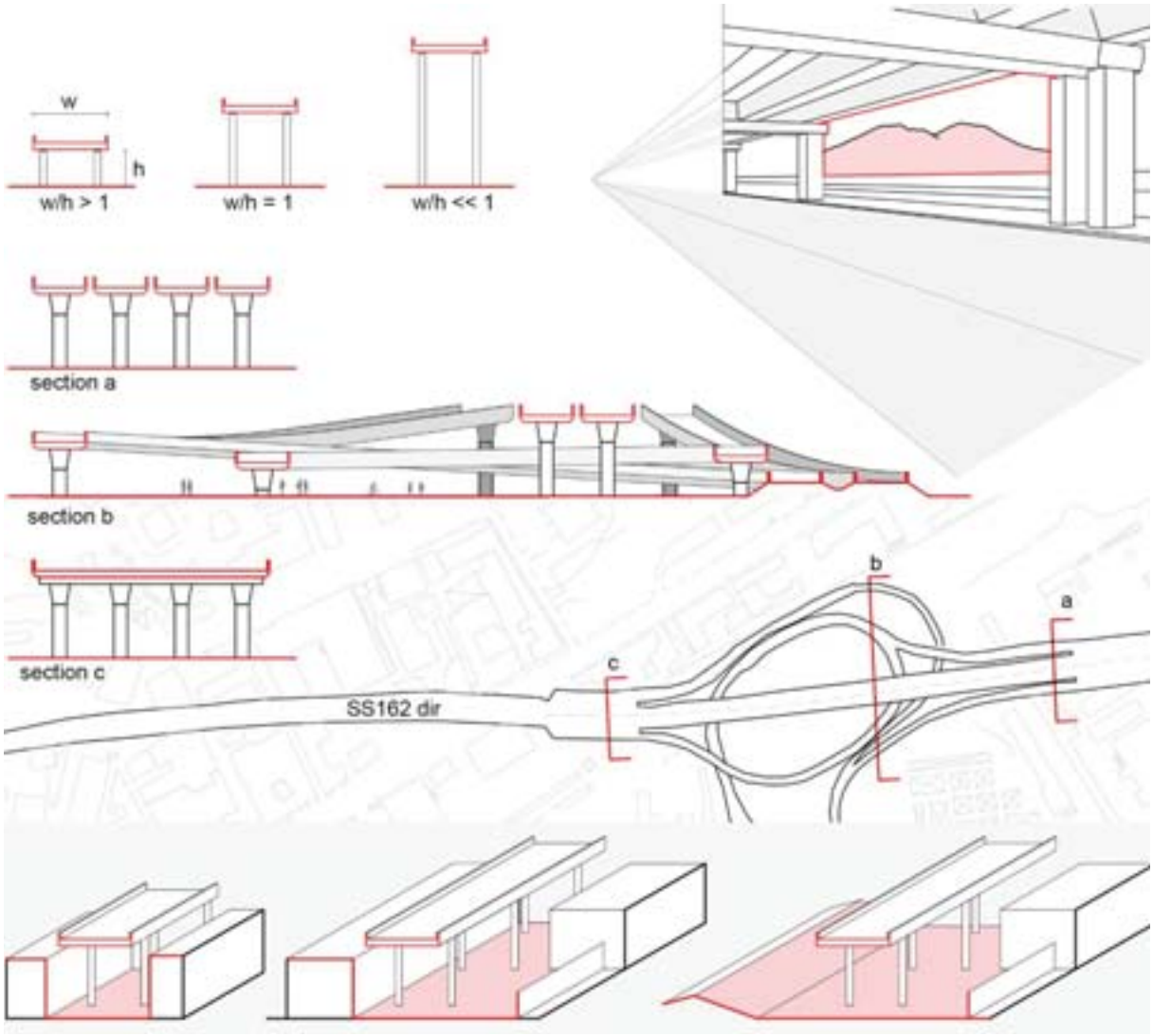


**Fig. 2:** Characteristics of B-Road spaces

The first one is the relationship between the width of the infrastructure and the distance of its ceiling from the ground. Indeed, the perception of a covered space decreases as the distance from the ground of the viaduct increases and as the width of the road section decreases. This relationship also affects the underlying urban fabric: the greater the distance between the viaduct and the underlying building, the less its influence will be on the urban fabric. When the distances between the infrastructure and the underlying city are very small and the infrastructure strips have a considerable width (the width/height ratio is very low), the architectural theme of the double ground becomes of particular interest. It may be the case of the juxtaposition of several road sections which overlap the underlying city shaping up a raised urban surface. The second parameter is the position of optical barriers that can configure the limits of the B-Road space. Indeed, it does not correspond with a plot of land or a specific property. The edge of the B-Road is not uniquely established: it can coincide with the façades of buildings, fences, or ground and landscape elements. Therefore, in the case of the B-Road space, an intervention area does not exist, but there is a space between urban, ground, and landscape objects with a variable width: an in-between space. The third parameter is the recognisability of B-Road spaces as points of landscape interest (landscape or urbanscape frames). In fact, many infrastructures configure optically a frame on the landscape or a base of an urban or natural view in the background. In addition, means a photographic reconnaissance has highlighted the architectural value of some details, such as the rhythm given by the repetition of elements, the cuts of light introduced by the slots in the intrados of the infrastructural strips, alignments, and paths (Fig.1, right side).

## 2.2. Urban design strategies for B-Road spaces

On the basis of the analysis of the area and the classification of B-Road spaces, the design strategies of intervention that respond to the mitigation of territorial fragmentation have been chosen among the unlimited possibilities of intervention:


**Fig. 3:** Masterplan for the case of via Gianturco.

1) recovering, where possible, the urban layouts highlighted through the morphological analysis of the territory. This strategy is, in a certain sense, philological, because it aims at the reconstruction of the

original layout of the territory through the study and interpretation of the traces of roads and urban fabrics;
2) building physical or perceptive connections between urban or landscape elements by exploiting random alignments and creating new relationships;
3) borrowing the formal logic from B-Road spaces for new architectural projects that aim to recondition a place.

Some examples of the application of the strategies listed above are given by two design proposals – hypothesized in the context of the B-Road research and still in progress – relating to two infrastructural nodes selected within the study area for their particular complexity. The first one is the area near the junction “Centro Direzionale” of the SS162 dir (Fig. 3). The limits of the area are the raised slab of the Centro Direzionale, to the west side, from which the skyscrapers of the business district rise, the Rione Luzzatti, to the east, via Poggioreale, to the north side, and the raised railway, to the south. Abandoned buildings and degraded green plots insist on this area, while via Gianturco, crossing it at grade from north to south, cuts it into two strongly disconnected parts. The second scenario concerns the crossroads between the important communication axes of via Ferrante Imparato (with north-south direction), via Argine, and via Galileo Ferraris, with east-west direction (Fig.4). Near this intersection, the A3 motorway, which runs a higher level, is flanked by a road linking via Argine and via Ferrante Imparato, which also acts as a motorway exit, while at ground level it is flanked by a pipeline. At the crossroads, the aforementioned link road forks into two ramps, one which runs parallel to the motorway and then turns back onto via Ferrante Imparato, the other which continues onto via Galileo Ferraris. Furthermore, at this point, the mobility plan of Naples provides the passage of a Bus Rapid Transit (BRT) and the building of a bus stop. The BRT should connect the eastern suburbs with the city centre travelling in an exclusive lane, a condition impossible in the current asset of the roads.

In the first case, the masterplan includes five main actions (Fig. 3):
- a new north-south viaduct that stands at the height of the slab of the Centro Direzionale. This action would make via Gianturco part of local mobility, because a large part of the users of the Centro Direzionale would be moved to the new viaduct;
- the creation of an urban park, linking the Luzzatti neighbourhood with Centro Direzionale, equipped with pedestrian paths oriented according to the directions of the ancient roads of the area. This action is made possible by the relocation of vehicular traffic at the higher level;
- the arrangement of the Caramanico market according to the directions of the original hydrographic system. This action, together with the previous one, would recover visual, spatial, and functional relationships with parts of the city that currently do not communicate at all with each other. An example is given by the Caramanico market and the facing former slaughterhouse;
- a series of long buildings for offices that will replace the abandoned ones currently laying between Centro Direzionale and via Gianturco;
- raised paths connecting the plate of Centro Direzionale with the park at the lower level. These routes, with a broken course, pointing towards the local landmarks make the slab of Centro Direzionale overlook the surrounding landscape from its east-west axes, recovering some sights on the landscape as the original project idea.

In the case of San Giovanni a Teduccio (Fig. 4), the theme of the design proposal is the double ground, due to the motorway and its numerous junctions, which make a plane overlapped on the intricate intersection below. A large plate stands at the higher level, with a compact edge, towards the south, which includes the motorway junctions, while it frays in several broken line stripes as it penetrates between the buildings, which the Urban Plan of Naples provides for leaving as evidence of industrial archaeology. The stripes, whose direction follows the traces of the original hydrographical system, connect the higher level with the lower level and bypass the very busy roads below. In correspondence with the compact edge, the project provides for the station of BRT, which would travel by exploiting a lane of the motorway junction. Finally, from the center of the plate, a tower for offices rises. It is made of steel and glass and provides for the reuse of ship containers slotted in the frame of steel. This design scenario would allow to:
- connect different territorial fragments and ensure the safety of pedestrian crossings in a particularly complex intersection;
- make travel the BRT in its own lane;
- recover the relationships with the territory by shifting the point of view of the users, from the lower level to the higher level, beyond the barriers of the infrastructural lines;
- mark the end of the important axis via Argine, a potential commercial axis for the future development of the area;
- rationalise the trajectories of vehicles in the complex intersection below.

The three strategies listed above recur in both design proposals to varying degrees and match each other. Strategy number 3 deserves particular attention because it is based on the counterintuitive awareness of the architectural value of the elements and materials that compose the infrastructures. Slots, concrete pillars and slabs become elements for composing new buildings and spaces matching the provisions of transformation of the urban project for the enhancement of the eastern suburb of Naples. In addition, the theme of the double ground could solve the problems of connecting the areas fragmented by infrastructure and re-establishing the relationships with the landmarks.


**Fig. 4:** Masterplan for the case of San Giovanni a Teduccio.

In conclusion, the urban design strategies elaborated for the case study of Naples could represent a solution for optimizing the exploitation of the urban space; contributing to stem the soil sealing in the case of the necessity of new buildings by exploiting the reserve of space represented by the residual

spaces of infrastructures; connecting the different levels of the city when it develops on overlapping plans; creating a comfortable urban space. They also give us a new point of view on the residual spaces of infrastructure. They are no longer intended as separations, barriers, or boundaries according to which to delimit areas on which to place projects. Through architectural and urban design, they become an opportunity to connect, in a transverse direction with respect to their course, parts of the city that were previously divided.

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# Preserve the Human

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**Abstract**
We often hear talk of ecological beauty, of raising the value chain and of conscious choices, we find ourselves living in a complex, articulated, altered world in which our activities unfold by untangling themselves between countless ambiguities and dichotomies.
In this constant dialogue between man and nature, knowledge is shared and transferred through a design faculty that is not additional but multiplicative, outlining a suspended contemporary living.
Man comes to the perception of himself, he comes to understand his own identity in the face of something that transcends him, through an experience of communication with the transcendence of something that exceeds and limits him at the same time. The experience of wonder interrupts the regularity of nature and puts us in relationship with an aspect of reality.
The sustainable turning point in the design sector with the New European Bauhaus indicates new project perspectives based on empathy, cohesion and a new recognition of meaning for contemporary aesthetics. Thinking then of the Bauhaus as a historical movement and of its founders such as Kandinsky in his publication "the spiritual in art" speaks of a new advent of art, defined by Elena Pontiggia as a secular prophet who announces a new art. A new concept of total art makes room that hurls against materialism and is deeply connected to an inner dimension, perhaps we can say to an inner need, in fact we find in the first production of the Bauhaus a strong connection with the artisan production.
Can we say that we have reached a moment of necessity, a point in which we can make choices that lead us to an "eighth day"?

**Keywords:** Human, dichotomy, empathy

## 1. Ecological beauty

If on the one hand it is true that "Man loves only what he knows" on the other it is inevitable to accept that today man cannot admit that he knows reality, in the sense that, including his own limits and going beyond the blind trust in mechanism, he realized that the present itself is poised between a multitude of possible choices that intertwine in a labyrinth, without being able to envisage an exit.
In defining and disseminating new interpretations, one cannot ignore a new beauty defined in sustainable terms that emerges from development needs based on responsible daily choices, tolerable by the natural context in which human beings live.
Enzo Mari stated that the best designer he had ever known is the simple farmer who plants a chestnut wood, knowing that it cannot be for himself but for his grandchildren. The territory itself, therefore, is designed for man to rediscover that simplicity that Bruno Munari called "resolved complexity".
In this regard, the thought of George Simmel is more current than ever. Simmel wrote in 1913:

the unity that the landscape realizes as such and the state of mind that originates from the landscape and with which we perceive it are only the successive decomposition of a single spiritual act. [...] by what right is the Stimmung, which is exclusively a human psychic process, a property of the landscape, that is, of a complex of things that are part of inanimate nature? This right would be illusory if
really the landscape consisted only of a juxtaposition of trees and hills, streams and stones. But the landscape is already a spiritual form, you cannot touch it from the outside or walk through it, it lives only in the grace of the unifying force of the soul, as an interweaving of the given with our creativity.
<<In the form of a "symbolic landscape", that is, as a way of seeing produced by the tension between subject and object, between the personal sphere and the social sphere, between cultural data and the natural field, it sets out to produce new fashions. Whose ingenuity rests precisely in their alleged audacity, which stops at the dematerialization of the concept without giving any account of the procedure that led from its concretion to its codification.From a set of existing things, and therefore tangible and countable, one now begins to look at the landscape ( we actually look again, and we will see shortly) as a universe of subsisting things, therefore that can neither be touched nor seen: again, but in an unreflected way, it no longer assumes the aspect of a complex of objects but the nature of a way of seeing.And the defect of this halved return to the origin consists in the fact that it continues to refer, despite everything, to a metaphysics of the "certainty of representing", to use Heidegger's words : starting from which, albeit unconsciously, the investigation limits itself to "bringing the mutable to stability", without however "allowing movement to be movement", as Heidegger instead - on the contrary - prescribed. But it is precisely in this movement, it is intended to argue here, that the essence of the landscape resides>>.
The possibility of a fusion between human beings and nature therefore lies in the spiritual synthesis of the act of mirroring between subject and object, where one echoes in the other in the definition of a new contemporary aesthetic.

**2. Life without object**

In 1972 the five members of Superstudio, Cristiano Toraldo di Francia, Gian Piero Frassinelli, Alessandro Magris, Roberto Magris and Adolfo Natalini participate in the largest exhibition in history built around Italian design and architecture at the MoMA in New York, Italy: The New Domestic Landscape with an environment and a short (9′28″) titled Supersurface. An Alternative Model for Life on the Earth. The film, produced by Marchi Produzioni Cinetelevisive with the sponsorship of Anic, was intended by the authors to form the first piece of a larger mosaic called the Fundamental Acts whose composition involved five films: Life, Education, Ceremony, Love, Death.
Of the five planned films, between 1971 and 1973, only Vita (that is, the previous Supersurface) and Ceremony were made; all the writings, drawings, storytelling, photos were published in Casabella in 1972 in various numbers (367-368-369-372).


**Fig. 1:** Casabella XXVI 1972 Luglio 367

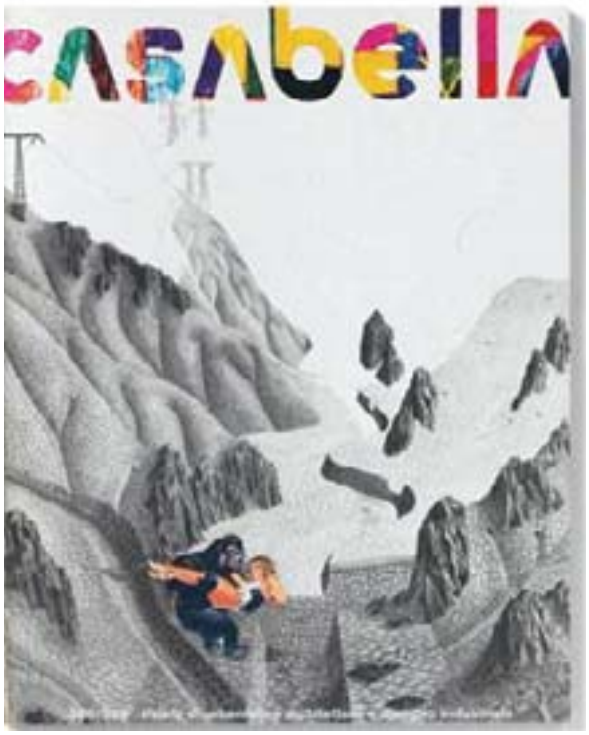


**Fig.** 2**:** Casabella XXVI 1972 Agosto/Settembre 368-369

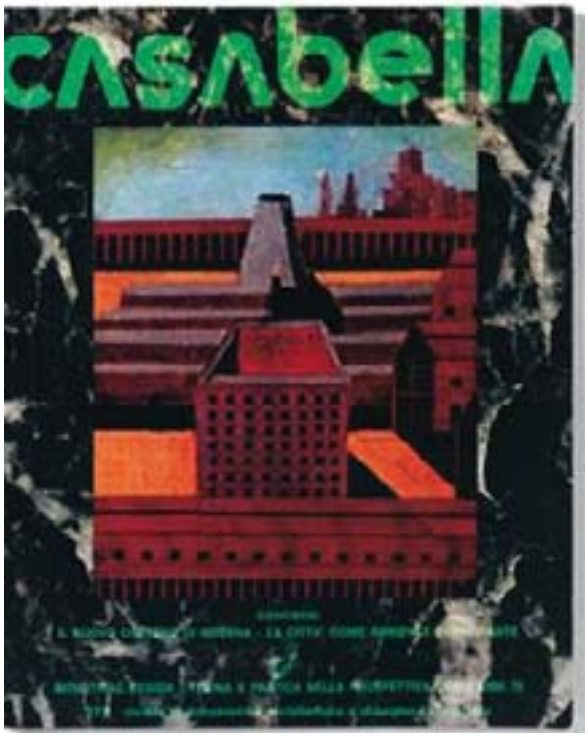


**Fig**. 3**:** Casabella XXVI 1972 Dicembre 372

In a moral fable by Superstudio he reads as follows: "So beyond the convulsions of superproduction a state of calm can arise in which a world without products and waste can be configured, an area in which the mind is energy and raw material and is also the product final, the only intangible object of consumption. The design of a region free from design pollution is very similar to a project of paradise on earth…" . It can be suspected that these explorations constitute the point of no return in the group's research, the maximum degree of conceivable reduction: disappearance of three-dimensional infrastructures, disappearance of architecture, disappearance of tools, project as a perfect cast of life itself. Along the lines of the famous Marxian passage – Jeder nach seinen Fähigkeiten, jedem nach seinen Bedürfnissen! – the destruction of the world of artifacts – destruction of the commodity as a «universal form» of the social configuration – is a process which implies the liberation from induced needs and hints at the destruction of work tout court. A photomontage, Journey from A to B, describes these mutual dependencies well: on a vast squared field a barefoot boy and girl hold hands as they proceed in the backlight towards the background; few people nearby, on the left the steep sides of cliffs evaporate in the mist of the horizon: "There will no longer be a need for cities or castles. There will be no more purpose than streets or squares. Each point will be the same as the other […] chosen at random on the map, we could say here will be my home for three days, two months or ten years…".
The publication Superstudio: Life without Objects brings together around 200 of the group's most important images, collages, storyboards and critical writings.
<<White monuments that cross entire landscapes and cities, vast reticular plains that extend onto endless beaches populated by wandering hippies: these are some of the most evocative images that have consolidated their reputation as avant-garde architects.>>
The assault on modernism and alternative visions are the basis of their studies, the resulting reflection inevitably pervades the contemporary world in which we live.

**3. Identity**
In 1919 the Austrian Raul Hausmann, a teacher at the Bauhaus school and later an exponent of the Dadaist current, began to denounce the dangers of excessive faith in progress where he witnesses the use of technology for weapons of mass destruction.

Emblematic is his work “Mechanical head. The spirit of our age, 1919” a wooden hairdresser's mannequin on which he mounted various components such as a ruler, clock mechanisms, the case of a printed cylinder, a tailor's measuring tape and a military telescope glass; the intent is to represent a human being who, overwhelmed by progress, has lost his humanity as his personality has been dominated by technology and machines.

**Fig. 4**: *Mechanischer Kopf "Der Geist unserer Zeit" (Testa meccanica "Lo spirito dei nostri tempi")* POSITIVO, 1919/01/01 - 1920/12/31

Sofia is a human-like robot created by a Hong Kong company, Hanson Robotics, in 2015.
The most famous humanoid robot in the world is called Sophia and was made by Hanson Robotics, a company based in Hong Kong. It is equipped with an advanced form of artificial intelligence that allows it to behave in a very realistic way. This, combined with a captivating physical presence (for some, her facial features would somewhat resemble those of the actress Audrey Hepburn), have made her a media phenomenon of considerable importance. Compared to previous models, Sofia is able to reproduce 62 human facial expressions and has been used in various interviews, Sophia is the robot of records: the first and only robot-citizen, however, obtained citizenship of a state in October 2017, Saudi Arabia; first robot-artist, for having created his own self-portrait in March 2021, sold at auction in April of the same year for $688,888.

**Fig. 5:** Robot Sofia, web foto

A humanoid robot is a machine equipped with artificial intelligence that has a human appearance. Humanoid robotics tries to reproduce as faithfully as possible, in some cases even improving them, the cognitive and physical activities of the human being. To the point of giving rise to the doubt, which for some is a fear, for others a chimera, that in the future robots will be practically indistinguishable from humans, as already widely predicted in cinematography.
The Sophia robot is able to answer the questions asked, for example by journalists during the numerous television broadcasts in which she appeared; moreover, he can remember previous conversations and is able to learn new things from each one.
It also learns from the internet, to which its AI is connected. In short, Sophia is able to "talk" to humans, has her own sense of humor and can assume 62 facial expressions; in practice, she manages to express emotions.
Sophia's "brain", or rather the electronics that make her "intelligent", is located in her head and is visible thanks to a transparent cap placed in the back.
How does the humanoid robot Sophia work?
Sophia acts according to logical processes based on artificial intelligence algorithms, capable of evolving over time through learning.
To teach Sophia to make human-like expressions, she was shown video clips from movies and the Internet. Sophia has publicly demonstrated that she can reproduce the sound of famous films by "mimicking" the original facial expressions of the actors.
Sophia also knows how to sing: in fact, she took part in a music festival in Hong Kong, "borrowing" a voice and interpreting it with original expressions.

**Conclusions**
In a hypothesis of definition of a new contemporary aesthetic we cannot fail to start from the crisis, from the uncertainty, from the condemnation of the empty aesthetics. The relationship with reality, with the world we inhabit, can only develop in terms of inclusiveness. The continuous changes solicit a turning point in a reflection on an inner dimension that relates knowledge with the territories, an element of value for Italy, in a dimension of relationship, exchange and experience.
If on the one hand, in a complex, articulated, altered world, new models of development of society are manifesting themselves, the "Human Center" is the value and meaning of the human that is called into question. Faced with the tradition-innovation dichotomy, and the ambiguity of human activity, craftsmanship itself becomes a participatory model that arises from the bottom of a territory.
Kandinski in his publication The spiritual in art aimed above all to reawaken the indispensable ability in the future to grasp in material things, in abstract things, the spiritual element that makes infinite experiences possible. What the artist represents is something that goes beyond the artist himself, it's like being immersed in a mystery that transcends him, so art says more than it is in the explicit intentionality of the artist himself, here because in some ways the artist is like a kind of prophet, as a prophet he is forced to say things he would do without saying, things that are uncomfortable but he must say them out of an inner strength, an inner necessity, not by chance Kandinsky it speaks of the inner necessity that sustains the work of art. The artist is free, he is totally free but in his freedom follows an inner need that guides the work of art, which supports the artistic experience and guides the work of art in its realization. Art always goes beyond. The meaning, the communicative capacity, the eloquence, the generating capacity of the work is something that infinitely surpasses even the intentions of the artist.
In the first production of the Bauhaus we find a strong connection with the artisan production and today the intuition of this value in the design on the value of use, in the ennobling of these ethically oriented paths are necessary for a social responsibility of an ecological beauty and a recognition of meaning for contemporary aesthetics.

**Fig. 6:** Max Peiffer-Watenphul, Tappeto (1921)

**Fig. 7** Gunta Stolzl, Arazzo di lino (1926-27)

**Fig. 8:** Breuer - AfricanChair1921

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# Transform of Traditional Urfa Houses Located in the Historical Area of the City

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## Abstract
The city of Sanliurfa is located on the Syria border,in the southeast of Turkey. The traditional houses of Urfa were built with limestone found in the region, in the late of 18th century. The architecture, buildings and streets were created an urban texture that attracts attention. Due to the shift of the city center to the north and the fact the life in the modern reinforced concrete apartments in the newly urbanized areas was more comfortable, by the time, the traditional houses were abandoned one by one, and the buildings remained empty for many years. In recent years, after the discovery of neolithic settlements such as Göbeklitepe or Karahantepe occurred intense tourist visits, caused demand of hotel accommodation in the city. Today, traditional houses located in the historical area of the city are being restored and re-functionalized as boutique hotels. During this new functionalization, various reinforcements such as wet areas (bath, kitchenet), heating and lighting systems equipment, etc. were inserted to the buildings. These new functions and restorations prevent the building from being demolished and destroy, but they also bring intervention and an additional load to structure. In this study, a discussion was made about the balance of protection and use in cultural heritage by examining local examples in terms.

**Keywords:** Re-functioning, adaptive, re-use, traditional building, renovation, conservation, Şanliurfa

## 1. Introduction
The historical center of a city is the most significant tool that transmits the city's past urban life, history, socialstructure, and cultural accumulation to the present day. The core of historical city centers generally consists of traditional residential structures and historical/traditional commercial centers [1]. Traditional residential structures are buildings that reflect the beliefs, traditions, customs, and lifestyles of the era in which they were constructed, using the materials available in the region and built according to the economic conditions of the time. The reasons why historical structures cannot continue to function are summarized as the loss of their original functions and the functional obsolescence of the structures [2].
Functional change is the creation of new usage opportunities, including interventions that will meet new userneeds, by preserving their architectural, aesthetic, social and cultural values, instead of the original functions of historical buildings that cannot be maintained due to different reasons such as environmental factors, economic reasons, socio-cultural changes. Reutilization is considered as a necessary practice for transferring historical structures and areas to future generations, ensuring physical and cultural continuity, providing contributions to the economic and cultural environment by re-evaluating the structures and areas, and meeting the needs of the city by beautifying the existing environmental appearance [3].
While bringing contemporary comfort conditions to traditional buildings made with old technology, various equipment such as wet areas (toilets, bathrooms, kitchens), heating and lighting systems are installed in the houses. These new functions and restorations prevent the building from being demolished and disappearing, but also bring intervention and additional load to the structure. With these additions, in somecases, the original architectural features of the buildings can be significantly

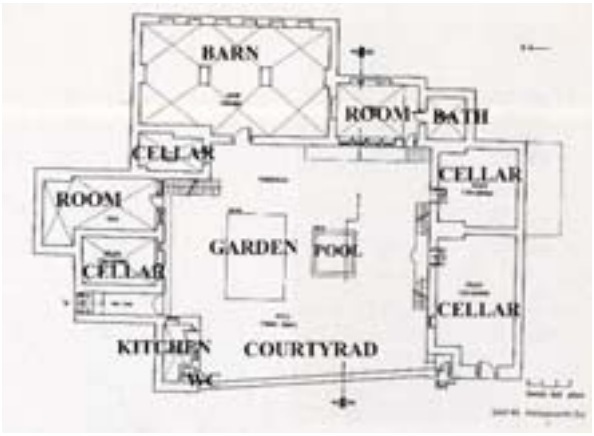
altered. The quality and quantity of the interventions can cause the historical documentation value of the buildings to be lost, and as a result, traditional buildings may not be able to obtain legal protection status as cultural assets, or may be excluded from this status. Therefore, the inability to preserve the originality of traditional residential structures has become a significant problem today [4].
The work area is the city of Sanliurfa located in the southeast of Turkey and adjacent to Syria in the south. With the discovery of settlements dating back to 10,000 BC such as Göbeklitepe and Karahantepe by archaeologists in recentyears, it has been seen that the region's history extends back to the Neolithic period. Sanliurfa had been under the rule of various empires such as Ebla, Akkad, Babylon, Hittites, Hurri, Mitanni, Arameans, Assyrians, Persians, Macedonians, and Romans since ancient times, and had witnessed invasions by the Sassanids, Goths, and Mongols. During the Byzantine period, the city was rebuilt and constantly changed hands between the Seljuks, the Crusaders, and other Muslim states. Şanlıurfa has attracted attention with its original historical urban texture that has been preserved until today. The traditional buildings located in the historic center of the city were constructed in the late 18th century using the technique of stone masonry with limestone, which was abundant in the region. The streets, shaped in accordance with the architectural texture and climate conditions, have created a remarkable and unique urban texture.
As a result of the comfort of living in modern concrete buildings constructed with evolving technology in the north of the historic city center, traditional houses in the historic city center had been gradually abandoned one by one. The traditional houses remained empty for many years. After the Syrian War in 2013, these historic buildings became living spaces for Syrian immigrants. In recent years, the intense tourist visits due to the discovery of neolithic settlements such as Göbeklitepe and Karahan Tepe have led to an increase in demand for hotel accommodation in the city. As a result of this demand, traditional houses located in the historical area of the city have been restored and started to be re-functionalized as boutique hotel.
In this study, 6 traditional residential buildings that have been restored using the method of re-functionalization within the framework of the Sanliurfa Conservation Purposed Zoning Plan, located in the Sanliurfa Urban Conservation Area, have been examined.The pre- and post-restoration conditions of the buildings were examined comparatively through project plans and on-site observation, the originality and changes before and after the restoration were analyzed comparatively. Based on the data provided by the comparison method, the changes made to the houses in terms of removed and added elements have been identified, and the authenticity losses and the current comfort conditions provided have been analyzed. In conclusion, this study aimed to examine the balance between cultural heritage preservation and practical needs in the context of local examples.

## 2. Architectural Features of Traditional Urfa Houses

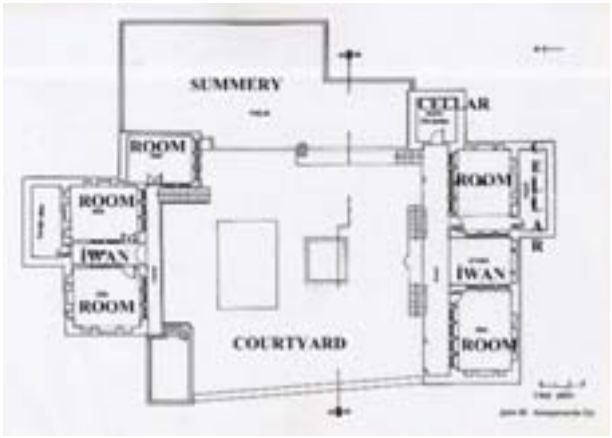
The formation of settlements within the historic urban texture of Sanliurfa has been influenced not only by beliefs, traditions, customs, and lifestyle, but also by climate. Streets were left with a maximum width of 3-4 meters to protect from the sun, and the courtyard and garden walls facing the street were kept high to provide shade to the street at all times of the day [5]. Urfa houses are settled on a flat topography, and in terms of architectural settlement, a complex and intertwined settlement with adjacent structures can be seen. The traditional houses and streets of Urfa are mostly made of locally sourced limestone. It is a lightyellow, creamy, beigecoloredlimestonefound in the vicinity of Urfa which is used in traditional Urfa Houses. This stone, which is soft and easy to shape as it allows the ornaments and decorations of the traditional Urfa architecture to come out from the quarry, then hardens as it is in contact with the air, increases strength and whitens. The historiccity of Urfa has a texture created by natural stone materials [6].
Traditional Urfa houses were shared by several generations living together (extendedfamily). The houses were generally planned as 1.5-2 stories and functionality was given priority. In some houses, spaces planned half a floor below or above the ground level can be seen. In these houses, winter rooms and the iwan were located half a floor above the courtyard. The cellars were usually planned half a floor below the courtyard to keep the food cool [7, 8].

### 2.1 FunctionalUnitsthat Form Traditional Urfa Houses

The functional units that shape traditional Urfa houses are the courtyard, iwan, rooms, and service areas such as "tandırlık" (kitchen), "develik" (stable), "zerzembe" (cellar), and "hela" (toilet) (Fig. 1).




**a.**Groundfloor plan




**b.** 1st floor plan

**Fig. 1:** Plan of Karacizmeliler House (Hanehan Boutique Hotel) (preparedbased on the plan obtainedfromSKVKK archive)

### 2.1.1 Courtyard:

In the region dominated by hot climate, houses are shaped around a courtyard (Fig. 2). The size and shape of the courtyards, which are actively used for seven to eight months of the year, are defined according to the size and shape of the parcel and houses. The courtyard floor is covered with cut stone with dimensions of 40x50 cm. Usually, there is a small garden in the courtyard where a pool, a well, and various fruit trees such as pomegranate and fig trees grow. In some buildings, there are two separate courtyards, one for women's quarters and one for men's quarters.

a. Before restoration

b. After restoration

**Fig. 2:**One of the courtyards in Vilayetler House Hotels

### 2.1.2 Iwan:

One of the most important factors shaping traditional architecture is the climate. The hot and dry climate of the Urfa region has also shaped the traditional housing form. The iwan is a semi-open space created by the hot climate (Fig. 3). The space, which is rectangular in plan, is usually designed with rooms on both sides. Corner iwans are also found in some buildings. The iwans on the ground floor are built a few steps higher than the courtyard level. In the iwans built on the ground floor, the windows of the rooms on both sides of the iwan can face the iwan and their doors open to the courtyard. On the upper floor, the windows as well as the doors of the iwans can be opened towards the iwan(Fig. 4-c).There are also examples where the doors do not open to the iwans. Upper floor iwans that face the street have windows on the sides and back. The surface of the iwans facing the courtyard is arched (Fig. 9). In addition, there are late period iwan types divided by one or two columns in front of them (Fig. 9-e).

According to their orientation, there are two types of iwans: summer and winter. Winter iwans are oriented towards the south to benefit from sunlight, while summer ones are positioned towards the north. Traditional Urfa houses have one or more iwans. The roofs of the iwans are usually vaulted, but it is also possible to find ones with timber beams, flat ceilings, or lattice ceilings (Fig. 14).

a. Before restoration

b. After restoration

**Fig. 3:** An example from the iwans in Vilayetler Evi Hotels

### 2.1.3 Rooms:

Rooms where activities such as sitting, working, eating, and sleeping take place are built with square or rectangular plans (Fig. 4). At the entrance of the rooms, there is a "gedemeç" area where shoes are taken off, which is 20-25 cm lower than the floor level and 100-110 cm wide, sometimes extending along the room facade and sometimes made as a square.

The niches located on one or several walls of the rooms with high ceilings add liveliness to the room (Fig. 4). Additionally, there are cabinets and built-in nichescalled "camhane" in the rooms (Fig. 4 a-b).

The floors of the rooms are paved with smooth cut stone. The uppercovering of the rooms on the groundfloor is generally a diagonal vault, and there is less use of timber beams as the uppercovering on the groundfloor. On the upperfloors, timber beams are mostly used as the uppercovering. In front of the rooms on the upper floor, a walking platform carried by stone consoles, which is open at the top and provides access to the rooms, has been built (Fig 9a-b-f).

a. Nahrin Otel/ Before restoration

b. Tessera Hotel/ Before restoration

c. Hanehan Boutique Otel/ Before restoration

**Fig. 4:** Examples of rooms found in traditional Urfa houses

### 2.1.4 'Tandırlık' (Kitchen):

The tandırlık (kitchen), located in the harem section of the house, opens directly onto the courtyard. It is the area where daily and seasonal meals are prepared. It contains a stove for cooking food (Fig. 5) and niches for placing food containers. It is covered with a cross-vault. The wall facing the courtyard is constructed with hollow spaces to allow for air circulation.

### 2.1.5 'Zerzembe' (Cellars):

This is the most significant service area of the house. This space, where winter foods are stored, is designed below the ground level to keep it cool (Fig. 6). It is generally rectangular and covered with a crossvault.

### 2.1.6 'Develik' (Stable):

These are the areas where animals are kept and are located near the entrance on the ground floor (Fig. 7). They are generally rectangular in shape and covered with a crossvault.

### 2.1.7 'Hela' (Toilet):

In somehouses, they are located in the courtyard, while in others they are located in the space between the outerdoor and the innerdoor called "doorway". The "hela" that opens to the courtyard can be locatedunder the stairs, in one corner of the courtyard, or on a wall of the courtyard (Fig. 8).

**Fig. 5:**Hasbahan Hotel/ Before restoration

**Fig. 6:** Nahrin Hotel/ Before restoration

**Fig. 7:** Nahrin Hotel/ Before restoration

**Fig. 8:** Hanehan Boutique Otel

## 3. Re-functioning of Traditional Houses

Historical buildings are documents and symbols reflecting the urban and architectural style of the period in which they were built, as well as the economic, social, and cultural accumulations of societies. Each building contains significant cultural values as it embodies the socio-economic, architectural, technical, and cultural way of life of the society in which it was created, forming an significant source of information on cultural values. For the same reasons, each building carries documentary, symbolic, and historical values within itself.

Over time, changes in people's way of life and evolving needs have made it difficult for traditional housing structures to meet the demands of modern living. The majority of traditional housing structures located in historic city centers have lost their users. Traditional structures that have lost their users are doomed to destruction over time due to neglect and abandonment. To prevent the destruction of these structures and ensure their sustainability by reintegrating the minto society, one of the primary practices carried out is the refunctioning of these structures. Re-functionization is a preservation method developed to transfer abandoned or original structures that cannot continue their original function to future generations by enabling their use with a new function. With re-functionization, traditional structures are preserved and reused by giving them functions such as hotels, cafes, restaurants, associations, museums, and so on.

## 4. Examples of Traditional Şanlıurfa Houses in the Historic City Center Re-functioned as Boutique Hotels

In recent years, the increase in the number of tourists has created a need for accommodation in the city of Sanliurfa. In order to utilize the abandoned and deteriorated housing stock in the historical center of the city, with the support policies of the Ministry of Culture, traditional houses in the historical city center have been converted into boutique hotels. According to the data obtained from SKVKBK, the number of structures converted from traditional houses to boutique hotels for this purpose is 47, of which 24 are currently in use. As part of the study, six of these buildings were examined on site: Tessera Hotel, Hanehan Boutique Hotel, Hasbahan Guest House, Nahrin Hotel, Muzepotamia Guest House, and Vilayetler HouseHotel(Fig. 9).


a. Tessera Hotel


b. Hanehan Boutique Otel


c. Hasbahan Guest House


d. Nahrin Hotel


e. MuzepotamiaGuest House


f. Vilayetler House Hotel

**Fig. 9:**The boutique hotels that were examined

## 5. Changes in Traditional Residential Buildings Re-functioned as Boutique Hotels in Sanliurfa

Over time, buildings can lose their original functions or their existing functions can become outdated due to changes in lifestyle and needs. However, the physical characteristics of buildings can have a longer lifespan than their original functions. Therefore, it becomes necessary to give appropriate functions to buildings according to the conditions of their time. Since re-functioned buildings can extend their physical life as tangible symbols of cultural and spiritual values, and the reasons that require their re-functioning are directly related to the current values of the building and can be approached with different typologies. Buildings may need to be renovated due to historical and/or cultural, economic, and environmental reasons [8].

Buildingsconstructed through human knowledge accumulation exist on earth and continue their own lives. Spaces and equipment added to the buildings according to their new functions will become a part of the new life of the building. Thus, the existence of the building will change and continue. During this transformation, new spaces required for the new function will be added to the building. Additionally, technical and technological equipment necessary to provide security and comfort for modern life are also added to the building. The registered historical buildings in Sanliurfa have been refunctioned as boutique hotels, and according to relevant laws and regulations, additions that will not disrupt the plan arrangement, can be dismantled, and will not create changes in the facade are made. However, it has been found that in some cases, excessive additions have been made. These include additions such as wet area additions, technical equipment (electricity, water, ventilation, internet, security cameras, water tank, TV antenna, etc.), closure of open elements such as iwans with wooden frames, covering of the terrace and/orcourtyard, conversion of windows and/or niches into doors, and conversion of niches into windows.

The interventions made on the 6 structures selected and examined in the working area during the re-functionization process are given below.

### 5.1. Interventions Made to the Courtyard Unit

In the transformation of traditional buildings into boutique hotels, it has been observed that in some buildings, the courtyard, which is the main element shaping the residences, is partially or completely covered (Fig. 10). Cameras, modems, and other devices have been added to the courtyards (Fig. 11), and in some buildings, fans have been added to the courtyard facade to provide coolness in the summer (Fig. 12).

**Fig. 10:** Nahrin Hotel

**Fig. 11:** Ve Hotels

**Fig. 12:** Hasbahan Guest House&Boutique Otel

It has been observed that the pool, flowerbed, and well in the courtyards are generally preserved during the conversion of traditional buildings into boutique hotels. However, there are also examples where the flowerbeds in the courtyard have been removed or reduced in size.

### 5.2. Interventions Made to the Iwan Unit

In some buildings where traditional houses are converted into boutique hotels, the iwan, a semi-open space created by hot climate conditions, has been completely enclosed. In some buildings, the back wall of the iwan has been brought forward to create a wet area for the rooms (Fig. ). In the building formerly known as the Karacizmeliler House and now operated as the Hanehan Boutique Hotel, the decorations on the ceiling of the eyvan have not been restored to their original state due to reasons such as a shortage of skilled craftsmen (Fig. 13). In some buildings, a fan has been added to the eyvan ceiling to provide coolness in the summer (Fig. 14).

**Fig. 13:**Before and after restoration

**Fig. 14:** Hanehan Boutique Otel

### 5.3. Interventions in Rooms

During the conversion of traditional buildings into boutique hotels, the biggest change seen in the rooms is the addition of wet areas in line with modern living conditions. Wet areas, which should be made of removable materials, have been added to some rooms in a corner of the room (Fig. 15). In some rooms, they have been extended from the floor to the ceiling on one side of the room (Fig. 16). In some rooms, they have been designed along the facade, but the walls have been raised to a certain height and covered (Fig. 17). In some rooms around the iwan, wet areas have been added by pulling the back wall of the iwan forward (Fig. 18).

a. Ve Hotels

b. Ve Hotels

c. Müzepotamia Guest House

d. Nahrin Hotel

e.Tessera Hotel

f. Hasbahan Guest House& Boutique Otel

**Fig. 15:** Added wet areas in room corners

a. Nahrin Hotel

b. Tessera Hotel

c. Hanehan Boutique Otel

**Fig. 16:** Examples where wet areas are added along the room facade and the walls are raised up to the ceiling

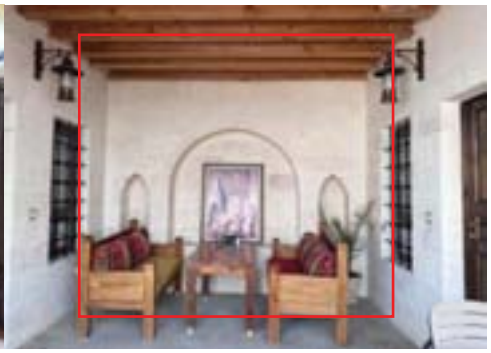
a.Tessera Hotel

b. Tessera Hotel

c.Nahrin Hotel

**Fig. 17:** Examples of wet areas added along the room facade and with walls raised to a certain height include

a. Muzepotamia Guest House



b.The bathroom entrance facing the iwan and the extended iwan in the room /Nahrin Hotel

**Fig. 18:** The wet areas added to the back wall of the iwan

It has beenobservedthat in the examinedexamples, the wetvolumesareadded to conform to currentconditions in terms of materials, usage, etc., but they areincompatiblewith the traditionaltexture (Fig. 19).


a. Ve Hotels


b. Tessera Hotel


c. Nahrin Hotel

**Fig. 19:** Examples from the wet areas added to the rooms

It has been observed that airconditioning units have been added to most of the rooms (Fig. 20). In addition, interventions such as converting niches and/or windows into doors/niches into windows have been detected in the rooms.


a. Hasbahan Guest House &Butik Otel


b. Müzepotamia Guest House


c. Tessera Hotel

**Fig. 20:** Air conditioners added inside the rooms

The examined examples show that the door handles, called "gedemeç" in Turkish, at the entrances of the rooms have generally been preserved.

**5.4. Interventions Made to OtherUnits (Kitchen, Cellar, Stable, Toilet)**

Tandırlık(kitchen) spaces are mostly used as kitchens again(Fig. 21a). There have also been cases where they areused as hotel rooms. The spaces like the cellar, stable with a rectangular plan and usually covered with a cradle vault located half a floor below ground level are used for the boutique hotel's breakfastroom needs.There are also instances where hotels have converted the upperpart of their terrace and/or courtyard into a covered space to serve as a breakfastroom for their guests (Fig. 21b). The original restrooms in the building are generally preserved due to their functional use(Fig. 21c).


a. KaracizmelilerBoutique Otel kitchen before restoration


b. Hasbahan Guest House& Boutique Otel


c.Restroomkeptin the place

**Fig. 21:**Interventions Made to Other Units

## 6. Results and Recommendations

Changing lifestyles, socio-cultural and economic structures over time also lead to changes in the space due to emerging new functional needs.The refunctioning of a valuable building involves the physical preservation and reutilization of the building's physical assets, which have become unusable with their current functions, and their reintroduction to human use. Refunctioning a valuable building not only allows for functional utilization of the building with various adaptations for contemporary use, but also makes the building habitable, preserves its spiritual values, and transfers them to future generations [9].

Especially in cities with high tourism potential, there is a tendency to convert traditional houses into boutique hotels to meet the accommodation needs of tourists. These restored buildings, designed to cater to tourists, also serve as cafes/restaurants for the local community in addition to their function as boutique hotels.

It is known that functional change has been going on since the earliest ages of history. The continuity of maintenance and repair of buildings has ensured their long life. Considering the previous conditions of buildings that have faced destruction and threat of disappearance, the practice of refunctioning has provided the opportunity to preserve the buildings. However, there are also negative aspects of refunctioning. In refunctioning, wet areas, electricity, water and heating systems, as well as infra structure such as internet, phone, airconditioning, etc. are needed to provide today's comfort conditions and meet new functional and spatial needs. In order to achieve these goals, some applications may cause a slight damage to the authenticity of the building. Therefore, it should be considered that every intervention for a functional change may harm the authenticity value of the structure to some extent. In this case, it is essential to observe the balance between conservation and utilization of the structure.

The cultural and socia benefits of the new function cannot be underestimated. In addition, it can be said that reusing a building that is indisuse provides economic benefits when takingin to account its contribution to the national economy, landprices in the city center, the cost of constructing a new building, and energy savings.

In terms of sustainability, reuse also contributes to environmental values. In Sanliurfa, the existing buildingstock wase is valuated instead of constructing new buildings to meet the accommodation needs.

The function selection is crucial in reusing buildings. Before assigning a new function to a historic building, a usage that is in line with the qualities of the building and does not disrupt the original perception of the building should be planned based on appropriate criteria.

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# A future for Kiribati.
# New models for resilient housing settlements

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## Abstract
According to the *Special Report on the Ocean and Cryosphere in a Changing Climate* [1], the sea level has grown at a rate of 3.6 mm per year in the period between 2005 and 2015, increasing faster over the last century due to the melting of ice caps and the thermal expansion of the ocean.
This increases the risks for populations living in coastal areas and in particular for those living in arctic regions and in the atolls, like the islands of Kiribati which, by the middle of the century, could become uninhabitable.
The coastal protection systems and the adaptation processes that use ecosystems and solutions derived from nature (ecosystem-based adaptation), foresee rather long realization times and the population of Kiribati runs the risk of being forced to move elsewhere in a short time.
From these premises, the study conducted at the Department of Architecture of the University of Palermo takes its cue, aimed at identifying new housing models capable of facing imminent emergencies and avoiding the abandonment of the lands of origin.
Sustainable housing solutions, designed in accordance with the local settlement tradition and able to satisfy the needs of a community that, although not having no role in the production of greenhouse gases, it must adapt to the new environmental conditions imposed by industrial development policies from which it is totally foreign.

**Keywords:** climate change, environmental emergency, Kiribati, resilient systems, adaptation.

## 1. Premise
The Republic of Kiribati is an island state of Oceania, located near the equator and made up of the volcanic island of Banaba and 32 atolls, spread over an area of about 3.5 million sq km of ocean. The three main archipelagos that make up the state of Kiribati are: the Gilbert Islands, the Phoenix Islands and the Equatorial Sporades.
The whole territory is spread over 800 sq km of deposits of loose materials consisting of calcareous fragments of biological origin, that is to say shells of clams shredded more or less coarsely by the mechanical action of wave motion, and emerges a few tens of centimeters above the level of the sea. For this reason, it is particularly exposed to rising water levels.
In 1999, two of its uninhabited islands, Abanuea and Tebua Tarawa were swallowed up by the waves.
The United Nations has included the Republic of Kiribati in the category of Small Islands Developing States (SIDS), that is to say a category that identifies the Small Islands of the Pacific as particularly disadvantaged and vulnerable developing countries.
A reason for concern is climate change, as already highlighted in 1989 by the United Nations in a report on the greenhouse effect and the risks associated with it.
Responsible for only 0.6% of global greenhouse gas emissions, Kiribati is, in fact, among the first victims of climate change, with consequences that seriously endanger the future of these territories and its inhabitants.

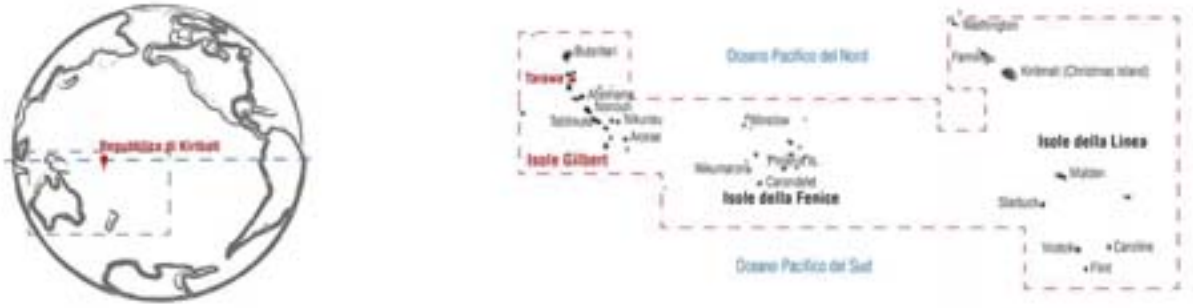


**Fig. 1:** Location.

## 2. Consequences of climate change in Kiribati

The consequences are already evident and the predictions are alarming:

*1.Increase in annual and seasonal temperatures, maximum and minimum.*

Since 1950, data from temperature records have shown a clear upward trend: maximum temperatures have increased by 0.18°C per decade.

*2.Increase in annual rainfall.*

The data collected since 1951 for Kiribati show an increase in annual rainfall, which is also expected to increase in the future, with a greater number of heavy rainfall and less days of drought.

*3. Sea level rise.*

Global warming warms the ocean waters and causes the melting of glaciers causing the water level to rise.

Due to the flow of ocean currents, the seas around the atolls of Kiribati rise by 1.2 centimeters per year, about four times faster than the global average, gradually submerging the territory of the islands.

*4.Increase salinization of groundwater sources and soil.*

The rising sea level has already begun to contaminate aquifers and fresh water reserves which are undergoing gradual salinization, reducing the already insufficient supplies of drinking water with serious damage also to agriculture.

*5.Increase Ocean acidification.*

Ocean acidification, caused by global warming, affects the growth of corals and organisms that produce their skeletons from carbonate minerals, jeopardizing the balance of tropical reef ecosystems.

But not only that, the increase in the acidity of the waters prevents the formation of some organisms that produce plankton, undermining the food chain of fish resources, forcing them to modify their migratory routes, with serious damage to the livelihoods of the population and the fragile economy of the islands, largely dependent on the catch.

*6.Increase demand for food.*

The damage caused to agriculture and fisheries resources risk no longer satisfying the food needs of the population: it is estimated that by 2030, Kiribati will need 50% more food to support domestic demand.

*7.Increase vulnerability to disease.*

In October 2022, a team of Doctors Without Borders conducted a study on the health conditions of the population of Kiribati, finding evident consequences caused by the climate emergency on people's health. A high percentage of cases of hypertension, diabetes, leprosy and tuberculosis have been found.

*8.Exodus towards the innermost areas of the archipelago.*

Due to the rise in water levels, many inhabitants of the coastal areas and outer islands have been forced to abandon their villages and move inland, concentrating in cities whose population increases year after year with the consequences of overcrowding and tensions.

According to Michigan State University, the urban population in 2020 was about 55.60% of that overall.

## 3. Measures implemented and in progress

Over the last two decades, thanks to the intense work of Anote Tong, president of the republic of Kiribati from 2003 to 2016, and current climate activist, the problem of the Kiribati archipelago has become a symbol of the fight against environmental disaster.

Tong has publicly called for an increase in policies and initiatives aimed at reducing polluting emissions but, despite the commitments made by about 190 countries to reduce climate-changing emissions, the archipelago risks disappearing by the end of the century and with it the history and the culture of a people.
The critical issues present in the State of Kiribati have generated great global interest by stimulating the proposal of adaptation strategies, compatible with a sustainable life model, to guarantee a future for the indigenous population so that they do not necessarily have to resort to exodus as a last solution but which unfortunately, it has already been taken into consideration. In view of a probable evacuation of the archipelago, in 2015 the government of Kiribati bought 20 square kilometers of land on the Fijian island Vanau Levu for 8.8 million dollars.
Currently the territory is used for agriculture and fish farming but is intended to accommodate the population in case of need. In view of this perspective, the Kiribati government has also asked Australia and New Zealand to accept the people of Kiribati as permanent climate refugees. Initiative supported by the World Bank.
To this end, the government of Kiribati has launched the *Education for Migration* program with the aim of offering the indigenous population of fishermen, sailors and farmers new professional skills useful after migration.
During his mandate, Tong considered, among the possible solutions, the construction of artificial islands, for the realization of which he asked for help from the United Arab Emirates due to their experience in this sector but the cost of the operation was estimated at 100 million dollars and international aid is slow to arrive.
Thought has also been given to the construction of floating platforms similar to those used by oil companies, but even in this case the costs are unsustainable for the local population.
In 2020 the new president, Taneti Mamau signed a memorandum for cooperation with China in the context of the Chinese New Silk Road project, known as One Belt, One Road (OBOR). One of the two main routes included in the plan is the one that will connect China with the Indian Ocean and the South Pacific. The plan provides for the construction of infrastructures that will allow trade between the various states involved. Micronesia could thus face a series of strategic initiatives to address and manage the consequences of climate change.
Meanwhile, the government, assisted by bodies and organizations, studies and implements short and long-term strategies to deal with the impacts of climate change, contain the force of the waters and the erosion of the coasts.
Among these initiatives, the *Kiribati Adaptation Program* (KAP) launched by the national government of Kiribati with the support of the Global Environment Facility, the World Bank, the United Nations Development Program and the Japanese government with the aim of improving Kiribati's resilience to impacts on freshwater supply and coastal infrastructure. The government has built embankments and planted mangrove trees which, with their dense aerial and curved root system, are anchored to the ground, retaining the sand and reducing the effects of the waves.
Another initiative is the preparation of new coral reefs whose growth rate in the Tarawa archipelago is 8 millimeters per year, a value that exceeds the speed of rising tides. However, there is a risk that many corals may not be able to adapt to warmer surface temperatures and increased atmospheric carbon dioxide concentrations, which inhibit coral growth.

**Fig. 2:** Mangrove cultivations along the coasts.

## 4. Goals and project proposal

The study conducted at the Department of Architecture of the University of Palermo [2] was inspired by these premises, aimed at identifying new housing models capable of dealing with imminent emergencies

and preventing the abandonment of the lands of origin. The general objective of the program is to guarantee a future for the population of Kiribati, proposing intervention solutions that involve citizens as an active part.
The study is strongly linked to the characteristics of sustainability and the protection of the territory and for this reason it tends to follow fundamental criteria for the protection of the existing natural landscape and the awareness of local communities for the defense of their territory.
The proposal involves the construction of a housing settlement for the native population and a tourist reception facility aimed at boosting the local economy. The elaboration of the project was preceded by a preliminary analysis of the natural and anthropic context, by the identification of the available resources and by an analysis of the climatic data aimed at identifying the characteristics of the place and the design strategies to be applied.

### 4.1 Natural and anthropic environment and local resources

Kiribati is one of five countries in the world made up almost exclusively of atolls. Atolls represent the most complex type of coral reef both in terms of morphology and origins. It is the ecosystem with the greatest biodiversity on Earth but, at the same time, the most complex and delicate of the entire marine environment.
The soil is poor, without waterways and with more or less luxuriant spontaneous vegetation that alternates with white coral beaches. According to the Global Forest Resources Assessment 2010, Country Report, Kiribati [3], an assessment prepared by FAO relating to Kiribati, 80% of the surface of the state is occupied by coconut palm forests; 15% is occupied by other trees and shrubs, such as pandanus and mangroves, while the remaining 5% is occupied by ponds, fields and buildings.
Local resources, as is often the case for isolated and distant places or for small emerged lands, are very limited. The inhabitants are used to making the most of everything that the area offers. Coconut palms, pandanus, bamboo, taro, banana trees and mangroves also provide the raw material for housing construction. Coral reefs also offer an excellent building material: the corals deposited by the tides along the coasts are used to build retaining walls to protect the waters and to make bricks.
Kiribati is particularly sensitive to the tidal phenomenon which occurs every six hours, reaching a height of about two meters, governing and profoundly influencing the life, habits and daily activities of the inhabitants. For this reason, traditional houses are raised above the ground but also without walls, to allow for good cross ventilation in an environment where humidity is very high.
The most important and sophisticated architectural component is the robust projecting and waterproof roof, able to resist the violent downpours typical of certain periods of the year and also provide excellent shelter from the sun.
The typical house is made up of an aggregate of pandanus wood huts, characterized by a particular constructive simplicity and spaces reduced to the minimum necessary, each of which is intended for a specific function: the Bwuia for resting and spending free time, the Umwa for cooking, the Bata for storing the canoe, the Kia-kia for sleeping. Much of life takes place outside shelters and toilet facilities are quite rare. Few homes have access to public water and the water supply generally comes from cisterns designed to collect rainwater and from private or neighborhood wells. The center of the community's social life is represented by the Maneaba, the largest and most identifying building in the village, used for meetings, celebrations, parties and also as a resting place for the community.
During the last two centuries, traditional building materials have been progressively replaced by imported materials, such as galvanized iron and prefabricated concrete blocks with which traditional buildings are built, keeping their original shape almost completely unchanged.

**Fig. 3:** Left: the roof of a traditional house made with pandanus leaves. Right: example of a galvanized sheet roofing.

### 4.2 Climate analysis

Kiribati has a tropical, rainforest climate, also known as an equatorial climate, with no significant seasonal differences. The average annual rainfall is 60 mm.
According to the Köppen-Geiger classification, the climate is of type Af which identifies a rainy tropical climate with an average temperature of the coldest month above 18 °C, without a cold season and with rainfall in all months.
The maximum daytime temperature in the hottest period (August-November) exceeds 31 °C. The predominant winds blow from eastern quadrants with a peak from the east in January, with an average speed of 24.4 kilometers per hour. Day length in South Tarawa does not vary substantially over the course of the year.

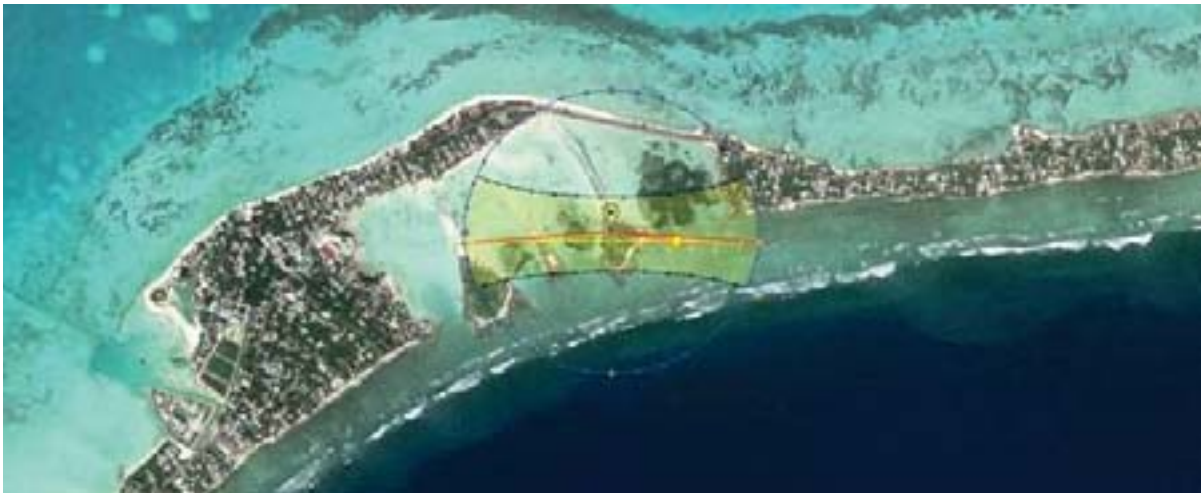

**Fig. 4:** Satellite photograph of the site with solar path. https: www.sunearthtools.com.

### 4.3 Design criteria

The fundamental criteria followed in the design phases can be summarized as follows:
• attention to the forms of existing architecture and landscape;
• use of materials and techniques of the local tradition;
• reversibility of the construction systems and ease of maintenance of all the elements that make up the housing settlement;
• recovery and purification of meteoric and marine waters;
• satisfaction of energy needs through the use of renewable energy sources;
• use of passive ventilation and cooling systems;
• preparation of careful waste management;
• use of low environmental impact systems for the treatment of waste water;
• coastal erosion protection.

### 4.4 Project area

Project site is the Tarawa atoll, in the Gilbert Islands; the most populated of the archipelago and the second by size. It lies approximately halfway between Hawaii and Australia and features a vast lagoon bordered by a 'V' shaped reef, approximately 35 km long, made up of over 30 islets.
As with most atolls, the phenomenon of the tides characterizes the life and habits of the inhabitants of Tarawa. The tidal excursion occurs every 6 hours and generates a change in the water level of about two meters.

**Fig. 5:** Left: Tarawa Atoll. satellite view and map. Right: the different phases of the tide.

Such a condition profoundly affects the lives of the inhabitants and their settlements which, in some places on the island, are subject to continuous flooding, the intensity and frequency of which are aggravated by climate change, which influences sea currents and causes tropical cyclones and rising seas.

**Fig. 6:** Effects of the floods in Tarawa.

A study conducted in 1999 by SOPAC (South Pacific Applied Geosciences' Commission), on the vulnerability of the southern coast of the atoll and on the possible consequences on the coral reef and on the inhabitants, predicted the increase in water salinization, coastal erosion, contamination of groundwater and coral bleaching, with major effects on coral reefs and ecosystems.

## 5. The project

The Tarawa atoll has already lost many square kilometers, now submerged by water, as well as the only driveway, subject to continuous renovations.
For those reasons and with the intention of offering a solution that contributes to implementing initiatives to adapt to the environmental emergency, the location of the settlement was chosen in South Tarawa, a thin strip of islets that house over half of the 100 thousand inhabitants of the archipelago and where the administrative capital of the republic of Kiribati is also based, in a coastal inlet characterized by a relatively shallow seabed, close to some islets.

### 5.1 Settlement principle

The complex develops on a floating platform according to a double cross system which houses the houses for the local population to the north-west and is characterized by the presence of the Maneaba. The tourist facility develops to the south-east, at the center of which is the meeting point containing a refreshment area and complementary services. The two plants, although independent from each other, find a meeting point in the large covered square which hosts an open-air market with small stalls for the sale of typical products.

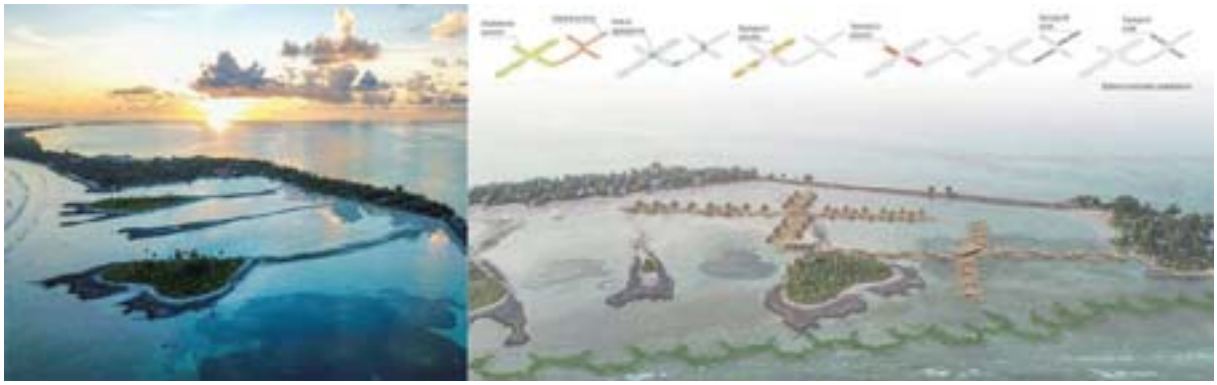

**Fig. 7:** Left: project site. Right: settlement principle and functional scheme. Graphic elaboration by S. Puglisi and A. Siligato.

The total area of the complex is 16,390 m2. The settlement principle is closely related to the wind direction, a resource used for cooling and passive ventilation of the settlement.
In order to safeguard the entire coastal inlet, the construction of a mangrove breakwater barrier is envisaged, which will favor sedimentary processes, opposing the phenomenon of erosion. The

hexagonal shape of the units that make up the barrier takes as a reference the modular system, known as the CALTROPE Project, conceived by a team of Hungarian architects, designers, biologists and engineers. The mangrove plants are placed inside pots of natural fibers which decompose naturally during the growth of the plant.

### 5.2 Floating platform

The floating platform is made up of the aggregation of irregular octagonal modules and is more versatile than fixed stilt systems. Indeed, the platform is connected to large vessels anchored to the ground which act as a guide for vertical lifting and the consequent adaptation of the system to the different phases of the tide; all this thanks to a floating system made up of recycled aluminum barrels which, placed under the platform, allow it to be lifted.

**Fig. 8:** Left: sketch of the node connecting the two settlements. Right: scheme of anchoring and floating of the platform in the different phases of the tide. Graphic elaboration by S. Puglisi and A. Siligato.

The pots contain the typical bawbwai plants, commonly known as taro, which can also be planted in swampy areas and are particularly resistant to brackish water. The dried leaves are also used to cover houses. The aggregation of the octagonal modules, replicated in series, allows the elimination of the traditional connecting walkways between the housing units, typical of this type of system. The modules have three dimensional types, based on the intended use of the housing units that responds to different needs.

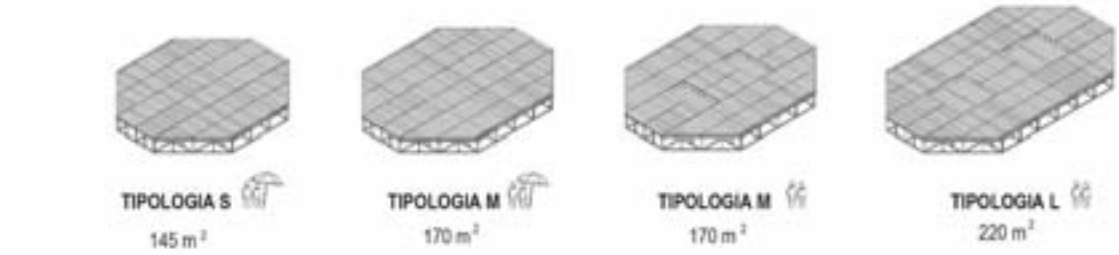


**Fig. 9:** Abacus of the octagonal modules making up the platform. Graphic elaboration by S.Puglisi and A. Siligato.

### 5.3 Housing typologies

Four types of housing are envisaged (two for the settlement intended for the local population and two for tourists), with a triangular matrix structural scheme that draws inspiration from the geometry of the existing structures in the place. Particular attention is paid to passive ventilation, an aspect that has influenced the layout of the houses in a windbreak position and the reason why there are two modules for each housing type.

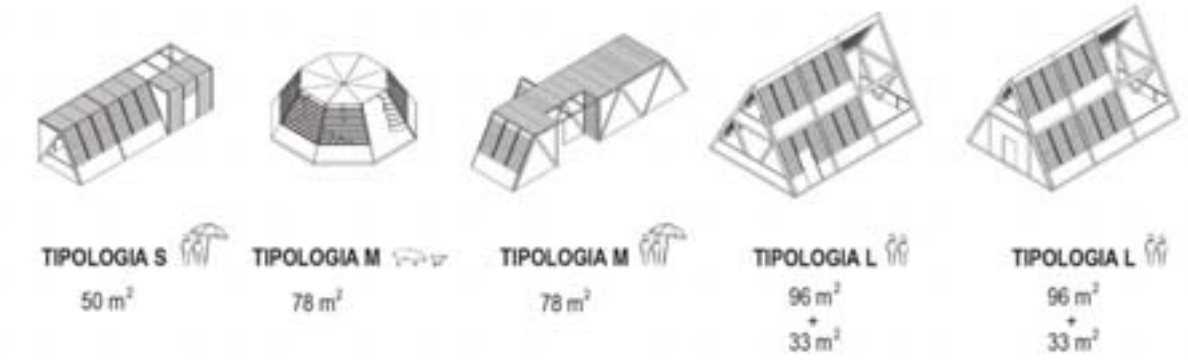


**Fig. 10:** Abacus of housing typologies. Graphic elaboration by S. Puglisi and A. Siligato.

*Settlement for the indigenous population*
The settlement complex intended for the native population is spread over an area of 11,740 square meters. The difference between the two types of homes for the local population is determined by the entrance which can take place from the short side or from the long side.
Both structures develop on two elevations and enjoy a particular constructive simplicity, typical of traditional houses and, in respect of local tradition and habits, they have no walls, replaced by brise-soleil that can be adjusted according to needs and weather conditions.
The spaces are reduced to the minimum necessary as much of life takes place outside the homes: the ground floor houses the living area with outdoor kitchen and bathroom; the rest area develops on the upper floor.
The choice of the outdoor kitchen respects the local custom.
The presence of the bathroom inside the house is, on the other hand, a choice dictated by health needs as part of the pollution of the few fresh water reserves is due to still archaic practices, due to the lack of a sewage system and the custom of discharging sewage into the sea, a habit that constitutes a serious problem of hygiene and a danger for the spread of diseases.
Each housing unit is equipped with a vegetable garden and an animal shelter in which it is also possible to grow small food plants vertically which, once grown, will be moved to the garden in front of the house.

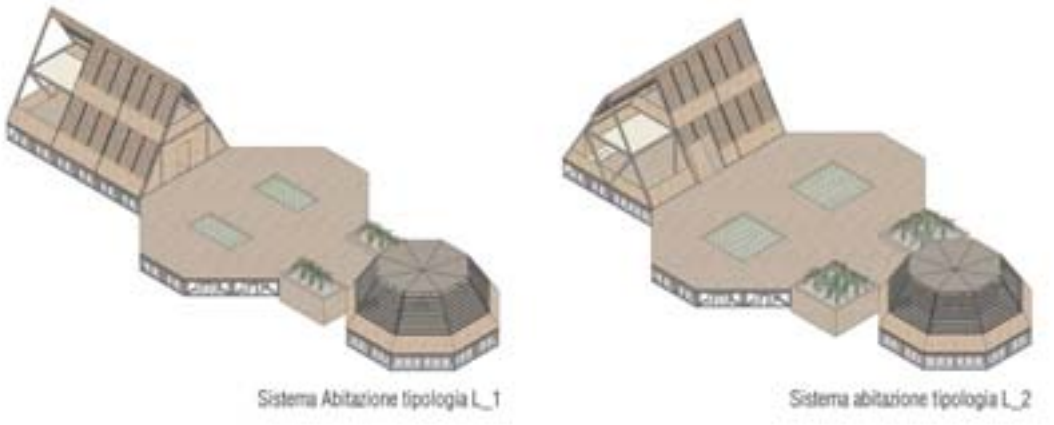


**Fig. 11:** Housing typologies. Graphic elaboration by S. Puglisi and A. Siligato.

**Fig. 12:** Glimpse. Graphic elaboration by S. Puglisi and A. Siligato.

*Tourist reception facility*
The settlement complex intended to host tourists is spread over an area of 5,140 square meters that can be walked on, partly public and partly private.
The houses are divided into two types, one double and one quadruple which, placed at the center of the corresponding platforms, separate the public area from the private one. They are articulated on a single level and have a covered area reduced to the essential minimum, as happens in traditional homes. A large part of the space is dedicated to the private exterior, from which you have the possibility of directly accessing the sea, when the tide allows it.

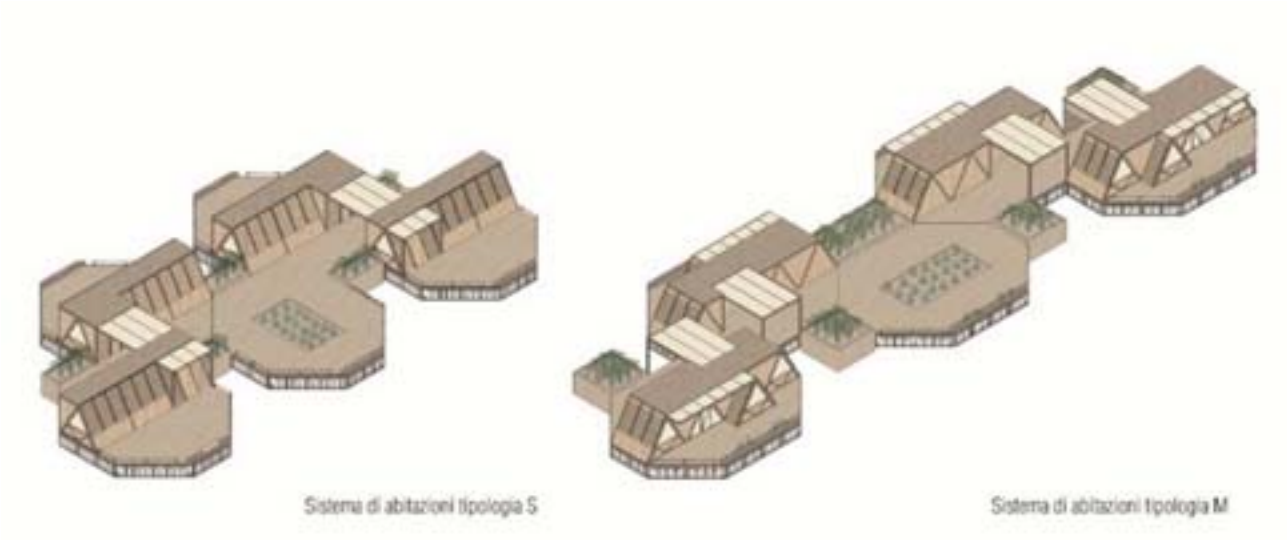


**Fig. 13:** Housing typologies. Graphic elaboration by S. Puglisi and A. Siligato.

**Fig. 14:** Glimpse. Graphic elaboration by S. Puglisi and A. Siligato.

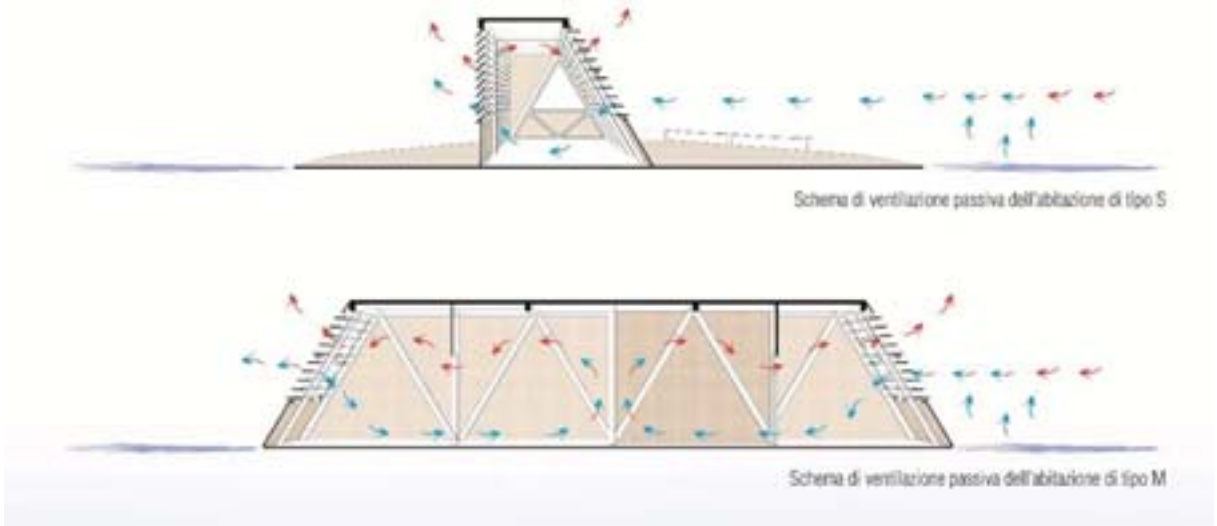


**Fig. 15:** Passive ventilation scheme. Graphic elaboration by S. Puglisi and A. Siligato.

## 6. Project materials and insights

Particular attention has been paid to the choice of materials and to the reversibility of the construction system in order to ensure easy assembly of the parts in the construction phase and equally easy disassembly.
In addition to the use of coconut palm wood for the structural part of the housing units, pandanus wood will be used for the construction of secondary structures and mangrove wood for the platform, as it is more resistant to humidity.
We also propose a reinterpretation of the weaving of pandanus leaves which is used to make the slats mounted on the palm wood frame of the brise-soleil.
A particular system for the recovery of sea water for domestic use is installed inside the houses and exploits the evaporation and subsequent condensation of the water which, during the hours of high tide, is conveyed inside a specially positioned barrel.
An electric motor pump leads the water to the tap by means of forced suction. The recovery of rainwater for irrigation is instead guaranteed both by a system of gutters installed in the roof pitches of the houses and by the elements that make up the roof of the large square.
The system consists of drainage chains, arranged inside each element, whose cone shape facilitates the conveyance of rainwater inside the structure itself, at the base of which the collection tanks are located.
The biological treatment of the wastewater makes use of a submerged flow constructed wetlands system, also set up on the floating platforms, each of which serves five homes.
As for the energy supply system, the use of wave and tidal energy conversion devices is envisaged, located near the coastline but hidden by mangrove barriers.

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# Intervention strategies for the enhancement of the Peruvian route of the Inca royal path Qhapaq Ñan

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**Abstract**
Qhapaq Ñan, a UNESCO World Heritage Site, was a complex administrative communication and transport system that connected the immense territory of the Inca empire for over 30 thousand km, intercepting sites of great historical and cultural interest today, first of all the Sanctuary of Machu Picchu.
The consequences of climate change and the high tourist presence, which is mostly concentrated in Machu Picchu, are seriously jeopardizing the survival of this precious asset.
The heavy rains that hit the monuments produce dangerous infiltrations of water between the masonry structures, compromising their stability; the transit of people along the paths and stairways erodes the rock and the soil.
A further burden is the new airport, nearing completion, located a few kilometers from the entrance to the Sacred Valley of Machu Picchu, aimed at strengthening the national and international tourist network, with irreversible damage to the territory and local communities. For these reasons, in 2016, UNESCO included Machu Picchu in the list of "World Heritage Sites in Danger".
The present study proposes an alternative that can shift the tourist flow towards other sites intercepted by the Qhapaq Ñan, less known but equally rich in history, culture and art, including the archaeological site of Raqchi and the Q'eswachaka bridge, for which interventions are proposed aimed at improving their accessibility through the redevelopment of the existing infrastructures and the construction of temporary reception facilities in respect of the identity of the places.

**Keywords:** Sustainable tourism, UNESCO heritage, Peru, Qhapaq Ñan, Q'eswachaka bridge.

## 1. Premise

The enhancement of the cultural, landscape and intangible heritage of any country in the world is an important and often difficult commitment to sustain and guarantee. It is a delicate responsibility that often risks being conditioned by economic and power interests which more often than not favor the exploitation of cultural and landscape assets, neglecting the main objective, that is to say, the protection of the heritage
The issue of enhancement tangible and intangible heritage is very extensive and complex and becomes even more so in contexts where political and economic instability do not allow for the planning and implementation of long-term protection interventions.
Among these is Peru, the cradle of important civilizations that have followed one another over time, each of which has profoundly marked the history of the country, leaving evidence of great value and a cultural heritage of inestimable value which is often the subject of interventions that have the sole purpose of increasing the tourist flow as much as possible by favoring the development of a "destructive mass tourism"; a phenomenon that is causing more and more trouble.
The prime example is the sanctuary of Machu Picchu, one of the twelve UNESCO World Heritage Sites. It is probably the most spectacular architectural work that the Inca Empire built during its years of greatest glory, the preservation of which is now in serious danger.

## 2. From cultural tourism to mass tourism

In Peru, tourism plays an important role in the country's economy and is considered by the government to be one of the main sectors to be developed.
The first flights over the Andes date back to 1928, with the Lima-Talara route, reserved for only six passengers. This was the period in which Machu Picchu received its first visitors, mainly scholars and archaeologists who came there to study and understand the nature of the sanctuary.
In the following years, a hotel plan was implemented which allowed, between 1940 and 1945, the birth of numerous state hotels in the cities with major tourist attraction.
Starting 1969, through the implementation of the COPESCO Plan and the PER-71/539 project, promoted by the Peruvian government with the collaboration of UNESCO, a series of regulations were issued and activities aimed at the restoration of monuments and the conservation of the Peruvian heritage.
Projects aimed at the development of cultural tourism were also launched, including the one on the Machu Picchu-Cusco-Puno-Desaguadero axis. The Tourist Development Plan of the Inca Region 1995-2005, prepared and commissioned by the Regional Council, has allowed the development of tourist activity in the last decade, through identified circuits. But, despite this, the attention of the whole world continued to be directed to the sanctuary of Machu Picchu which, in July 2007, was declared one of the seven wonders of the world by the institution New Open World Corporation (NOWC).
A series of projects followed such as the National Strategic Plan for Tourism - PENTUR 2005- 2015 and the Master Plan of the Qhapaq Ñan section. All tourist strategies that have generated an exponential growth of foreign visitors with the movement of masses of travelers from all over the world, intrigued and fascinated by so much beauty. But the tourism development policies that the Peruvian government has adopted seem to have led to the development of destructive mass tourism, which generates anthropic pressure higher than tolerable and which is increasingly causing concern.
In recent years, the most important archaeological sites in Peru have been greatly threatened by the effects generated by human presence, often uncontrolled, with devastating consequences: dispersion of solid waste, soil erosion, exploitation of the local population, pollution caused by the conveyances which generate, among other things, vibrations on the ground and on the monuments.
Already today the locality of Aguas Calientes, called Machu Picchu pueblo, which is a few minutes from the archaeological site of Machu Picchu is invaded by illegal building and tons of waste and polluting waste that are poured into the Urubamba River.
It is estimated that this destination is reached by 900,000 travelers annually [1] and it is feared that the high tourist flow could further damage the UNESCO heritage site. Machu Picchu already has a carrying capacity of 5,000 tourists a day, double the 2,500 visitors recommended by UNESCO.

## 3. Intervention proposal and objectives

The study conducted at the Department of Architecture of the University of Palermo [2] draws inspiration from these premises, aimed at identifying a travel alternative that can stimulate tourist interest towards lesser-known sites but equally rich in history, culture and art.
Attention was focused on the sites intercepted by the Qhapaq Ñan, or Royal Inca Trail, one of the greatest works of the Inca empire, the largest pre-Columbian domain in the Americas, which marked an era of great splendor until the arrival of the Spanish conquistadors.
Specifically, the goal is to create a tourist flow towards sites of particular historical and cultural interest intercepted by the Cusco-Desaguadero section and which currently have a low tourist turnout.
Objectives of the program are:
1. Decentralize the tourist flow towards other little-known locations;
2. Ensure the preservation and protection of the natural landscape and existing cultural heritage by making local communities aware of the defense of its territory;
3. Guarantee a future for the indigenous populations, proposing intervention solutions aimed at increasing the local economy by involving the communities as an active part.

The study began with an analysis of the infrastructures and sites of greatest interest in the area. An analysis was then carried out on the presence of tourists in some of the most interesting UNESCO heritage archaeological sites which are intercepted along the Cusco-Desaguadero stretch and which are compared with those of Machu Picchu, in order to establish which of these destinations are less known and visited.

### 3.1 Qhapaq Ñan

The Qhapaq Ñan is a complex administrative communication and transport system built over several centuries and largely based on the existing "pre-Inca" infrastructure.
The capillary road network guaranteed a rapid circulation of goods and information throughout the territory of the empire. The route originates in the center of the main square of Cusco and winds for over 30,000 km, branching out towards the four cardinal points and crossing 6 Latin American countries: Argentina, Bolivia,

Chile, Colombia, Ecuador and Peru. Qhapaq Ñan, declared a UNESCO World Heritage Site in 2014, is still surrounded by millenary traditions, stories and legends that constitute a precious cultural heritage.
Of the entire road system, only a few sections and two particular places have been included among the protected sites. These include the Cusco-Desaguadero stretch and the Q'eswachaka bridge.

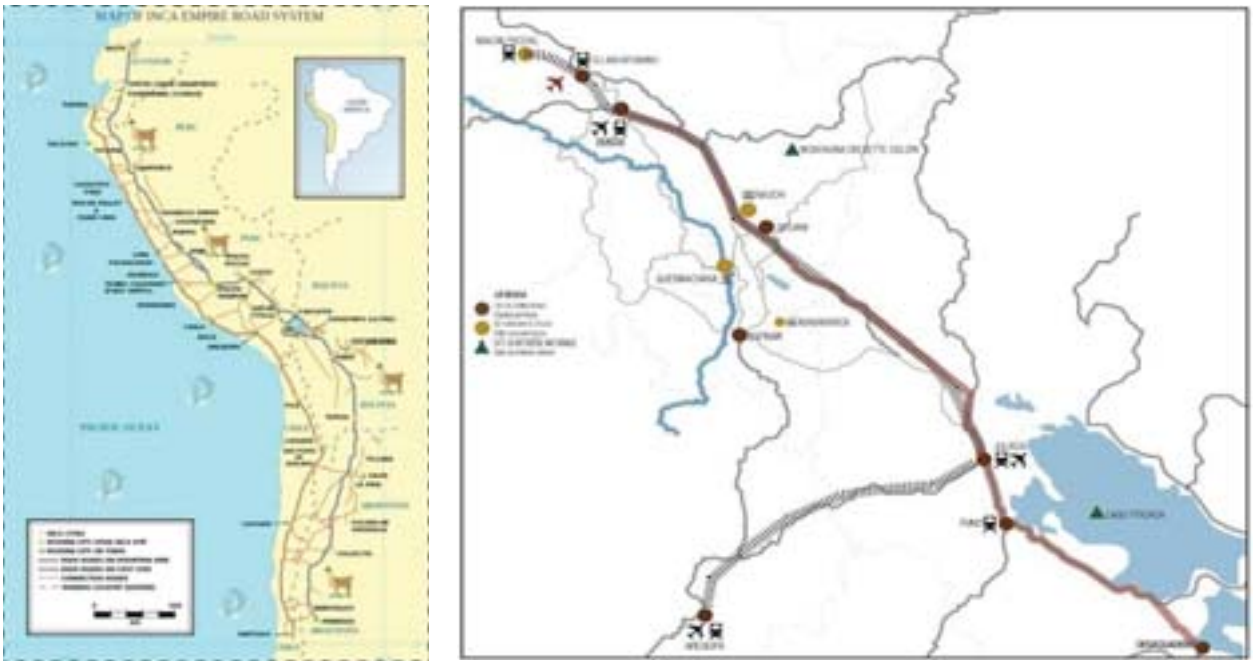

**Fig. 1:** Left, map of the Inca Road system. To the right, the Cusco-Desaguadero section.

### 3.2 Cusco-Desaguadero route

The Cusco- Desaguadero route extends between the city of Cusco and Desaguadero, a city bordering Bolivia. It connects two very important places of the Tawantinsuyo (the Inca empire): Cusco, the ancient Inca capital, and the Sun and Moon islands on Lake Titicaca, a place which in Andean mythology is considered as the origin of the Inca civilization.
Along this route you will come across sites of great landscape and historical-cultural value, declared a UNESCO heritage site. Despite this, this territory complains of a lack of tourist attention also due to the criticality of the infrastructural systems that make travel difficult, especially as one moves away from the city of Cusco.
Unfortunately, the lack of attention is also from the responsible administrations and although various state programs have been launched to guarantee the development of services in the entire section, little has yet been done.

### 3.3 Infrastructure analysis

The Cusco-Desaguadero route is currently served by two airports. Cusco airport and, to the south, Juliaca airport. A new airport is under construction near Chinchero, a town about 50 km from the entrance to the Sacred Valley of Machu Picchu and 20 km from the city of Cusco. The latter, while on the one hand it will strengthen the national and international tourist network, on the other it risks channeling the tourist flow towards a single destination, the sanctuary of Machu Picchu which is already undergoing enormous pressure due to mass tourism.
The railway line that crosses the entire route is in a precarious state. It consists of a single track and, near villages and towns, it crosses markets and passes near houses without any protective barriers. The trains are almost exclusively luxury trains used for the transit of tourists and with exclusive stops: Arequipa, Puno, Cusco, Ollantaytambo and Machu Picchu pueblo.
The state road, with two lanes, follows the railway line. It generally crosses towns, but sometimes it simply skirts them. The road has well paved stretches and stretches where transit becomes difficult; in these cases the road section looks like a "dirt track" often intercepted by small streams that make the passage problematic.
The conveyances are insufficient. In addition to the luxury tourist trains, in perfect condition and with excessive costs, travel can be made with buses, taxis, shuttles and other alternative means called "moto moto" by the local population.

### 3.4 Sites of greatest interest and tourist flows

The places of greatest interest identified along the Cusco-Desaguadero route are: Mount Vinicunca, also known as "The Mountain of Seven Colors", the Raqchi archaeological site, the Q'eswachaka bridge, the Kanamarka archaeological site, the Titicaca.

From the general analysis of the data concerning the accesses to the archaeological sites intercepted by the Qhapaq Ñan path within the Peruvian territory, it appears that 57% of the tourists prefer Machu Picchu, 33% Ollantaytambo, 7% Lake Titicaca, 4% Raqchi and 1% the Q'eswachaka Bridge.

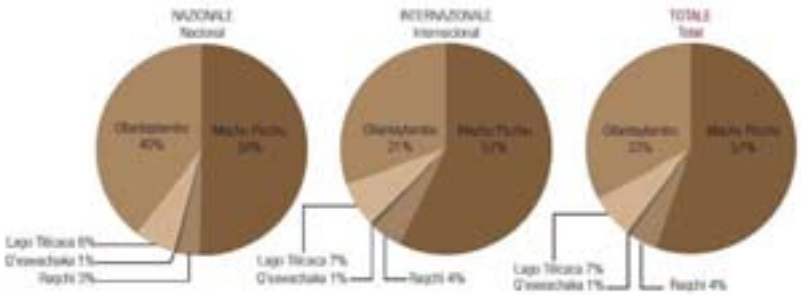

**Fig. 2:** Analysis of tourist flows.

## 4. Intervention area

From the above, it appears that the Q'eswachaka bridge is the least known and frequented destination and for this reason is the subject of this study.


**Fig. 3:** Q'eswachaka Bridge.

The Q'eswachaka bridge, named in 2014 as a UNESCO tangible and intangible world heritage site, is currently visited by just over 10,000 Peruvian and foreign tourists a year. It is an exceptional testimony of Inca engineering and the last of the suspension bridges that has survived to this day.

With a length of 28 meters and a width of 1.20 meters it is suspended about twenty meters above the level of the bed of the Apurímac River. It is located in the district of Quehue, in the province of Cañas in the department of Cusco, at 3,792 meters above sea level.

Made with ropes tied to the ends of the river banks, at a base built in stone and raw earth. The ropes constituted both the support structure of the walking surface for crossing the bridge, and the handrail. In the past, the Q'eswachaka was the only way to cross the river and therefore its state of conservation was absolutely essential.

Although today it does not play a role of fundamental importance, since there is an iron bridge that allows the river to be crossed, its annual renewal is a significant event. The work done by the communities on the days when the bridge is being built is called mink'a or minga, a term that defines an Andean form of unpaid collective work that has the benefit of the community as its objective.

**Fig. 4:** On the left, the walkway of the bridge. Right, a moment of the reconstruction.

The tourism development plans and programs implemented in the past by the government and the Cusco region for this site concern punctual interventions, aimed at improving the conditions of the site itself, leaving out actions aimed at improving the infrastructures.
The project proposal therefore includes the following interventions:
- identification and redevelopment of existing routes and infrastructures;
- design of rest areas along the pedestrian path, with reference to the ancient architectural pre-existence of the tambo Incas;
- design of an interpretation center near the Q'eswachaca bridge.

The elaboration of the project proposal was preceded by site visits which made it possible to carry out punctual analyzes of the natural and anthropic context and of the available resources, integrated by an analysis of the climatic data aimed at identifying the design strategies to be applied.
The protection of heritage is also expressed through the study and understanding of the traditional techniques of the Andean communities which have been re-proposed in a contemporary key, together with the application of appropriate technologies and bioclimatic strategies aimed at achieving comfort and energy efficiency of the plant.

### 4.1 Design criteria

The fundamental criteria followed in the design phases can be summarized as follows:
• attention to the forms of existing architecture and landscape;
• attention to socio-cultural and economic realities;
• respect for local identity;
• adoption of bioclimatic planning criteria;
• use of traditional local materials and techniques;
• adoption of strategies aimed at achieving comfort and energy efficiency
• easy maintainability;
• easy accessibility and connection between spaces;
• recovery and rainwater purification;
• obtaining of energy needs through the use of renewable energy sources;
• predisposition of careful waste management;
• use of low environmental impact systems for the treatment of waste water;
• reuse and/or recycling of all materials and components.

### 4.2 Climate analysis

The territory of Q'eswachaka is characterized by a cold and semi-humid climate, characteristic of areas with an altitude ranging from 3,000 to 4,000 meters above sea level, defined as "Mesoandine Valleys".
According to the temperature graph generated by the Climate Consulte 6.0 software, there is an average annual temperature of around 9°C, with average minimum values of 3°C and maximum values of 16°C. The

coldest months are June and July, where temperatures reach -3°C and the hottest ones are October, November and December where temperatures reach 17°C.
The rainiest months are January, February and March, with a maximum of 25 mm of precipitation per day. The predominant winds blow from the north-western quadrants, with an average speed of 12 m/s, and from the south-east with an average speed of 9 m/s.
The psychometric diagram shows the total lack of comfort conditions throughout the year and indicates the design strategies that can be pursued to obtain indoor thermo-hygrometric comfort conditions. The considered strategies include in the present case: thermal mass, evaporative cooling, natural day and night ventilation, passive heating.

### 4.3 Identification and redevelopment of routes

Two types of routes have been identified that adapt to the needs of visitors:
*Pedestrian path*: Suitable for the practice of tracking, it develops between the slopes of the Andes enjoying a wonderful panorama. Along the way there are some of the oldest communities in the area. Travel time is seven hours.

**Fig. 5:** Pedestrian path to the Q'eswachaka Bridge.

*Driveway path*: The driveway is difficult to pass due to the condition of the road section. The estimated travel time is one hour.

**Fig. 6:** Driveway path.

The arrangement of the road sections that are in poor condition is envisaged, in order to improve their practicability and the design of indicative signs that identify the two different practicable routes.

### 4.4 Parking area design

The design of rest areas for those who undertake the tracking route is envisaged, equipped with the characteristic tambos placed at a distance of five kilometers from each other, equal to about an hour and a half of walking.
The tambo, from the Quechua tanpu, "temporary accommodation", was a receptive structure used to accommodate travelers and groups of state officials and as a warehouse for food and wood reserves. Located near the roads that made up the Inca Road system, they were built at a distance of about 20 km from each other (one day's walk) and their management and maintenance was entrusted to neighboring communities.

The intervention involves the recovery of the tambos intercepted along the way and, where necessary, the construction out of new structures.

**Fig. 7:** Tambo ruins along the walkway and tambo construction schemes.

## 5. Interpretation Center

The project proposal involves the construction of an interpretation center aimed at enhancing the UNESCO heritage site and at the same time preserving the identity and ancestral traditions of neighboring peoples. The "heritage" interpretation centers are structures conceived for the enhancement of the cultural and/or natural heritage of a given place or geographical area.
The goal is to facilitate the understanding of cultural and natural values, through awareness-raising and education that considers heritage as a reference. Inside there are laboratory activities, exhibitions, seminars and conferences, refreshments, souvenir sales. The construction of lodgings for scholars and researchers is foreseen.

### 5.1 Project area and Settlement principle

The project is inserted northwest of the Q'eswachaka bridge from which it is about 300m away. The position allows you to enjoy the view of the site without compromising the peculiar landscape characteristic of the place. The settlement complex is located at an altitude of 3,629 meters above sea level. and about 27 meters above the banks of the Apurimac River.

**Fig. 8:** On the left, project site. Right, settlement principle. Graphic elaboration by Simona Timpa.

The interpretation center can be reached via a driveway obtained from the fork in the main road and designed exclusively for use of the center. A pedestrian path is obtained from the extension of the pedestrian path designed in 2017 for the Q'eswachaka bridge.
The design proposal refers to some of the most important concepts of the Inca culture and proposes a traditional architectural typology. Among these emerge: the chacana, the tambo, the structural modularity, Inca shapes and configurations. The settlement develops along an axis obtained from the rotation of the chacana or Inca cross which depicts the Andean cosmovision and which is reproposed in the pavement of the square.

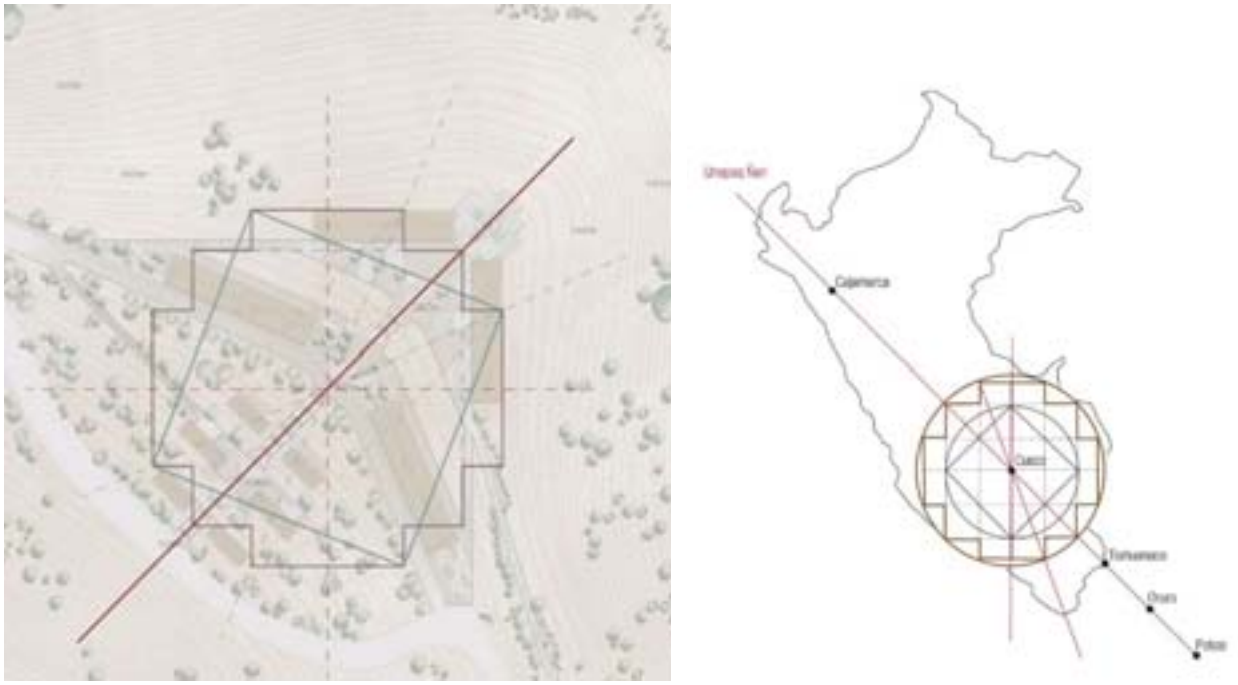

**Fig. 9:** The chacana at the base of Inca architecture. Graphic elaboration by Simona Timpa.

The buildings are arranged symmetrically along this axis, which is perpendicular to the route of the Qhapaq Ñan and which is characterized by a flight of steps that longitudinally crosses the complex connecting all the elevations of the settlement. The entire complex is divided into two areas: a public area and a private area. The first consists of 3 buildings: one intended for laboratory and research activities, one as a refreshment area, the third, at a lower level, spread over two buildings that house exhibition halls and multifunctional rooms.

**Fig. 10:** On the left, laboratories and refreshment area. To the right, exhibition halls and multifunctional rooms. Graphic elaboration by Simona Timpa.

In the second area, at a higher level than the other buildings, there are the residences intended for the workers of the interpretation center and for the scholars. It is a complex of six autonomous residences on two levels, arranged along the steps, interrupted by a small panoramic square, according to the settlement principle of the ancient Inca cities.

**Fig. 11:** Left, residences. To the right, refreshment area. Graphic elaboration by Simona Timpa.

All the buildings designed maintain the typical shapes and proportions of the Inca tambo and recall traditional construction techniques.

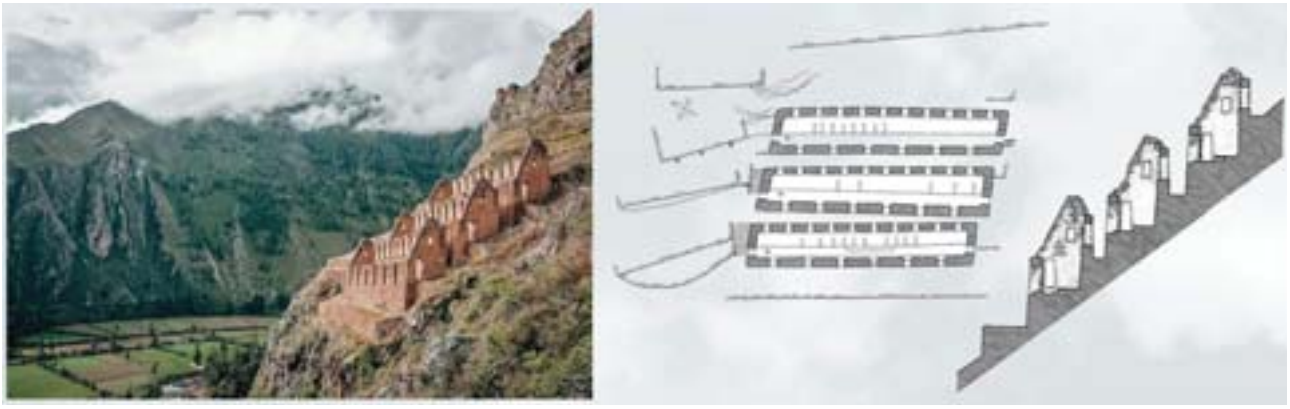

**Fig. 12:** Inca settlement of the city of Ollantaytambo.

The entire structure is built with eco-sustainable materials mainly available locally, such as earth, straw, wood and q'oya, and construction technologies applied in compliance with current Peruvian legislation [3]. Rainwater recovery and purification systems are planned, as well as an energy supply system using river water through a bypass channel which diverts part of the water flow, conveying it to a turbine and then returning it to its original route. This ensures minimal impact on the surrounding environment.

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# A new legacy. The shape of contemporary reuse

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## Abstract
The theme of legacy, of what "remains", has always questioned the action of the project which over time has faced different spolium conditions. The mythical practice of the city, as described by Michel de Certeau, is represented by the unexpected, by stratified places which in the common image appear as incidents along the way, as conditions on which the seal of error stands, the scarlet letter of speculation. Yet, the relationship with the ruins has always been described by Piranesi's beautiful drawings as a fantasy world so exceptional that observation alone builds new possible views of elements that appear lifeless. The contemporary appears to us uncomfortable, insidious and a source of continuous rewriting which, very often, is limited to adding, increasing the quantity of volumes which will themselves be a further legacy to deal with. In this multitude of accidents and unexpected beauty, this research tries to lead the observer towards scenarios in which our new concrete-frame legacy can be an inexhaustible forge of beauty.

**Keywords:** reuse, upcycling, architectural design, spolium, legacy

## 1. The unfinished as a promise
The contemporary gives us an infinite series of abandoned concrete frames, dormant architectures imaged with a different destiny but which for various reasons – economic, political – have not completed their construction process. What the observer perceives are elements that lie without value in territories now tormented by unauthorized building and easy construction, a dream deriving from the most courtly of forms of modern architecture, the Maison Dom-ino. «And yet, unfinished architectures, authorial or otherwise, evoke precisely that mix of misery and grandeur that leaves one dumbfounded and can surprise, fascinate, make one shiver, arouse a feeling of both beauty and fear. (…) They are infamous architecture because they are brought to share with art the most classic and problematic of its qualities: the lack of purpose» [1], but it is that greatness that could be revealed again, that unexpected event that witch enables the architecture to reinterpret the reading of what appears ordinary and purposeless. As Michel de Certeau wrote, the city is made up of a bumpy time, «an indeterminate fable, better articulated on metaphorical practices and stratified places than on the empire of evidence in functionalist technocracy» [2]. What makes the use of ruins fascinating is the modification of the sense of time precisely because the reuse of the existing is a millenary practice; it can be read from the stratifications of the churches in which pagan elements are transformed into altars and columns are inserted into buildings that belong to a different time. The space of the action of time and how it creeps into the re-edition of the space of the rest is what fascinates the observer. What has made it difficult to re-edit this practice in the contemporary world is precisely the quantity of toxins that have spread throughout the territory and a detox action appears necessary but it is also true that the palimpsest of the built which has by now lost its sense of living can be a starting point for a revolutionary action of the architectural project. As Marc Augè wrote, the incompleteness of construction sites contains a promise [3] and this impression still lives on in the unfinished architectures, eternal forges of possibilities not expressed yet.

**Fig. 1:** Time doesn’t exist, Digital Collage, Concetta Tavoletta, 2022

When Bernard Rudofsky in his Architecture without architects describes the strength and power of spontaneous architecture, also a derivation of the story in images and text of Italian rural architecture by Giuseppe Pagano and Guarniero Daniel, architectural critics praised the description of that form of architecture that cames from the hands of craftsmen, inventors of housing actions and design methods that inspired and still inspire the architectural project [4]. It seemed necessary to exalt the architecture deriving from necessities such as that of Capri and Procida which turned into a model for many authors of the project [5]. If in the years of the Ina Casa projects it was possible to appreciate the possibility of architecture to lead to a cultured and conscious transition of the needs of living, from the seventies of the twentieth century, the virtuous model was lost and the urban landscape took on a image corrupted by the false hope of using a method from the Maison Dom-ino model. Over time, the scenario of the self-made home, especially in Southern Italy, has described a total paradigm shift where the project space has become accustomed to the housing needs that required a home for everyone. The contemporary aspect of the city, deriving from the same need to "inhabit" the spontaneous architectures so loved since the 1920s, suddenly revealed itself to our eyes again only when the space of speculation had now devoured the ground without the necessary planning which zoning had only accentuated. It is enough to observe carefully what has happened in the landscape from the end of the twentieth century up to the present time where the problem was not in the large infrastructures but precisely in the many scattered buildings that had taken over [6]. This story of the housing condition is confronted with the elements of the city, the truest and most sincere ones, even if "uncomfortable", what makes up the living space where the monument is no longer part of the urban story. The method of observing the phenomenon of using existing resources, understood as a social product, as well described by Michel de Certeau was the forerunner of an innovative system of investigation of what could appear everyday - therefore imbued with addiction in the eyes of the observer - and which can then be re-read as an opportunity to discover existing resources.

**Fig. 2:** Do you look the sea?, Digital Collage, Concetta Tavoletta, 2021

### 1.2 Examples of reuse from the Modern to the contemporary time.

One of the most influential figures relating to the rereading of the rest can certainly be found in Dimitris Pikionis, one of the architects of the twentieth century who underlined the strength of the new writing of the present. The numerous trips, the close relationships with poets, painters and sculptors have only reinvigorated his idea of a modern reworking of the space of the ancient. The well-known action of recomposing the paths of the Acropolis of Athens remains his testament which brings to mind the story of Pikionis himself when, as a child in his countless walks he observed the ground with all its imperfections, with tufts of grass that the ruins underlined the power of time over all things [7]. Just like Francesco Venezia and his composition of spaces that appear to be timeless architectures such as in the Material Testing Laboratory of the Iuav in Mestre or in the small garden in Gibellina. Precisely in one of his laboratories, experimentation on the theme of ruins, a topic of his innumerable research and projects, can be a further element of analysis of how composition can relate to contemporary ruins. The study of Anne Lacaton, Jean-Philippe Vassal and Frédéric Druot PLUS – Les grans ensembles de logements is also masterful. Territoire d'excepion (PLUS. Social housing. Exceptional territory), a 2007 study financed by the Ministry of Culture and Communication for the recovery of the residential architecture of the benlieue. The research had the opportunity to transform itself into architectures that had zero demolition as their goal or, at least, try to demolish the bare essentials to make the architectures more livable. The best known examples are the Tour Bois-le-Prêtre in Paris and The Transformation of 530 housing units, buildings G, H, I, in the Grand Parc district in Bordeaux, projects where an ethical and conscious analysis of the trace of the Modern is evident re-edited to the present. In the first project, the tower developed over 16 levels which each served four or five apartments and the intervention focused on increasing the square meters of the building through an unusual action, adding elements on the façade and winter gardens which allowed to reduce energy consumption by

50%. Also in the Bordeaux project a prosthesis hooks onto the pre-existing structure which adds winter gardens and balcony systems which allow for an interesting and previously unexplored relationship with the view of the city. Lacaton and Vassal's approach to the reuse project of the existing building opened the debate on the existing building which then led scholars and designers to an idea that was not only sustainable but also attentive to the needs of the territory and the landscape from a design point of view. Just like the Flores&Prats studio which has made its own design manifesto of Second Hand architecture and has identified artists and professionals who, in different ways, approach the theme of the trace of the present without any prejudice with the aim of enhancing the existing by considering it as precious as the courtly traces of the past.

**Fig. 3:** Pimp my frame, Digital Collage, Concetta Tavoletta, 2023

### 1.3 Building on the built

«The stories of places are bricolages. They are made with the remains of the world [9]», this is how de Certeau defines the composite space of the contemporary, fragments that coexist between beauty and a sense of disorientation. Places whose nature we do not recognize and others that beautifully remind us that the power of architecture can sometimes change the sense of space. In fact, there are good practices, ways of working with the project – interrupted, abandoned – which marks the interpretation of reality and which vigorously tries to escape that idea of the irreparable. As previously described, the attention to upcycling and the idea of giving a second life to incomplete and forgotten architectures has attracted the attention of many scholars and artists. «Anthropologists», Marc Augè wrote in 2004, «find themselves today before the vast sodaglia that extends to the entire planet, they feel that the inventory of the ruins is not an end in itself and that what really counts is the invention , even when subjected to enormous pressures and effects of domination that threaten its existence. Humanity is not in ruins, it is in the works. It still belongs to history. An often tragic story, always unequal, but hopelessly common» [10]. In his text, the anthropologist leads us into an observation of the world linked to the action of the find and the rubble (war or post civil revolutions) where we find his 1994 theory of "non-places". what fascinates about his examination of the present, certainly steeped in nostalgia, is that there is a trust in the contemporary as in his analysis of construction sites which «possibly at the cost of an illusion, are poetic spaces in the etymological sense of the word: something can be done there; their incompleteness contains a promise» [11]. I believe that the idea of a "promise" is precisely the action of the project, different from the idea of "prophecy" in that promising considers the possibility of trying to be adherent to reality. And the promise of a second chance to those architectures that symbolize society's decay and loss of values is a powerful poem that we have the task of dedicating to the city. The projects that will be shown below are some of the works that were carried out during the Final Synthesis Workshop

that I held. On this occasion, I would like to thank the students who have dealt with the theme of building on the built with great passion. In particular, the projects are part of an area of Villa Literno, in the province of Caserta, where it is possible to find a lot that had been structured with the intention of building low-energy houses and collective spaces. As often happens, unfortunately, the company that had won the contract for the work went bankrupt and today what remains of that project are the skeletons of the structures, unusable and crystallized places when the construction site was abandoned. The objective of the research carried out during the Laboratory was to propose a series of solutions that differed according to the methodologies used to renew the unfinished ones. In some cases, the space underlines the structure as a compositional element, in others a double ventilated façade is used and in others, through minimal demolitions, the spaces have been transformed into useful places for the third sector.

**Fig. 4:** Project Area, Villa Literno, Building A, Zenithal view.

The Second skin for a second life project considers the building's framework as a body on which to wrap a new life. Block A had been imagined as a residential system and it was decided to leave the previously defined but unfinished destination. Small compositional actions have managed to enhance the existing through the insertion of a light double facade which ends with a total white press-bent sheet metal panel that builds a system of light openings that subtract volume from the object. The roof is made up of a set of objet trouvé imagined making the open-air space a place for socializing.

**Fig. 5:** Second skin for a second life – Building A, Luca Romano, 2022

**Fig. 6:** Second skin for a second life – Building A, Luca Romano

The design composition focuses on the pre-existing structure considering it a palimpsest to be enhanced where pillars and beams are precious design elements. A mesh of pillars and beams is added to the main building which wrap around the structure and which allow the elevation to be punctuated through different materials and colours. The culmination is declared through projecting elements that give impetus to the structure while the zero level welcomes collective spaces. The roof, also in this case, assumes the role of social space that can be used by the residents. Not (only) a skeleton underlines the

strength of the unfinished by enhancing the existing by adding expressive and functional elements to the residential block.

**Fig. 7:** Not (only) a skeleton – Building A, Lucia Tartaglione

**Fig. 8:** Not (only) a skeleton – Building A, Lucia Tartaglione

### 1.4 Conclusion

The practice of reuse is a millenary practice, it allowed a consumption of raw materials that appeared manageable and, we can say, also sustainable but the real leap in scale, what contributed significantly to the loss of management of the phenomenon, was the demographic growth. Millions of people have migrated to every part of the world and every geography has managed to respond differently to this phenomenon. What resulted from this is a real intoxication of the housing stock that has delivered infinite toxins into our hands in the built territory. If the Modern has given us the possibility to quickly build new homes even with an interesting economic return, the ruin of the Modern itself has produced many concrete works which inevitably lead to energy and environmental problems. This work has tried to tell happy ways of reusing the unfinished, trying to give a second life to architectures that had lost all hope. The examples put into a system allow for a reading as a phenomenon which is not limited to a cataloging of possibilities, but to a proactive approach which, aiming at zero demolition, seeks, however, to read what really contains the possibility of being re-read as a space with a new possibility. The paradigm of the function of architecture is changing and the project must place itself in dialogue with respect to the possibility of an architecture to be many more things than what it was imagined for. It is important to consider that the changes in our society will not stop today, new needs will arise over time and an elastic architecture, ready to be remodeled with small actions is a possibility that architecture cannot decide to lose. "Here and now" is no longer an expression of our time but "it's already tomorrow" is what architecture must aim for, to be something else at the very moment in which it is imagined by seeking a new form of eternity that we do not find in the " firmitas" [12] understood with the traditional exception of the term but in the very evolution of form and function, without fear.

**Fig. 9:** Me and the sky, Digital collage, Concetta Tavoletta, 2023

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# A new model of detention. The Bolzano prison

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## Abstract
The need for a transformation of the Italian prison system is constantly emphasised in the news; this is mainly due to the state of the existing building stock, which is not in line with the principle of rehabilitative punishment, marked by the Italian and European constitutions. Structural deficiencies, overcrowding and the planimetric conformation of the buildings are only some of the reasons for the difficulties of the Italian prison system. The architectural project must be central in contributing to the cultural change of course; it is an indispensable tool for rethinking a new model of prison 'open' to the city.

The article explores scenarios for the gradual decommissioning of the current prison in Bolzano, a city in northern Italy, in favour of a new construction outside the city centre. Such a solution allows the study of innovative spatialities, with a focus on the single dimension of the prisoner; at the same time the progressive decommissioning of the old prison allows the reuse of a building of symbolic value and historical interest, as a cultural space.

The method and experimental results in this historical, theoretical and experimental study of detention spaces in the city of Bozen/Bolzano can also be extended to other Italian realities, which are no longer sustainable, spatially or socially, and for which the thought of an "advanced" detention architecture, with respect to current models, and a complex process of decommissioning, construction, reuse at several times are necessary.

**Keywords:** Prison – City – Opportunity - Bolzano

## 1. The Italian prison system and its criticalities

Italy saw the birth of its national penitentiary system roughly a century later than the rest of Europe. Starting with Royal Decree No. 255 of 9 October 1861, a national body was established to manage and organise the entire system.
Tracing an excursus on the Italian penitentiary situation, bringing together the main historical facts of the evolution of the penitentiary system in Italy, is useful to understand how the penalty structures influenced the growth of urban centres and how the decisions taken over time affected the welfare of the prison population.
At the end of the Second World War, the facilities in Italy were almost totally in a poor condition and in a general state of neglect. Prisons were neglected and living conditions inside the institutions inhuman. Until 1949, the fascist code remained in force, which was responsible for violent riots in all major Italian institutions after the end of the regime. The first reform, enacted with Law No. 460 of 1949, started a period of renewal by seeking new typological and spatial solutions. Between this period and the end of the 1970s, 65 new prison complexes were built, the best known of which were those designed by architects belonging to the Roman School, including Mario Ridolfi, Sergio Lenci and Pasquale Carbonara.
The year 1975 paved the way for the creation of innovative programmes and projects relating to prison architecture. In particular, in that year, a law was enacted that sought to adapt the prison system to the principles enshrined in the Constitution, namely those expressed in Article 27 paragraph 3. However,

the spirit of change dictated by this law clashed with the public order emergencies that hit Italy in the 1970s and 1980s, which meant that subsequent prison constructions, rather than going against a concept of an open and re-educative prison, moved away from the guidelines issued by the 1975 law, favouring compact typological solutions based exclusively on the security and control of prisoners. The result is a progressive reduction of outdoor spaces, as if to deny outdoor activities as a punishment.
At the same time, the use of prefabricated concrete panels is favoured in this period, clearly making any possible future expansion or change difficult.
With the end of the crisis period, the compact high-security typology was progressively abandoned in order to favour the emergence of new typological schemes, thinking of the prison also as a place containing spaces for work, education, sociality and recreation, in line with the guidelines of the 1975 reform. These new reflections favoured the progressive development of the telegraph pole typological model, which envisages long central routes, between 250
and 300 metres, along which the different bodies containing a plurality of functions and spaces are distributed. In the year 2000, a new 'Regulation containing rules on the prison system and on measures of deprivation and restriction of liberty' was issued. It has the merit of having introduced a number of innovations in terms of the design of prison establishments; in particular, the indications given mainly concern architectural and plant engineering aspects, as well as functional aspects in order to guarantee an acceptable standard of living for prisoners. It defines the spaces dedicated to housing, work, leisure and study; it introduces a fundamental theme: the relationship between prisoners and their families, seeking to develop increasingly dynamic contacts. However, not even this regulation served to mark a real turning point, due to overcrowding. The facilities created in this period propose a cross-type scheme, already widely explored in the past. The different typological schemes experimented in the course of Italian prison history are illustrated in Figure 1.
Turning to the current consistency of Italian prisons, it can be seen that the building structures are extremely varied, about 50 per cent of which were built before 1945. They are located in urban centres and often have valuable architectural and historical features.
Only 5% of the prisons were therefore designed and built after 2000. Although these prisons are of recent construction, they are far removed from what are considered to be international models, such as Austrian and Finnish prisons.
The facts summarised so far therefore give an idea, in their crudeness, of the overall state of the Italian prison system, which presents highly critical elements, linked on the one hand to the age and inadequacy of the buildings and areas, and on the other to overcrowding. It should be emphasised that the long-standing structures, due to their location, mostly within the historic city limits, do not allow for the possibility of extension/revision of the present spaces. This entails, on the one hand, the need to rebuild these spaces outside the city's settlement perimeter, and on the other, the strategic possibility of exploiting hypothetical disused buildings by changing their use, returning them to the community.

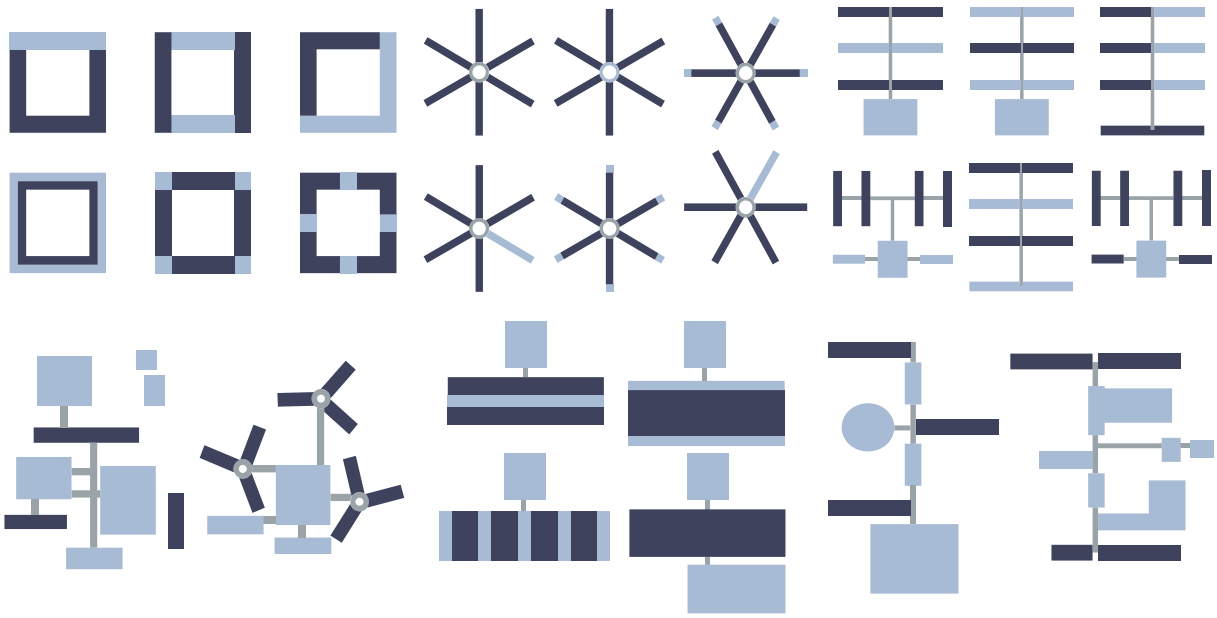

**Fig. 1**: Main type configurations (court, radial, telegraph pole, mixed, compact, modern telegraph pole system).

### 1.1 The overcrowding

An important aspect to be considered in terms of humanisation but also in terms of prison design is certainly the issue of the progressive and variable increase in the prison population; the problem of overcrowding requires both legal and architectural interventions. Over the last forty years, there has been an increasingly significant increase in the prison population in Italy, and overcrowding is the most obvious problem of life inside a prison because it affects the performance of daily activities, the space of prison cells, and the treatment processes provided for by law. It should be emphasised that overcrowding is the result of an ineffective prison system that is unable to re-educate and rehabilitate the inmate population. But what has happened in recent years? From the post-war period to the present day, the trend of prisoners in Italy has been very fluctuating. The irregularity does not, however, prevent the identification of two very distinct seasons: the first, from the end of the war until 1970, in which there was a constant and net decrease in the prison population; the second, from 1970 to the present day, where the exact opposite has occurred, with a profile of constant growth, as can be seen in Figure 2. Prison policies have created remarkable discontinuities without changing the trend of the period in question; particularly in the second phase, in which we still find ourselves today, the ineffectiveness of the measures has been strongly evident. After each resolution operation, the numbers quickly returned to higher levels than at the time of the measure itself. In 2010, the year in which a state of national emergency was declared due to prison overcrowding, the prison population had reached levels never before seen in our republican history. Since then, a series of interventions have been put in place that have led to a significant drop in the number of inmates, from 68,000 in 2010 to 52,000 in 2015. However, from 2015 onwards, until the partial emptying of prisons caused by the pandemic emergency, there has been a progressive increase. It should be emphasised that a significant drop in admissions in a prison facility can also affect an improvement in all the indicators that are traditionally used to record a facility's state of crisis. First of all, the correlation between the crowding rate and the suicide rate is significant. By decreasing crowding, the data suggest a significant decrease in suicide cases in prisons. To cope with the problem of overcrowding, the various prison administrations asked themselves what potential solutions could be found to address the serious space problems. As a result, two strategies were devised: the first consisting in the decriminalisation of certain offences, with the consequent early release of a considerable number of inmates; the second recourse to alternative detention modalities such as probation and custody. From a purely spatial point of view, a third solution was devised: distinguishing the inmate population into specific prison circuits, so that each category could benefit from a facility designed specifically for that type of user. This principle has given rise to the creation of different types of institutions such as facilities for drug addicts (I.C.A.T.) or those for mother prisoners (I.C.A.M.), which have brought positive results in terms of quality of facilities and services. The idea of adding units dedicated to particular categories of inmates within existing prisons has also led to significant benefits in terms of the liveability of prison complexes. In view of these considerations, the planner must therefore be called upon to define an appropriate spatial organisation for inmates and for each prison circuit, favouring the re-education and reintegration of subjects into society.

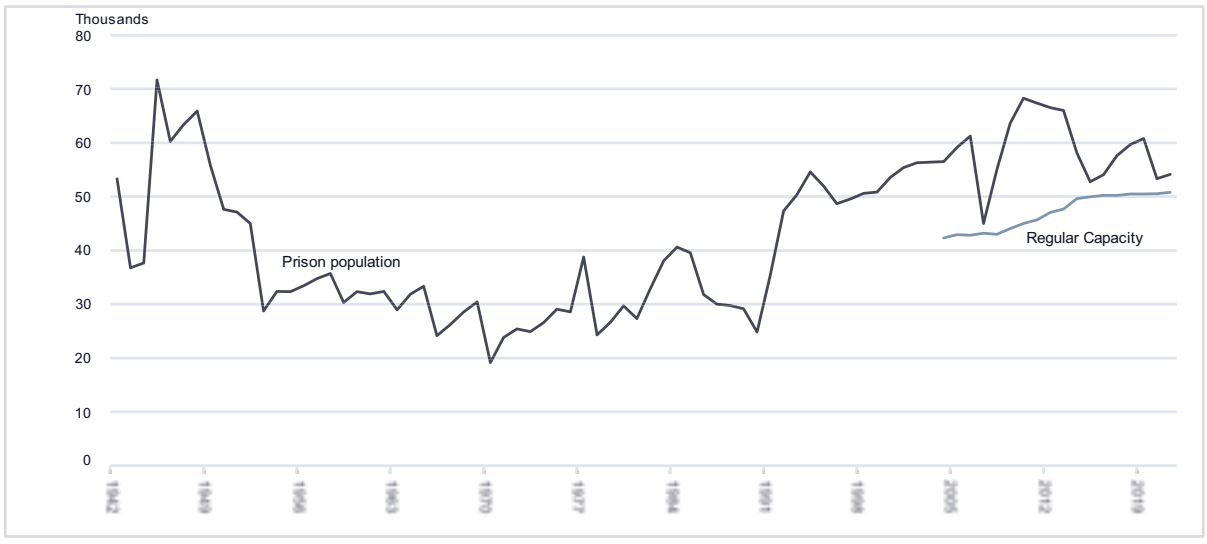


**Fig. 2**: Prison population trend from 1942 to 2019 (Source: DAP, Department of Penitentiary Administration)

### 1.2 Covid 19

To further complicate the condition of prisons, Covid-19 has contributed. The pandemic emergency has profoundly affected the lives of the entire population, not just the prison population; it has changed our habits, the way we work and live, as well as the way we communicate with others. In this respect, even the prison world has had to adapt to a new 'normality' made up of further closures to the outside world and an even more marked isolation of prisoners. In order to understand how our facilities were not able to cope with a problem of this magnitude, it is necessary to briefly retrace the main stages linked to Covid within prisons. Let us remember that the pandemic appeared in Italy in the first days of February 2020; at the time, it was not thought that this virus, which originated in China, affected us that much. The first restrictions in the prison world were put in place at the same time as the national measures towards the end of the month. In fact, the DAP began to suspend admissions, activities and interviews in the areas that were most exposed to the virus at that time, i.e. those in northern Italy. As the situation worsened and the virus spread throughout the country, 8 and 9 March became the hottest days of spring 2020; they are remembered as the first two days of a generalised lockdown in the country and, above all, coincided with the emergence of riots in 49 Italian prisons. The sad outcome of these two days is unfortunately not only limited to material damage but also claims the lives of 13 inmates. Following the riots, many escapes are also recorded; the most numerous take place in the prison of Foggia, where as many as 23 are recorded. Right from the start, it emerges that the facilities are not able to cope with the problem of overcrowding and the pandemic emergency at the same time; this is why in the first weeks of March, the inmate population begins to decrease thanks to fewer arrests and a greater use of alternative measures by the judiciary. All the measures put in place have indeed favoured a drop in the number of inmates but have certainly also contributed to consolidating a cultural climate
marked by fear of the spread of the virus in prison. In any case, Covid-19 also ended up arriving in Italian prisons. The timid measures put in place by the government have not succeeded in stemming the virus in penal institutions. In fact, the prison, as it is designed today, is the most crowded place in Italy and the cell shared with 5/6 inmates can become a congested and pathogenic space. It may seem paradoxical in some ways, but the hope is that this emergency situation can act as a forerunner to turn the spotlight on the prison planet, so as to induce politics to get back on the path of reform, starting with the design of spaces and places, suitable also for dealing with a health emergency. Certainly, every type of crime must require adequate responses in terms of penal enforcement, but any intervention in this area must not neglect the protection of human dignity.

## 2. The Bolzano prison

The present-day Bolzano Prison is located at Via Dante, 28, in Bolzano (BZ). The prison is located in an Austro-Hungarian building dating back to the end of the 19th century, right in the centre of town. It was opened in 1890. The building is connected to the Provincial Command of the Carabinieri of Bolzano. The entrance is on the east side and is located on Via Dante, while the rear of the entire complex, on the west side, overlooks a dog area on the Lungo Talvera degli Alpini, a small meadow with a walkway attached to the banks of a stream. To the north and south, the prison is set against other private buildings intended as residences. Structurally, the building suffers from its age; in addition to being very old, it is also poorly maintained. It is difficult to determine which sections of the prison are in the most critical situation; in general, every room, exterior and interior, would need partial reconstruction or renovation.
partial reconstruction or rehabilitation. The structure appears to be divided into two sections; each of them includes sleeping rooms accommodating between three and eight inmates; each cell is equipped with a washbasin and a toilet but no shower. As far as common areas are concerned, there is only one room on the first floor, in which there is a table football. However, this room is
very small and does not contain all the potential inmates on the floor. There are two gyms, one on the first and one on the second floor; they are old and poorly maintained; the inmates can attend four at a time and consequently the spaces present are not sufficient for all. There is also a library and a space dedicated to schooling and training. However, there is no place dedicated to work. With regard to outdoor spaces, the only area present is a courtyard, which is narrow and absolutely too small to accommodate the inmates; the courtyard is fenced off with walls on each of the four sides. As can be seen from the data, illustrated in Figure 3, the facility is permanently overcrowded and absolutely unsuitable due to the lack of basic spaces. However, it must be emphasised that this lack is not due to inattention on the part of the prison system, but rather, as in other ageing prisons, to the age of the building and its layout. Since it is a building located in the historic centre, it is not possible to think of hypothetical extension spaces, and even with regard to interior work, the planning possibilities are very limited.

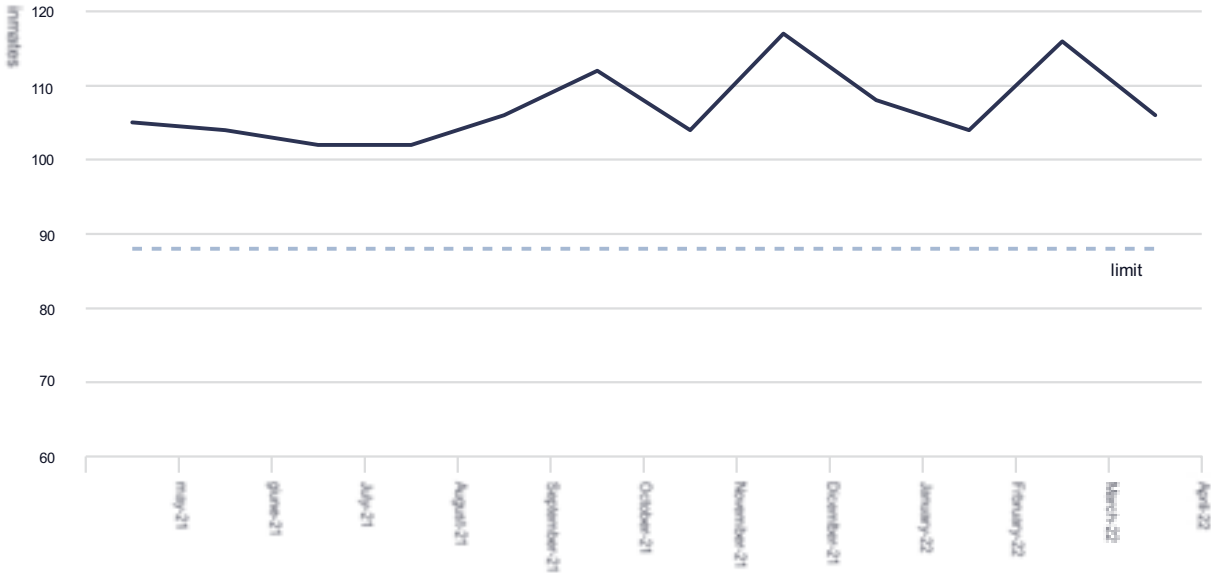


**Fig. 3**: Inmates present in the Bolzano Prison

### 2.1 Design competition for a new prison and guidelines

The National Prison Construction Plan, prepared by the Delegated Commissioner on 27 April 2010, provided for the construction of a new medium-security Penitentiary Institute on the southern outskirts of Bolzano, with a capacity of 220 inmates. On the basis of these acts, a call for tenders was issued for the design, construction and management of the new Penitentiary House through a public-private partnership. In July 2013, the Autonomous Province of Bolzano published a call for tenders for the financing, planning and management of the new prison. The basis of this notice is the updated criteria for prison construction, the key elements of which are listed. The most recent indications on the design criteria for prison buildings concern: (1) choice of area; (2) settlement principle; (3) S.M.E.P. model.

The choice of area is made according to the type of institution to be built. The different levels of security require a distinction of criteria for ordinary and high security institutions. An ordinary facility can be located in an area that has an effective relationship with the surrounding area and guarantees adequate security; on the other hand, for high-security facilities, more isolated areas must be chosen to avoid social risks. The guidelines also refer to the morphological, plano-altimetric, hydro-geological and structural characteristics of the intervention area. Among the key factors determining the choice is the relationship and connection of the area to be realised with service infrastructures (electricity, gas, water, sewerage

etc.) and communications (motorways and railways). A new and fundamental concept has also been included in the general criteria: that of prison city; this is a new way of seeing the prison as a city where different functions take place and in which different relationships are established between the parties. From the indications provided, it emerges the need to design the entire complex in line with the analysis of functions, flows of people, methods and times of access to the different places that make up the prison city. The internal organisation must be able to give rise to public, semi-public and private spaces, as in an urban city. This innovative vision is applicable in all those cases where the prison structure is a central and strategic pole. On the other hand, it is difficult to propose this approach for smaller facilities; interventions must be closely related to available resources. For a small prison, it is more appropriate to think in terms of the logic of the urban block or city district.

It has been shown that prison centres that are too large are very complex to manage in terms of supply and control and surveillance operations; sociological studies also show that excessively large detention sections (100-200 people) produce an excessive increase in anxiety levels, thus increasing the occurrence of violent episodes and/or riots. In conclusion, it should be made clear that the concept of prison cities in Italy is currently little applied. This stems from the peculiarity of the territory, the absence of large areas and the lack of a real cultural change in the country. The most important novelty concerns the S.M.E.P. system (Sistema Modulare Edilizia Penitenziaria); it was elaborated in 2009 by an interdisciplinary study group at the Department of Prison Administration with the aim of elaborating the design criteria for the construction, modernisation and conservative management of state-owned buildings housing penitentiary institutions. The S.M.E.P. system is composed of modules that can be aggregated according to a Scottish mesh by means of connection joints around uncovered areas, according to patterns reminiscent of ancient urban aggregates. This model elaborates a rationalisation of the pedestrian and vehicular routes by imagining them as rectilinear to reduce transfer and travel times within the institution; each part must be composed of different modular units (administrative module, semi-liberated prisoner module, detention pavilion module, etc.), so as to unite similar functions

in compact complexes that can be covered in a short time. The absolute novelty is the introduction of the canteen; in fact, meals are currently provided in the cells or in special spaces within the detention sections. A further novelty concerns the streamlining of passive security devices such as grates and gates. There are usually no escapes and/or violent incidents that are based on tampering with these systems. Traditional devices are replaced by video surveillance and access control systems, making the prison facility as similar as possible to other civil buildings such as hospitals and schools. There is however a necessary consideration to be made: the risk that the use of a standardised model will then result in a cloning process of the project-types drawn up by DAP is concrete. It must be borne in mind that each new design can be improved and updated. Furthermore, one cannot design the entire complex without taking into account the different territorial contexts. Consequently, the fundamental points of these Guidelines must be taken into consideration without forgetting the subjectivity of the project. The S.M.E.P. project therefore represents an opportunity that must become mature, must correct itself over time and be able to adapt to different project situations.

**2.2 The new prison impossible to build**

The construction of the new prison was supposed to be finished in June 2016. At the time the call for tenders was published in 2010, Luis Durnwalder, President of the Autonomous Province of Bozen/Bolzano, predicted: 'We will start in 2012 with the procedures and by 2014 the inmates will be transferred'. In reality, things went very differently. In 2013, the Società italiana per Condotte d'Acqua in a consortium with INSO (a subsidiary of the Condotte Group) won the tender. Shortly afterwards, in 2014, however, the construction giant went into receivership, effectively blocking the realisation of the works. This event therefore prevented even the first works from being carried out and the situation, currently the subject of legal disputes, is at a standstill, both in terms of financing and in legal terms. In fact, as Condotte Spa is under extraordinary administration, it is de facto prevented from starting the work. Between 2013 and 2021, a whole series of talks took place between the Autonomous Province of Bolzano and the Ministry of Justice, which, however, did not lead to the situation being resolved. Even recently there was a meeting between the current president of the province, Kompatscher, and the Draghi government's Minister of Justice, Cartabia. In this meeting it emerged that the current prison is at the bottom of the rankings in terms of quality. The governor reiterated to the minister the need for urgent state intervention to shake up the situation, pointing out that there must be an agreement so that the state assumes the costs of building the facility. Unfortunately, among the outstanding issues there is still the knot of Condotte Spa and the judicial events mentioned above.

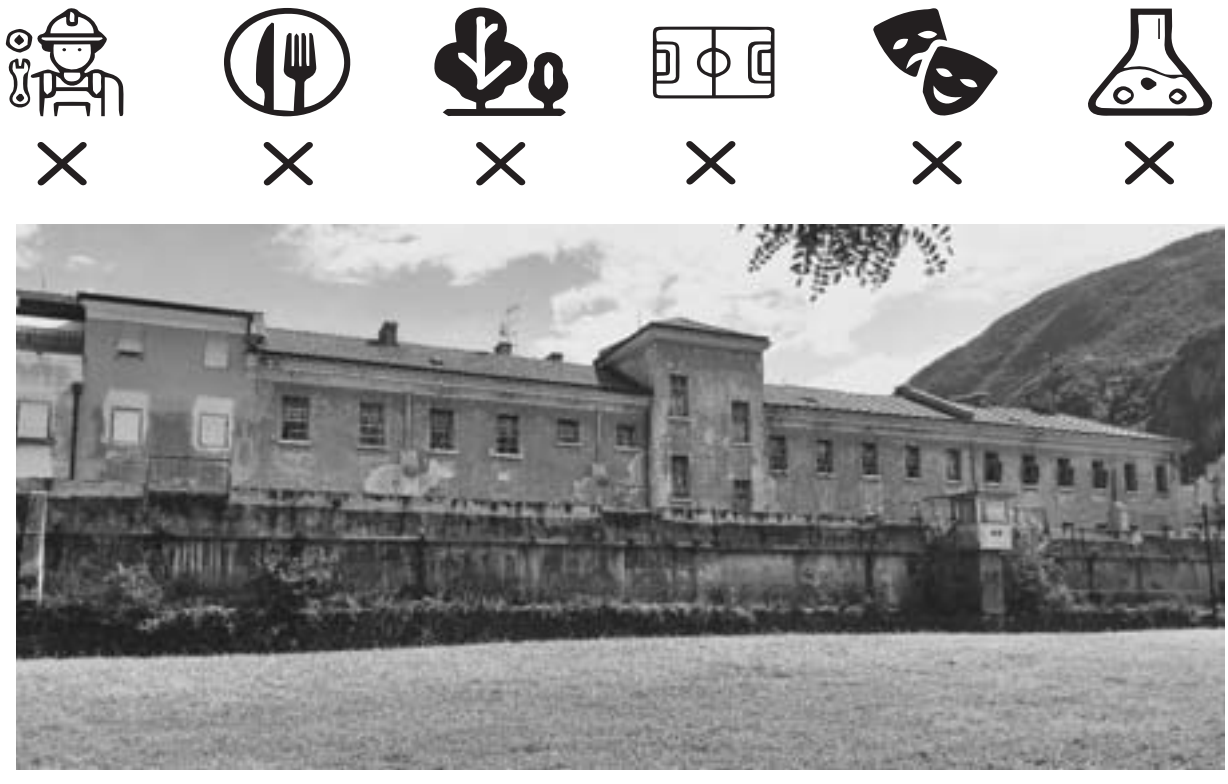

**Fig. 4**: The current Bolzano Prison

## 3. A new prison model

Prison, and in general the structures related to it, are constantly the subject of debates between political and institutional actors; what distinguishes this debate are the conditions of liveability of places of detention, at the same time as the actual effectiveness of the penalty applied. In order to imagine a custodial sentence marked by respect for the prisoner's dignity, one cannot ignore the fact that the place in which he is confined is of fundamental importance. Hence the need to define clear design approaches capable of giving rise to a structure that is an expression of this sensitivity.

### 3.1 Designing the new prison in Bolzano

The concept of this project for the Bolzano Prison stems from the need to break out of the traditional design circuit of prisons, considering contemporary architectural culture. It takes into account a broad path of knowledge and the complexity of the factors that characterise the theme of detention; it is intended to be a turning point after a long domination of a concept of detention inadequate for our times, which unfortunately still pervades segments of prison construction. The original idea in architectural terms is not the development of a passive prison, of waiting and empty time; rather, it is a structure that favours the autonomy and responsibility of the occupants and above all that has a different perception of the community, so that, within the allowed limits, it can be fully integrated with the rest of the city. The basic idea starts from the already well-known typological and spatial scheme of the telegraph pole; this design concept, however, is intended to be a contemporary reworking of it, partly changing its characteristics. It was immediately clear that, given the plurality of functions to be accommodated by the project, a design scheme with several volumes, well connected to each other and with easy accessibility and accessibility was necessary. First of all, we started with the idea of a compact volume, capable of containing all the design potential; it was immediately clear that this body needed to undergo clear compositional operations. First of all, we set ourselves the problem of creating two distinct areas, one that could fall within a rigid perimeter, the other outside it that could communicate with the city. Thanks to an operation of disjunction of the compact body, a head volume was then developed, extruded in one direction to mark the typological difference between the two bodies. Then thanks to an operation of subtraction of both bodies, different typological volumes and a clear and effective dialogue between spaces and light were obtained. From the subtraction of the first body it was possible to obtain, above the large plinth, three different volumes (combs) attached perpendicularly to a large communication gallery between the head and the rest of the volumes; thanks to an operation of overhang, further dynamism and importance was then given to the three volumes, which immediately seemed suitable to house the residential core. In order to complete, also on a typological level, the initial idea of the telegraph pole, two further volumes of exceptional architectural character were added to the entire complex, which could stand out in form and function. The entire compositional process was then summarised in a conceptual table shown in figure 5. The telegraph pole thus conceived encloses all the spaces necessary for the smooth functioning of the entire prison complex. Furthermore, the idea of creating a head building favours a clear distinction between the administrative part and the prison part, despite the fact that both are easily accessible from the connecting element, the gallery.

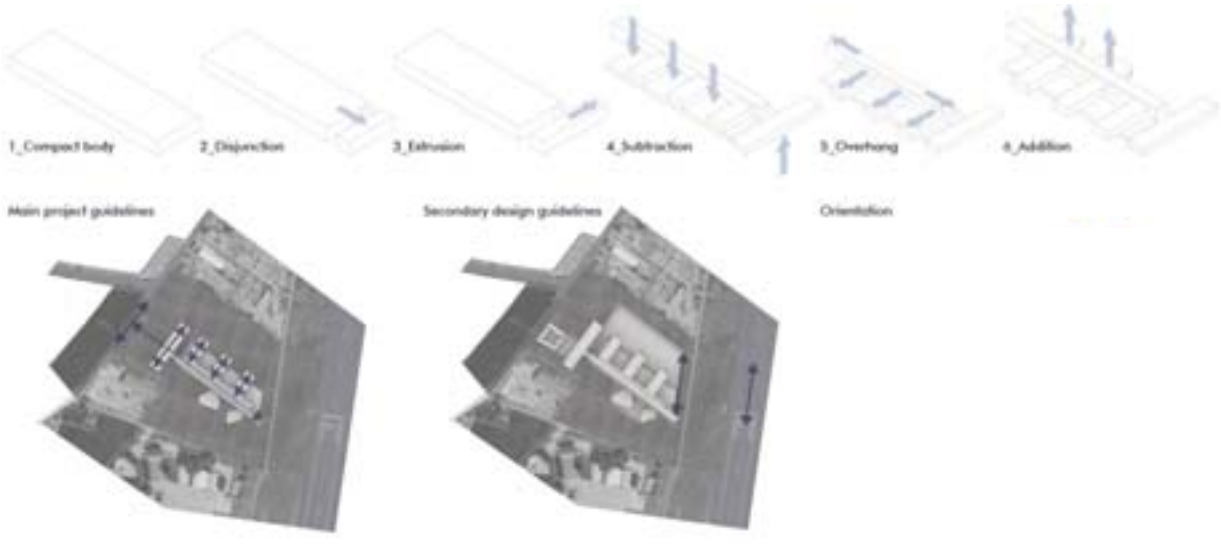


**Fig. 5**: Concept of the new prison

Another fundamental element of reflection concerns the study of the perimeter wall; it is conceived as the perimeter boundary of a large open-air space. In this way, the boundary wall not only fulfils a mere security function, but is also that element of the project which clearly defines the safe and impermeable area dedicated to outdoor activities. The outdoor area is excavated down to the base level of the entire complex. The boundary wall thus becomes for one part retaining wall and for the part protruding from the zero ground level a perimeter that cannot be crossed. The earth from the construction of this excavation is then partly reused for the creation of an artificial terraced hill for the cultivation of vineyards. It is intended to be an integral part of the project; it picks up on the theme of agricultural cultivation, clearly marks an uncrossable boundary and separates the prison complex from the internal road system. A further excavation is made in correspondence with the square where a space is created for the construction of a bastion that will occupy the section of the semi-release prisoners.

### 3.2 From the cell to collective spaces

The most important part in a prison is certainly the cell, the place where the inmate spends most of his time, the place where he can be in silence and reflect on himself, the place where he can rest, study, read, live his daily and night life. However, as already mentioned, very often the residential detention sections of Italian prisons are overcrowded, outdated and the cells occupied by more than 5 inmates. This makes it impossible for inmates to experience their own intimacy; in this way, no privacy is guaranteed and very often the multiple cohabitation within the cell leads to social discomfort and sometimes to cases of violence and, in the most dramatic situations, suicide or homicide. These issues of reflection are fundamental to understanding what must be the guiding principle of the prison project, i.e. residence. In the light of what has just been said, the project must be composed of single residential units, both to guarantee autonomy and for the security of the prisoner himself. The convivial aspect is instead implemented and thought out in the design of the common parts. This is intended to encourage conviviality and sociability during the day, and then to guarantee an intimate space during the night. This premise is very necessary, since usually in Italian prisons the moments in the cell are extremely superior to the moments shared outside it. Another fundamental point is the aspect of meal consumption. They are usually consumed inside the cell and the food is heated with electric ovens. In this case, the project envisages the design of a communal canteen, so that the eating of meals becomes a moment of sharing and conviviality, and above all an opportunity to leave the residential unit.

The first type of residence is a room designed to accommodate a single inmate; it consists of a bathroom, a bedroom and a terrace. The second type of residence is designed to accommodate a single inmate; it consists of a bathroom and a bedroom, the latter being visible as soon as one enters and accessible via a very short corridor.

The architectural choices of the entire design scheme stem from the study of the area, the choice of the typological scheme and the analysis of the surrounding context. After having thought out the general layout already described in the conceptual schemes, it was necessary to detail the scale of the project, starting with the distribution of the interior spaces. The need for separation between two major realities immediately emerged: the administrative one located in the head building and the purely penitentiary one occupying the rest of the facility. The head building is elevated and is accessible from different points of the square according to the type of user. It consists of two floors that enclose the offices, administration and visits. Uniting the exterior with the interior is an elevated bridge leading to the gallery, the energy and distribution hub of the entire project. It is necessary to access all the spaces and is designed as a steel frame structure independent of the basement. The latter stems from the need for a basement car park, but above all from the idea of inserting the outdoor space, a fundamental living space for the inmates, delimited by the walls, at a lower level than the design zero. The basement floor is therefore open to a large park, a space useful for sports and recreational activities. The floor located at project level zero, i.e. that of the square, encloses the services including the gymnasium, canteen, school and work spaces.

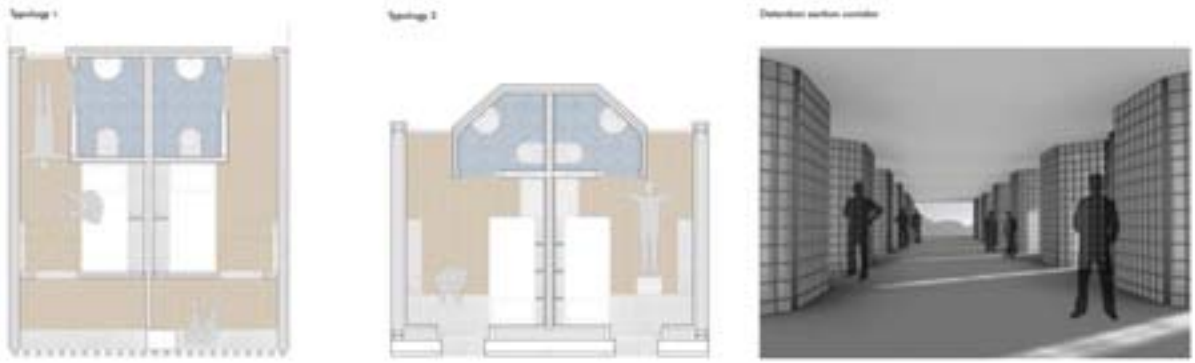

**Fig. 5**: Detention cells

The floor above the services contains the first detention sections and the relational and distribution spaces for use by the inmates. It leads to the green courtyards, additional spaces designed for water and outdoor activities. The courtyards are also perforated at various points to allow light to enter and illuminate the lower floors and plants to grow inside the basement. Attached to the entire project like steel brackets are the three combs, cantilevered blocks dedicated to residences; they consist of wide corridors and individual residences. The combs have two mirrored floors and contain most of the residential units.
The project also contains other key elements; the earth from the excavation of the basement is reused to create an artificial terraced hill, designed as a place of work for the inmates and consequently for the cultivation of vineyards and other fruit trees. Another peculiar element is the enclosure; unlike other penitentiaries, it occupies a very limited portion of the project area; in addition to its fundamental function, it plays an important and intrinsic architectural role. Concluding the overall layout are the auditorium and infirmary in the spine of the gallery. The exceptional element is the semi-liberation detention section; located in the outer corner of the square, it is designed as a green bastion.

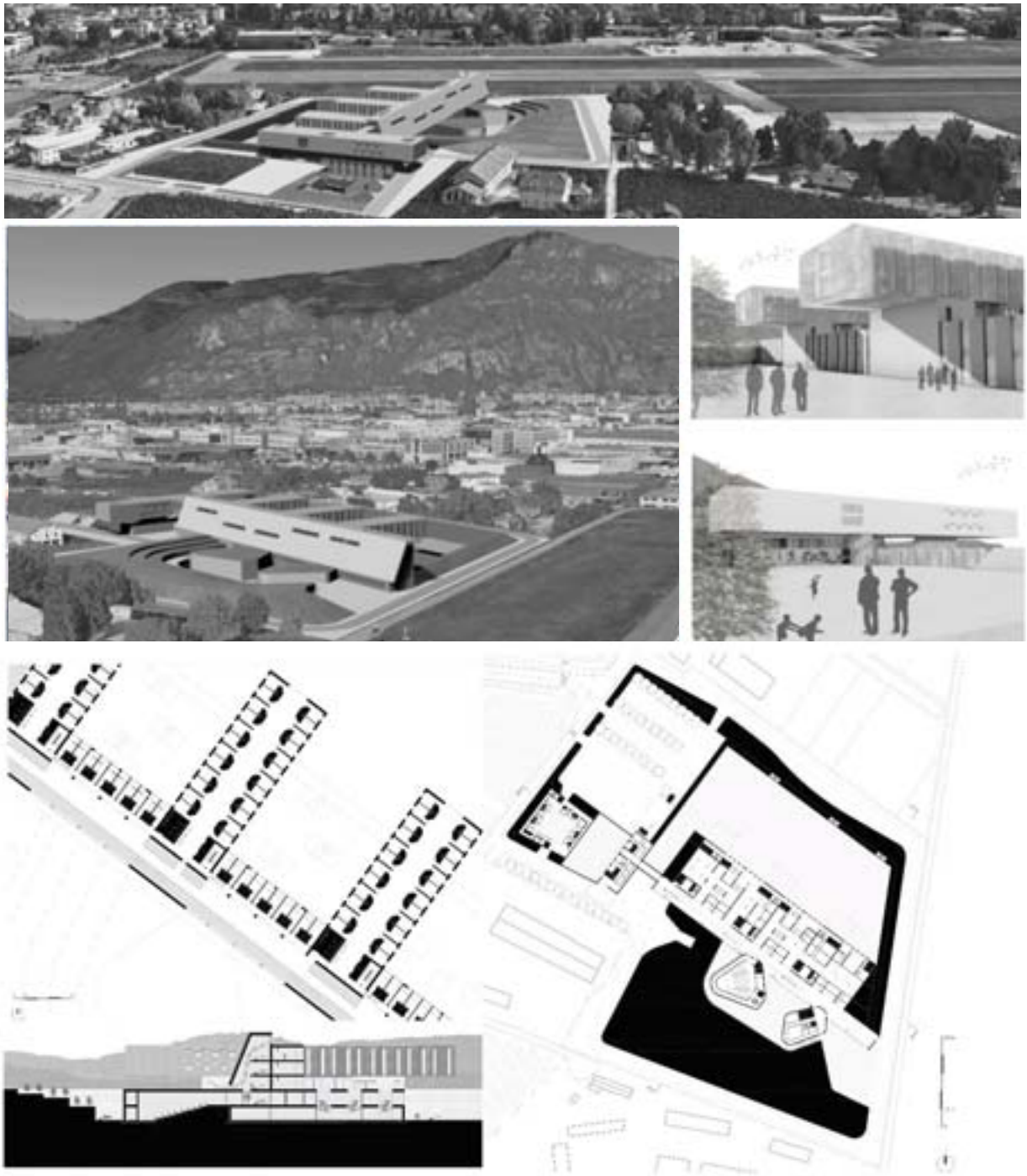

**Fig. 6**: Architectural plans and sections, overall view of the new prison

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# The analysis of values as a strategy for the conservation of cultural heritage.

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The relationship between cultural heritage and the topics of sustainability and resilience requires a reflection on the cognitive analyses underlying the conservation and valorization project. The theme is particularly complex because it relates systems of "measurement" and objective analysis with subjective assessments such as the attribution of value. The value analysis stands as a distinction with respect to the planning actions that can be of safeguarding, conservation or valorization. Although cultural heritage is often experienced and remembered as immutable, careful analysis shows how this apparent stability is the expression of a constantly changing process. Identity elements are formed and reformed through the interaction of numerous human and non-human factors. The scientific debate on the way in which heritage values can be defined and evaluated has recently assumed a role of primary importance in the light of the reflections conducted in relation to the UNESCO sites registered in the WHL. Among the first studies, the Nara Grid represents in this sense a tool of proven interest, but which perhaps needs further developments to adapt it to a situation in which there is an increasing need for a weighing criterion. This paper proposes a reading of this methodology in relation to the application of quantitative analysis matrices linked to hazard and risk phenomena and how these can be read depending on a qualitative factor as well.

**Keywords:** conservation, values analysis, risk analysis, Nara Grid, heritage

## 1. Introduction. The analysis of values as a methodology for conservation

Contemporary European approach to heritage is marked by t the entry into force of the Framework Convention on the Value of Cultural Heritage for Society, also known as the Faro Convention in 2011. This convention emphasises the value and potential of heritage as a resource for sustainable development and quality of life in a constantly evolving society, highlighting important aspects of heritage related to human rights and democracy.

So, according to this approach, in a way, we can affirm that conservation of heritage relies under this approach in its capacity of being a resource of sustainable development and quality of life for the society, displacing the focal point of the former theories of conservation, focused on the object itself, to its “utility” for the society.

One of the milestones of the Faro Convention is to encourage citizens to recognize the importance of cultural heritage objects and sites through the meanings and values that these elements represent to them.

The concept of “recognition of values” has been widely developed since its first theorization that we could place in the work *The Modern Cult of Monuments: Its Character and Its Origin*. (1903).
But it has been in recent decades, and especially because of the need to develop effective management instruments for some sites included in the World Heritage List (WHL) when we have seen systematization through different schematization proposals that attempt the difficult, impossible, task of measuring the immeasurable.

It is noted that UNESCO, in the *Guide for managing World Cultural Heritage* [1] recognizes this approach as a possible response to the growing complexity of the Heritage and to the need to define values by elaborating a *Declaration of meaning* as a basis for the development of conservation and management strategies.

This approach was later developed by the work on conservation plans. Kerr [2] introduces a systemic approach to the development of conservation and management plans based on the values and cultural significance of heritage places for society. The meaning of the property is established through a participatory process involving stakeholders. The resulting declaration of meaning becomes the reference for the conservation strategies which, considering the conditions of the site, the reference legislation, and the needs of the community, emerge as a reference basis for the management of the site.

The reference to the World Heritage Convention appears fundamental as the latter is founded on the Outstanding Universal Value of the assets and from which derives the need to consider them as an essential aspect for their management and transmission. This approach, also applicable to properties not declared World Heritage, would allow the qualitative structure of significance to be transferred to a quantitative distribution in terms of percentages. This method, although starting from a quantum basis, is however subject to assessments that are not always objectifiable.

The systematization of the analysis of values also finds significant references in the approach formulated by the Nara Document on Authenticity (1994). The Nara Document attempts to broaden the concept of heritage of the Venice Charter by placing it in relation to the cultures that generated it and consequently consider a wider variety of values that can be attributed to it. Based on this vision, Van Balen [3] develops a method of analysis of the values in which the authenticity of an Heritage asset resides. This analysis relates the "dimensions" (artistic, historical, social and scientific) with the "aspects" (form and design, materials and substance, design and function, etc.) so as to identify the assets' assets.

This approach is shared in the Faro convention by the development of democratic participation as one of the priorities of the Faro Action Plans, that aims to illustrate the richness and novelty of the principles of the Faro Convention, as well as providing possibilities for interpretation in relation to current societal challenges.

Based on the Faro Convention Action Plan motto “Peoples, Places and Stories”, the Council of Europe’s ongoing reflection on the Faro Convention draws on three main ideas:

- Prioritising inhabitants in their relationship with cultural heritage;
- Reaching out to heritage communities and groups;
- Strengthening linkages between all the local, regional and national heritage stakeholders, through synergetic action.

The dual objective of this plan is implementing “shared responsibility” involving citizens and civil society in mechanisms integrated into public action for the purpose of identifying values, defining priorities and managing heritage projects.

One of the key factors of the Faro Convention to reach this objective is the development of the concept of “heritage communities” which are defined according to the Article 2 as people who value specific aspects of cultural heritage which they wish, within the framework of public action, to sustain and transmit to future generations”.
These heritage communities[1] suggest two important elements as far as the role of citizens in the presence of heritage is concerned:

[1] This definition of heritage communities includes all those people in an open process that sense the importance and necessity to reflect upon “the ethics and methods of presentation of the cultural heritage, as well as respect for diversity of interpretations, the establishment of processes for

- the competence of citizens to determine heritage values
- the will, freedom and decision to outline actions for the preservation and transmission in the framework of the public authorities
- the legitimacy of the citizens to decide about their heritage and to initiate processes in which heritage occupies a central place and role

In relation to the first point, the recognition of the competence of citizens to recognize heritage values, still needs a deep reflection that leads to establishing one, or several, methodologies that can systematize this recognition, and above all, establish criteria of prioritization of these values that allow informed decisions to be made, since as sometimes happens, these values themselves can conflict with each other resulting contradictory.

But how to translate those principles in a practical way of assessing values remains still a big challenge.

## 2. Proposals for assessing values. When hazard and risk came into play.

An interesting reference on this topic is the Getty Conservation Institute (GCI) forum where "the complex social, political and economic issues raised by [heritage] protection could be explored and debated". This initiative evolved into the research project on the heritage values of the GCI, which aimed to link economic and cultural approaches to heritage valorization and to promote the development of a more integrated approach to conservation. Between 1998 and 2005 the project defined and assessed the heritage values considered to be fundamental for conservation and examined case studies relating values to the management of heritage sites The understanding of cultural significance becomes the reference for decision-making processes and can form a basis for the formulation of resilience projects.

Ruins of the ancient village of Belchite (Saragozza, Spain). Conserved as a place of memory of the Spanish Civil war (1936-1939). Photography of the authors.

conciliation to deal equitably with situations where contradictory values are placed on the same cultural heritage by different communities, the development of knowledge of cultural heritage as a resource to facilitate peaceful co-existence by promoting trust and mutual understanding with a view to resolution and prevention of conflicts, and the integration of these approaches into all aspects of lifelong education and training". (Faro Convention. Article 7)

Values-based conservation approaches as well as considering different aspects integrate citizens into the decision-making process.

What has been illustrated highlights how conservation actions prove to be even more effective when the complexity of values is understood and supported in decision-making processes. Concepts of "value" vary greatly in the language of different professional domains. In the context of conservation, values refer to the different qualities, characteristics, meanings, perceptions or associations attributed to the things we wish to conserve: buildings, objects, sites, landscapes, settlements. The latest trends that embrace the analysis of values as a strategy for conservation are based on the ability to recognize, discern, document and act on the dynamism of values.

Another interesting approach is to introduce the factor of hazard and risk in this analysis in the view of conserving cultural heritage.

Cultural heritage is under constant threat, as evidenced by recent catastrophic events, whether natural such as earthquakes, volcanoes or anthropic such as the war in Ukraine.

These borderline situations make it possible to establish factors in the evaluation that further define the hierarchy of these values if one attends to the need to preserve those considered essential for a project of conservation, reconstruction and recovery of identity.

When conducting risk analysis in relation to assets, it is first necessary to distinguish between two concepts: the terms "hazard" and "risk" are often used interchangeably. However, these terms have completely different meanings and functions.

- Hazard: something that has the potential to cause harm.
- Risk: the degree of likelihood that harm will occur.

Commonly used formulas for risk analysis are:
$R = H * D$
$D = V * E$
Risk is calculated as the product of the hazard, vulnerability, and value (damage) of exposed items: R = Hazard [$]; H = Hazard [-]; D = Damage [-]; V = Vulnerability [-]; E = Value of exposed items [$]

Meaning by:
Risk (R) the probability of adverse consequences (to human life, property and resources, economic activities, or the environment) resulting from the interaction between the development of an event and man-made areas;
Hazard (H), the temporal probability that an event (hazard, process, phenomenon) of given intensity will affect a certain area in a given time interval;
Expected damage (D), the amount of potential losses in the event of an event of a certain intensity. The unit of measurement depends on the unit used to indicate the value;
Vulnerability (V), the degree of loss of an exposed element due to impact with a natural phenomenon of a given intensity.
It is expressed in qualitative or quantitative terms on a scale of 0 (no loss) to 1 (total loss) and is a function of the intensity of the active process and the type of element at risk.

From the formulas proposed above ( $R = H * D$ and $D = V * E$), related analyses can be derived.
- Hazard analysis, which consists of outlining an evolutionary model of the process that answers the following questions:
What kind of process? typological recognition;
How much energy does it develop? understanding of evolutionary mechanisms;
When can it be controlled? identification of the frequency of activation;
Where can it occur? identification of spatial distribution.

- Risk analysis, which, starting from hazard analysis by combining it with the concept of damage, answers the following questions:
What elements (people, things, activities) are affected? identification of the elements involved;
How impact-resistant are the elements involved? Assessment of the vulnerability of the elements;

What is the amount of loss? Assessment of the expected damage.
It is in this analysis that a "subjective" factor is introduced, the value of the elements involved, traditionally divided into four categories: physical value, social value, economic value and environmental value.

At this point a new concept is added, that of vulnerability assessment, which depends on the type of elements at risk involved (E) (and thus their impact resistance characteristics) and the intensity of the process (I), hence the formula: V = f (E, I)
Vulnerability is identified with a value ranging between 0 and 1, i.e., between 0% and 100% loss of function of the element.

Obviously, this concept is extremely related to the physical consistency of the asset, and it is in that one that it is easiest to think about intervening to reduce risk through structural solutions.

The real challenge comes when a value is established and given weight in all the analysis formulas previously described.

It is then that all the concepts previously described come into play, where the attribution of value by heritage communities acquires meaning when it comes to "weighing" the importance of heritage, and, without having to resort to the extreme case, it is possible to introduce the concept of value into a quantitative field such as hazard and risk analysis, as a determinant of the "importance" of heritage and the design and conservation choices that affect it.

Table 1. Nara Grid

| Aspects ↓ | Dimensions ⇝ | Artistic | Historic | Social | Scientific |
|---|---|---|---|---|---|
| Form and design | | | | | |
| Materials and substance | | | | | |
| Use and function | | | | | |
| Traditions, techniques and workmanship | | | | | |
| Locations and setting | | | | | |
| Spirit and feeling | | | | | |

As we have explained, one of the most commonly used systems to establish these values is the Nara Gird developed by Van Valen from the 1994 Nara Document of Authenticity. In any case, this table remains qualitative, and it would therefore be necessary to establish a numerical order a priori to the importance of the aspects and dimensions, which could be the same or vary depending on the heritage object studied or even the focus of the analysis to be carried out later.

In the same way, the value of each one of the boxes should be determined in relation to the previous ones, and it would be a first approximation to a search for an agreement between the parties.

The result of this analysis should be transformed into a corrective factor (positive multiplicative from a value greater than 1 or negative in values less than unity) of the value E (Value of exposed items) and of influence on investments to decrease V (Vulnerability).

This means to introduce a qualitative weighting that has been attempted to be systematized in order to be able to apply it to a quantitative system.

## 3. Conclusions

The topic of value analysis appears to be of great interest and topicality, especially in the European context to overcome the approach of assigning values according to a top-down process. Increasingly, the vastness and complexity of cultural heritage, and of the phenomena that affect it, require awareness on the part of citizens. The creation of bottom-up sharing processes looms as an effective and sustainable solution to heritage conservation.

Historical center of Moncalieri (Turin, Italy). The building depicted in the image constitutes a controversial example of conservation.

Hazard and risk analyses, briefly described in the text, are known to be used to set priorities and strategies for disaster response. The hierarchies of intervention that such analyses define place people's lives first and property second. The resulting intervention priorities, however, cannot fail to consider that individual assets take on different values, not just economic ones, and that these constitute an important reference element in defining intervention hierarchies of safeguarding, protection and conservation.

It thus becomes clear that weighting this value according to people's perceptions of heritage is a possible strategy for rationalizing and optimizing efforts devoted to heritage conservation and ultimately ensuring a resilience strategy.

Thus, if the values attributed to assets are connected in the analysis to their vulnerability, dealing with cultural heritage it is necessary to consider that the loss of functionality, understood as the possibility of use, is not always a discriminating element.

While what distinguishes architecture from the other arts is the need to perform a function, except in the case of monuments erected as such, its value as heritage requires a process of social recognition that occurs over time due to various artistic, social, historical, and cultural/scientific circumstances, as reflected in the Nara Grid dimension line, which are interrelated with the different aspects that characterize the asset.

In the case of a tragedy, once the disaster has occurred, we find different positions towards it, depending on the attribution of values that is made in each specific case, both to what the building was before and what it represents now.

We can simplify the strategies to act in three positions:

- Protect. This is a strategy that seeks to reduce the vulnerability factor, even though the events to which the building will be subjected are not always predictable.

- Rebuild. From strategies of rebuilding where it was as it was, recognized by the 2000 Krakow Charter as a possible extreme solution to keep the memory of communities alive, to consolidation, reformulation of architectural spaces or addition of new parts that keep the heritage active.
- Preserving the ruin. Deprived of their function, heritage sites can become a place of memory with high value for the community that owns it, or even universal in scope.

Among all of them we find notable examples such as the Campanile in Venice, the reconstruction of the Warsaw Center, the Cathedral of Noto in Sicily, or the memory sites of Hiroshima, Coventry, or Gibellina (Sicily).
Analysis applicable upstream and downstream to outline a conservation strategy that goes beyond the formal and material approach and considers the more current vision of heritage as a resource for endogenous development.

One of the challenges facing conservation today is to understand the shift in focus that has occurred in recent years from "what" and "how" to conserve to "for whom" to conserve. Understanding this can help develop the tools needed to outline conservation strategies.
Efforts must therefore focus on applicable upstream and downstream analysis of risky events to outline a conservation strategy that goes beyond the formal, material approach and takes into account the more current view of heritage as a resource for endogenous development.

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# Puzzle design
# Between Vision, Speed, Design and Sustainability

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## Abstract
The cultural and methodological trend in project elaboration follows increasingly specialized dynamics and abilities that are mostly autonomous compared to other themes. They must be achieved quite rapidly, thus losing sight of processes and integrations of many other subject matters that should bring forth innovative and sustainable solutions, thus becoming most attractive in the territories they are set up in, sites that nowadays most often need urban-regeneration interventions.
Living on Earth is a complex theme to plan. Taking into account the lengthy realization and rapid social mutations, the complexity is even greater if the areas being considered include Cultural Heritages. These themes cannot be managed by using solely political, philosophical, economical or urban considerations; nor can the architects, archeologists or restorers be left alone in their abilities and competence. The method-model that is used is practically always carried out by one of the figures mentioned above. The context “to be sought after” and the socio-cultural composition of the site is however forgotten.
Thus said, it would be wise to use a multi-disciplinary model of research beforehand, reflecting and sharing thoughts among the various competent entities that participate together (we shall call this Puzzle Design).
Prior to the projection and realization of the project, it is necessary to have the various analytical aspects interact.
Another aspect that must not be considered as secondary in putting this approach method into action is the speed of realization.
Paraphrazing a quote by G.K. Koenig in the actualization of Puzzle Design we could say: “Attention to detail is needed, because the gap between a roar and a bray is short”.

**Keywords:** Urban regeneration, Architectural design, Urban design, Social design, Industrial design.

The cultural and methodological trend in project elaboration follows increasingly specialized dynamics and abilities that are mostly autonomous compared to other themes. They must be achieved quite rapidly, thus losing sight of processes and integrations of many other subject matters that should bring forth innovative and sustainable solutions, thus becoming most attractive in the territories they are set up in, sites that nowadays most often need urban-regeneration interventions.
The solutions adopted today, more often than not, cause concern for cultural and methodological trends in project elaboration, which prioritize specialized and autonomous abilities over a more holistic approach that considers the integration of different subject matters. This approach, you argue, may lead to the rapid achievement of project goals but may overlook the importance of innovation and sustainability, especially in the context of urban-regeneration interventions.
Your concern is valid, as a narrow focus on specialized abilities may lead to siloed thinking and prevent the identification of opportunities for innovation and sustainability. It's important to adopt a more holistic approach that considers the interconnections and integrations of different subject matters, such as social, economic, and environmental factors, to develop innovative and sustainable solutions.
In the context of urban-regeneration interventions, for example, a more holistic approach would

consider not only the physical infrastructure but also the social and economic needs of the community. This would involve engaging with stakeholders and community members to understand their needs and priorities, and developing solutions that are responsive to these needs while also promoting sustainability.
In summary, while specialized abilities are important in project elaboration, it's crucial to adopt a more holistic approach that considers the integration of different subject matters to promote innovation and sustainability in urban-regeneration interventions and other projects. [1]

Living on Earth is a complex theme to plan. Taking into account the lengthy realization and rapid social mutations, the complexity is even greater if the areas being considered include Cultural Heritages. These themes cannot be managed by using solely political, philosophical, economical or urban considerations; nor can the architects, archeologists or restorers be left alone in their abilities and competence. The method-model that is used is practically always carried out by one of the figures mentioned above. [2]
As you can understand then, the planning of life on Earth is a complex theme, and the challenges are even greater when we consider the preservation of Cultural Heritages. Cultural Heritages are not only important for their historical and cultural significance but also for their social and economic benefits.

That managing the complex themes of living on Earth and preserving Cultural Heritages cannot be done solely through political, philosophical, economic, or urban considerations. Similarly, architects, archaeologists, and restorers cannot be left alone in their abilities and competence.
To effectively manage these themes, it's essential to adopt a multidisciplinary and collaborative approach that brings together various stakeholders and experts from different fields. This approach recognizes that these themes involve complex interactions between social, economic, environmental, and cultural factors, and that no single discipline or profession can address them alone. [3]
In addition to political, philosophical, economic, and urban considerations, managing these themes requires input from experts in fields such as architecture, archaeology, restoration, anthropology, ecology, and sociology, among others. This diverse expertise can help ensure that all relevant factors are considered, and that strategies are developed with a comprehensive and holistic perspective.
Furthermore, it's essential to engage with local communities and stakeholders in the planning and management of these themes. These individuals and groups have important knowledge and perspectives that can help ensure that strategies are responsive to local needs and priorities, and that they promote social and economic benefits while also preserving the environment and Cultural Heritages.
In summary, managing the themes of living on Earth and preserving Cultural Heritages requires a multidisciplinary and collaborative approach that engages various stakeholders and experts from different fields. This approach recognizes the complexity and interdependence of these themes and ensures that strategies are developed with a comprehensive and holistic perspective. [4]

Therefore, it would be appropriate to use a multidisciplinary model of research, such as Puzzle Design, to ensure that all relevant factors are considered when planning and managing living on Earth and preserving Cultural Heritages.
A multidisciplinary approach involves engaging experts and stakeholders from various fields and disciplines, such as architecture, archaeology, restoration, anthropology, ecology, sociology, economics, and politics, among others, to collaborate and develop comprehensive and holistic strategies. This approach recognizes that the complex themes of living on Earth and preserving Cultural Heritages involve many interrelated factors, and that no single entity or profession can address them alone.
Thus said, it would be wise to use a multi-disciplinary model of research beforehand, reflecting and sharing thoughts among the various competent entities that participate together (we shall call this Puzzle Design).

Using a Puzzle Design approach can help ensure that the context of the site and the socio-cultural composition of the community are taken into account when developing strategies. This approach can also help identify potential conflicts and trade-offs between different priorities, such as economic development and environmental preservation or Cultural Heritage preservation and social development, and develop strategies that balance these priorities.
Furthermore, a Puzzle Design approach can help ensure that strategies are developed through a participatory and collaborative process that engages local communities and stakeholders. This approach can help build trust and ensure that strategies are responsive to local needs and priorities, promoting social and economic benefits while preserving the environment and Cultural Heritages.

In summary, a multidisciplinary approach, such as Puzzle Design, can help ensure that all relevant factors are considered when planning and managing living on Earth and preserving Cultural Heritages. This approach can help balance different priorities, engage local communities and stakeholders, and develop comprehensive and holistic strategies.
Prior to the projection and realization of the project, it is necessary to have the various analytical aspects interact. All of the following, social design, urban design, architectural design, industrial design, alongside political design, economic design, legal design, will all have social, economic, environmental sustainability, as well as energy, health, safety and aesthetic related sustainability components as the common denominator.
In order to create a sustainable project, it is important to consider all of these analytical aspects and have them interact with each other. Social design, urban design, architectural design, industrial design, political design, economic design, and legal design all play a role in creating a project that is socially, economically, and environmentally sustainable, as well as safe, healthy, and aesthetically pleasing. By considering these different aspects and ensuring that they work together in a holistic way, it is possible to create projects that are not only sustainable but also beneficial to the communities and environments in which they are located.

All of these design disciplines have social, economic, environmental sustainability, energy, health, safety, and aesthetic-related sustainability components as the common denominator. By integrating these various analytical aspects, designers can create projects that are not only visually appealing but also sustainable, economically viable, socially responsible, and environmentally friendly. This approach to design considers the needs and aspirations of various stakeholders, including local communities, governments, businesses, and the environment. It also promotes a holistic approach to problem-solving that fosters innovation and creativity, leading to more resilient and adaptive solutions that can address current and future challenges.

Another aspect that must not be considered as secondary in putting this approach method into action is the speed of realization. In other words, each competence and ability needs a different timing approach, that has to most certainly tend towards the established goal with due flexibility throughout the time span needed for the actualization of the project.
The speed of realization is an important aspect to consider when implementing a multidisciplinary design methodology. Each competence and ability involved in the project will require a different timing approach, and the timeline for the project must be flexible enough to allow for these differences. For example, legal and regulatory requirements may take longer to fulfill, while design and construction may require more intensive efforts over a shorter period of time. A flexible timeline allows for the necessary collaboration and coordination between various competencies to achieve the established goals while ensuring that quality and sustainability are not sacrificed for the sake of speed. Additionally, a flexible timeline can also allow for adjustments to be made during the project's implementation as new information or circumstances arise, ensuring that the project remains responsive to the needs of stakeholders and the environment.

Many projects and achievements have followed a multidisciplinary design methodology that considers various aspects of sustainability, such as social, economic, environmental, energy, health, safety, and aesthetic sustainability. Some examples of such projects and achievements include:
1. The Vancouver Convention Centre West by LMN Architects and MCM Architects: This project is an example of sustainable design that integrates environmental, economic, and social sustainability. It features a green roof, seawater heating and cooling systems, and a program that employs homeless individuals. [5]
2. The Bullitt Center by The Miller Hull Partnership: This project is an example of sustainable design that achieves net-zero energy and water use, and incorporates innovative building systems and materials that contribute to its energy efficiency. [6]
3. The High Line in New York City by James Corner Field Operations and Diller Scofidio + Renfro: This project is an example of urban design that incorporates ecological and social sustainability. It transformed an abandoned elevated railway into a public park that provides new green space for the city and promotes community engagement. [7]
4. The Bosco Verticale in Milan, Italy by Stefano Boeri Architetti: This project is an example of architectural and industrial design that integrates environmental sustainability. It features two residential towers covered in greenery that improve the local air quality, provide habitat for wildlife, and mitigate the urban heat island effect. [8]
5. The Masdar City in Abu Dhabi, United Arab Emirates by Foster + Partners: This project is an example of urban, architectural, and industrial design that integrates environmental sustainability. It aims to be the world's first carbon-neutral city and features renewable energy sources, water management systems, and sustainable transportation. [9]

These are just a few examples of projects and achievements that have followed a multidisciplinary design methodology that considers various aspects of sustainability. Many other architects and designers have also embraced this approach, recognizing the importance of sustainability in creating livable, healthy, and thriving communities.

There are many examples of projects that have taken a multidisciplinary design approach to achieve sustainable and socially responsible outcomes. One notable project is the High Line park in New York City, which transformed an abandoned elevated rail line into a vibrant public space that integrates ecological sustainability, Cultural Heritage, and urban design.
The High Line project involved collaboration between landscape architects, urban designers, ecologists, and engineers to create a park that enhances the ecological health of the area, celebrates the Cultural Heritage of the surrounding neighborhood, and provides a unique and attractive public space for residents and visitors. The project includes sustainable design elements such as green roofs, rainwater harvesting systems, and a planting scheme that supports local biodiversity.
In addition to ecological sustainability, the High Line project also prioritized social sustainability by providing free public space that is accessible to all members of the community, including those with disabilities. The park also supports local arts and cultural events, and has become a hub for community engagement and social interaction.
Overall, the High Line project is an excellent example of a successful multidisciplinary design approach that integrates ecological sustainability, Cultural Heritage, and social responsibility to create a vibrant and sustainable public space.

## Conclusion

Paraphrazing a quote by G.K. Koenig in the actualization of Puzzle Design we could say: "*Attention to detail so that the gap between a roar and a bray is short*". [10]
In the context of Puzzle Design, we could interpret the quote by G.K. Koenig as emphasizing the importance of paying attention to details and ensuring that the various components of the design are integrated seamlessly. This requires a multidisciplinary approach that brings together experts from different fields to work together towards a common goal.
By minimizing the gap between different aspects of the design, such as social, environmental, economic, and aesthetic considerations, we can create a cohesive and sustainable design that addresses all of these issues in a holistic manner. This requires careful planning and coordination, as well as a willingness to adapt and adjust the design as needed to ensure that all aspects are properly integrated.
Overall, the quote highlights the importance of attention to detail and a multidisciplinary approach in the actualization of Puzzle Design, and reminds us of the need to ensure that all components of the design work together seamlessly to achieve a cohesive and sustainable outcom

The method "Puzzle Design" encompasses the important aspects of Vision, Speed, Design, and Sustainability.
Vision is crucial in providing a clear goal and direction for the project. It helps to align all stakeholders towards a common purpose and provides motivation and inspiration for the design process.
Speed is also important, but it must be balanced with a thoughtful approach. Rushing the design process can lead to mistakes, oversights, and ultimately, a poorly executed project. Therefore, a well-considered speed approach is necessary to ensure that the project is completed in a timely and efficient manner without sacrificing quality or sustainability.
Design is at the core of Puzzle Design methodology. A thoughtful and innovative design can create spaces that are not only aesthetically pleasing but also functional and sustainable. Puzzle Design encourages a multidisciplinary approach to design, incorporating social, economic, and environmental sustainability into the design process.
Sustainability is a critical component of Puzzle Design. It is essential to ensure that the project has a positive impact on the environment, society, and economy. The project must be designed to be resilient and adaptable to changing circumstances and future needs.
Overall, recognizes the importance of balancing vision, speed, design, and sustainability to create successful and sustainable projects.

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# Emotions and memory to change behaviors

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**Abstract**
The environment and landscape decay that we are currently experiencing is not recent but it is the result of policies, collective and individual behaviors, rooted in times long past. It is not enough to draw up defensive projects if at the same time we do not act on these behaviors. People's well-being is not simply the passive outcome of external strategies, but derives first and foremost from intimate transformations in citizens themselves. Objective well-being is certainly the result of external conditions, but subjective well-being also depends on awareness, behavior and positive expectations.
This paper focuses on the contribution that Cultural Heritage can give to this process enhancing the citizens' memory of the past. However, the current attention devoted to tangible and intangible heritage makes use of unidirectional (top-down) communication, focused on 'cultural learning' and a basically cognitive approach. Conversely, neuroscience (still applied at an experimental and pioneering level to Cultural Heritage) today shows us that the emotional component can elicit responses at a deep, transformative level.
Citizens know what should be done to safeguard the environment, but this is not enough to change their behavior if they don't really feel deeply affected by this. This paper describes some ongoing studies and experiments, suggesting new participatory practices on the part of citizens, also with Neuroscience's support.

**Keywords:** Cultural Heritage; transformative encounters; cultural communication; neurosciences

## 1. Well-being, behaviors and Cultural Heritage's role

The environment and landscape decay that we are currently experiencing is not recent but it is the result of policies, collective and individual behaviors, rooted in times long past. It is not enough to draw up defensive projects if at the same time we do not act on these behaviors.
Behaviours can be changed, and the educational role of families, schools, and work environment is crucial. Cultural Heritage conservation and communication are also dedicated to education intended as human growth and promotion, of individuals and communities.
For this, museums and cultural institutions are *ethical places,* and their educational role cannot be limited to the *cultural* growth, since it is also related to well-being, that is a general concept today studied under different sides.
People's well-being is not simply the passive outcome of external strategies, but it derives first and foremost from intimate transformations in individuals themselves. While objective well-being is the result of external conditions, subjective well-being also depends on personal awareness, behavior and positive expectations.
These components can be strictly tied to the encounter between citizens and Cultural Heritage.
During a cultural experience, not only the citizens' memory is improved, but also their intimate transformation is fostered. Drawing messages from the past that are not simply pre-packaged *lessons*, but instead the outcome of personal elaboration, is the challenge asked of cultural places today.

## 2. Cultural Heritage as booster for confidence, resilience and empathy

Changing one's behaviour is complex process, for which citizens must learn to be flexible and resilient. Often when faced with dramatic contemporary challenges, such as climate change, people react with a

kind of resignation to the ineluctable decline of the environment, on the grounds that the individual cannot influence global processes that go over everyone's head.
Conversely, the encounter with Cultural Heritage can help increase confidence, resilience and empathy, needed for make people aware their active role in changing the future.
The first one is as complex construct, although it may seem a banal concept, which can be disassembled in several psychological and neurophysiological components: positive thinking, sense of security and quiet, mental openness to stimuli, sense of control, feelings of well-being, quiet inner sense, being active, and social relations.
The resilience is intended as the aptitude to cope with and overcome dramatic changes, accepting crisis as an opportunity for understanding and positive evolution without dismantling one's deep identity [33]. It is a psychological function, and it is distributed among several psychological and neurophysiological components: positive thinking, the confidence to play an active role, the sense of control, the sense of challenge, being listened to, the quality of social ties.
The empathy is the ability to share the feelings or experiences of another person by imagining “how one would be in their shoes”; it does not arise from an intellectual effort but from a reaction on a neurophysiological level, which has been related to mirror neurons.
Unlike compassion, empathy actually generates a sense of identification with the other person: it is a vision that takes on the 'frame of reference' of the other, realising that there are always different points of view. Empathy is a phenomenon whose components are akin to those of resilience and generates an inner transformation: the emotions experienced through empathy are particularly intense and enduring, which is why they are transformative.
There is a close relationship between empathy and the sense of confidence.
Some scholars [12] have stated that delivering content in an empathic manner, valuing and incentivising the personal contribution of the learner, increases the level of self-esteem and fosters a more positive, collaborative social self-concept, as well as relationships of trust. Theodor Lipps [20] considered empathy to be the attitude of feeling in tune and in harmony, the founding conditions of an attitude of “confidence”. Empathic transformation is therefore able to help us face the changes and dramatic challenges of contemporary life with greater confidence.
For instance, people expect museums and cultural places’ role to go beyond mere object exhibition with explanatory texts; they should become places where all members of society feel represented and are stakeholders in their Cultural Heritage.

## 3. Cultural messages co-creation to make citizens participate in understanding Cultural Heritage

Actually, new technologies and especially social media have caused a great impact in the field of cultural democratisation, and already Simon [30] attributed to them a preponderant role in the upheaval of the museum model towards the participatory museum. In the last 15 years, the participatory, co-creative and proactive museum model has developed, which fosters two-way communication and a sense of belonging to a community [7]. The user has become a creator of personal digital contents, the so-called User Generated Content; the perceived distance to the cultural institution has been shortened and the user feels a more defined role for him/herself [30]. Co-creative processes of cultural value have long been considered forms of cultural crowdsourcing and even co-production of collection-related content 15].
The concept of co-creation has then been introduced and widely discussed, intercepting citizens’ desire to be active societal players and protagonists [26, 9]. The powerful democratising element in co-creation has been influential in the development, for instance, of participative platforms such as Wikipedia. Many authors [28] stated that co-creation practitioners should concentrate on how to make groups productive by working to create an atmosphere where people trust each other and the organisation, and that creativity is a result of engagement and knowledge [13]. Then, some authors conclude that everyone has the potential to contribute to creative processes if they are motivated to do so and if the right conditions and processes exist [17].
*Co-creation* and active user contribution to social storytelling can help to accord cultural experiences with individuals’ interests, and to produce ideas, particularly among younger age groups. People can become active players in creating dynamic and constantly changing cultural contents. It is not about the “absolute value” of Cultural Heritage, but what the individual person ascribes.
Cultural Heritage in turn transforms society and individuals if people personally and emotionally *appropriate* it [4], in an intimate and empathic way: if they transform it, they are also transformed by it. This deep transformation has both conscious and unconscious components.
“Transformative encounters” trigger a personal appropriation of Cultural Heritage and active participation and, as such, generate confidence and resilience, because they increase understanding, self-esteem and the sense of control, and they give a sense of being protagonist.

Therefore, museums need to foster inner, emotional, persistent appropriation of Cultural Heritage content, but also increasing levels of self-esteem and confidence. Engaging all kinds of audiences, having a positive impact on their lives, is crucial.
The role of emotions in communicating Cultural Heritage has been recognised since at least the end of the last century. A strand of research shows that museum visit involves the individual more deeply than one might expect. For a cultural experience to leave a lasting mark on all the visitors, something must happen that we can call a transformative encounter: transformative experiences are such because we live them, not because we reflect on them [24, 25].
Emotional and rational spheres are not alternative expressions of dualism but are inextricably intertwined in a complex system: museum practices in recent decades have moved towards emotional solutions, and emotion-based museology and museography are, in fact, developing [32]. It has been confirmed that, in general, a response capable of activating not only the mind but also the body stimulates curiosity and facilitates recollection and memorisation [10].

## 4. Cultural Heritage lessons about environment protection

**Fig. 1:** Byzantine Museum, Thessaloniki: terracotta vessels used as a ligh fill-in material in the spaces between the vaults and the walls

**Fig. 2:** MAC, Archaeological Museum, Chieri (Torino): terracotta amphorae used as insulating material to create crawl spaces under the floor

**Fig.3:** MAC, Museu d'Arqueologia de Catalunya, Barcelona: temporary exhibition on underwater archaeology (2022)

From the past, many messages about environmental conservation and protection can be discerned. For example, the terracotta amphorae produced by the ancient Romans to transport goods along marine trade routes, once their function was over, were waste difficult to be disposed of. Certainly, they were made of natural materials that were not as harmful to the environment as today's plastic, yet they occupied large volumes.
The various ways ancient people found to recycle them as building materials (insulators or fillers) are from this point of view interesting lessons to ponder.

**Fig.4:** The “Seventh Continent”, a waste-filled area in the Pacific Ocean

The underwater archaeology itself could be an opportunity to talk about environment protection: actually, countless remains of objects built in locations other than that of their discovery have been discovered in the seas, due to shipwrecks and other events of unintentional nature (which of course also happens nowadays).
However, in ancient times, objects were left in the sea unintentionally, whereas today they are abandoned to a large extent intentionally, in order to dispose of them in the sea, causing a staggering impact on the ecosystem: see the case of so called “seventh Continent”, located in the center of the Pacific Ocean, it is a waste-filled area that accumulated high concentrations of plastics, chemical mud and other debris.
An archaeological museum can therefore take the opportunity to provoke reflection in the contemporary visitor.

## 5. Emotional *appropriation* of Cultural Heritage

The most important thing is that the message is not limited to the cognitive and mental level, but touches the emotional side of the person. Indeed, the latest trends in contemporary museology emphasise that what moved the visitor will be remembered more vividly by him/her.
Conversely, the current attention devoted to tangible and intangible heritage makes use of unidirectional (top-down) communication, focused on 'cultural learning' and a basically cognitive approach.
Neuroscience (still applied at an experimental and pioneering level to Cultural Heritage) today shows us that the emotional component can elicit responses at a deep, transformative level.
Citizens know what should be done to safeguard the environment, but this is not enough to change their behavior if they don't really feel deeply affected by this.

**Fig. 5**: Etruscan Museum of Villa Giulia, Roma 2022: the experiment “headquarters”

To understand the psycho-physiological responses of visitors, an experimentation has been carried out in 2022 by Polytechnic of Turin and University of Turin, at National Etruscan Museum of Rome: 57 participants were recruited to investigate their implicit reactions to museum rooms and the contents’ memorization, monitoring the visit in *ecological conditions*.
In specific points (relevant from a museographic perspective) along the visit route, participants' positioning data have been collected, while wearable devices have been used to gather physiological parameters. Two questionnaires (before and after the visit) profiled participants and collected their conscious responses and perceptions.
Regarding quantitative parameters, results show that young visitors bodily react quite differently than elderly, as well as *museumgoers* than *disaffected* public.
Entering the museum generated an emotional reaction, but the communicative solutions (that require a certain degree of cultural background on the part of visitors) have caused “museum fatigue” to increase while emotional involvement to decrease. Actually, in front of the museum’s masterpiece, this was evident. These results partially confirmed by questionnaires, suggesting that our conscious perception of a cultural experience is not always consistent with its deep effect on us.
Although the detailed interpretation is still in progress, due to the large amount of data, some interesting perspective have been opened. Two further steps are planned, in laboratory, to observe, in VR, how totally different display solutions and spaces could differently involve visitors. Being the long-lasting memorization and transformative effect the most significant parameter, this experimentation should be completed by a survey on the same participants after some time, but this would be particularly difficult to be implemented.

**Fig. 6**: Etruscan Museum of Villa Giulia, Roma 2022: participants in the experiment were invited to “normally” visit the museum, equipped with wearable devices

## 6. Conclusions

The 2015 UNESCO Recommendation (*concerning the protection and promotion of museums and collections, their diversity and their role in society*) consolidated the role of museums as places of intercultural dialogue and social cohesion, reaching new and diverse audiences.
Therefore, Cultural Heritage can have an important role in changing behaviours connected to values crucial for the contemporary society, as the respect for the environment is.
However, the communication cannot be top-down: citizens have to actively participate in developing messages and interpretation of Cultural Heritage values, in order to *deeply appropriate them.*
As general conclusion, we can observe that museums avoid to directly deal with values, focusing on information and descriptive narrations.
In particular, museums displaying historical and archaeological heritage although potentially relatable to contemporary issues, often engage the visitor from an intellectual point of view ((in fact, the participants showed good memorisation of the information conveyed by the museum) but much less so from an emotional point of view. In fact, participants after the visit perceived a relaxation state rather than a strong, emotional involvement. This latter aspect, however, is fundamental to generate transformative encounters, able to affect the citizens behaviors.

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# Spaces of cultural contamination. Creative places of sociality, integration, inclusion.

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## Abstract
The well-being of the person is closely linked to the spaces in which they live and the resources they access. The recent slogan and urban paradigm "happy city and healthy city" bring attention back to the person and investigates the role of the built environment, individual, social and cultural well-being, as indicated in the sustainable development objectives of the 2030 Agenda. However, combining the city with the health and well-being of citizens requires an overall vision. It is necessary to graft a plot that can create - through resilient planning - interconnected and engaging open spaces, open and multiform specialized areas and, at the same time, incorporate pre-existing places and buildings in the city, safeguarded in their identity, but related and used in an innovative way. The interventions already carried out in some national and international urban realities confirm the importance and role of urban public space in the redevelopment of cities. Projects that promote architectural quality and favor a climate of social well-being and civil coexistence. In this study we will deal with the "rediscovery" of some urban squares in southern Sicily that reflect and identify the state of "health" of the cities, the work of local governments and reflect the "goodness" of business ideas. They are degraded urban areas, poorly cared for by the administrations, mainly used as parking lots. A good reason to transform them, in the near future, into places of cultural contamination and creativity.

**Keywords:** spaces, creativity, contamination, integration, inclusion

## 1. Introduction
The social distancing caused by the Covid-19 pandemic has increased the physical distances between individuals and determined a new relationship between the inhabitants and the public urban space. Suddenly, in March 2020, without having time to plan and/or design, we found ourselves reorganizing and transforming the city's public spaces, adapting them into temporary field hospitals or care centers to conduct swabs and serological tests for the population.
This condition, while revealing a negative element in terms of use of the spaces, is to be considered a stimulus for the future *governance* of cities, as well as an opportunity for a more radical, far-sighted, sensitive urban renewal [1, 2].
Indeed, the health emergency has led to the "rediscovering" of public urban spaces, rethinking the road system and promoting "active" forms of mobility to protect the well-being of the community [11, 12].
Actions that aim to improve the quality of life and which, according to some scientific studies, lead towards the transition from the *Smart City* to the *Humane City* (1) outlining a new scenario that brings into play technological innovation factors, responsible and inclusive citizenship approaches, exploiting the human, cultural and creative potential of each individual and of the different communities [10].
This transition, which defines the adaptive reuse and "rediscovery" of some public urban spaces, through new resilient planning strategies, favors the economic recovery of cities and, above all, improves the safety and psychophysical well-being of citizens, as indicated in the sustainable development goals of the 2030 Agenda.

The well-being of the person is closely linked to the spaces in which they live and the resources they access (table 1).
Among the most recent urban slogans and paradigms are "*happy city and healthy city*," which overwhelmingly brings the focus back to the individual and investigates the role of the built environment on individual, social and cultural well-being.
The public urban space, understood as an open space, with collective responsibility, accessible to all at any time, in the many and varied forms in which it is declined, constitutes one of the fundamental elements of the physical and symbolic structure of the city [5].
The interventions already carried out in some national and international urban realities confirm the importance and role that urban public space plays in operations of sustainable development and redevelopment of cities, in order to promote architectural quality and foster a climate of social well-being and civil coexistence [14].

| **Phase** | **Environment** | **Health** |
|---|---|---|
| Deficiency | Lacking personal hygiene, contaminated potable water, unhealthy dwelling. | Infectious diseases, malnutrition. |
| Industrialization | Air and soil pollution by rubbish, chemical residues and harmful gases. | Respiratory diseases, heart diseases, oncological diseases. |
| Consumerism | High consumption of natural resources, energy consumption. | Chronic disease, obesity, diabetes, heart disease, cancer. Accidents, depression. |
| Healthy City | Lifestyle in balance with your body and the environment | maximum health potential |

**Table 1 -** Relations between urban development, environmental conditions and health.

## 2. Urban spaces and socio-cultural well-being of citizens.

The theme of well-being, the health of citizens, the quality of life in cities requires careful reflection on urban spaces which, in recent decades, have changed profoundly.
Increasingly fragmented, unstable, mutable spaces that need "care" and adequate projects in order to satisfy diversified social programs and needs, as well as guarantee a healthier life in cities.
Some urban realities have succeeded in combining the relationship between health, citizen well-being and public spaces through the implementation of exemplary urban redevelopment projects. The only objective is the 'care of the city and its citizens' [6, 7].
A significant example is, in fact, the redevelopment project of the urban space of Superkilen - in the Nørrebro district, in Copenhagen - carried out by the BIG group (Bjarke Ingels Group), with the landscape architects of Topotek1 and the visual artists of Superflex. The project is intended as a large open-air museum to be walked through, promoting new sociality, cultural exchanges and a new quality of life by eliminating cars with the opportunity to walk around and stop to look at the 60 works of art from around the world (fig.1a). Superkilen, represents the ultimate expression of Danish multiculturalism, hosting objects, structures and street furniture from virtually all nations, an excellent model of urban design of public urban space [8], among the most original created in all of Europe.
A model to be taken as a reference that fosters cultural contamination, relational exchange, personal training, and sharing of interests.
A second example concerns the creation of urban spaces in which the relationship between nature and well-being is generated more directly, assigning a marked centrality to citizens' health, cultural enrichment, and also issues of sociality. This is a fundamental aspect, which goes beyond the theme of therapeutic gardens and which concerns the creation of new systems of equipment and urban services concentrated in areas - highly variable in size - in which spaces are built which are also intended for the prevention of pathologies, through the promotion of physical and sporting activities [3, 4].
This is what we find in the *Culture Park Wester gas* fabriek in Amsterdam. The cultural park is conceived as a large public space, designed by Gustafson Porter & Bowman, with the aim of offering conditions of comfort and perfect environmental quality for citizens and potential users. It is a model of brownfields reclamation within an urban, densely populated context, where the natural and environmental qualities of the site are enhanced by the possibility of socio-cultural, physical and recreational activities in contact with water and nature (fig. 1b). Also in this case, the benefits that the individual derives from it, both for the mind and for the body, are many.
And again, we recall the experience carried out in Lisbon, in the district of the historic centre called "Mouraria" (fig. 2a). Interventions called "urban rehabilitation," which began in 2010, have activated a considerable circuit of private investment and prompted residents to promote and interact with small-scale projects.

The streets and public spaces of the historic city are the protagonists of the "cities within the city" project, a 7.4 million euros program (almost half covered by European funds) which identifies a very articulated, non-linear path, characterized by structural interventions on accessibility for the elderly to connect strategic places that work on collective identity. Each intervention promotes the social improvement of the neighbourhood by leveraging the public space and involving the resident population [9, 14].
Another example of urban redevelopment and cultural contamination can be found in Rotterdam. Here the central role of the urban project emerges in the definition of spatial, cultural and social transformations, thanks to a planning that competently addresses the themes and challenges of the city of the future. The creation of an urban park above the viaduct of the old Hofplein station, northeast of the city centre returns the genesis of a project - to be implemented in phases - in which an association of private companies and a group of citizens, through shared planning with the National Railway Group and the municipality of Rotterdam, aim to redevelop the neighbourhood by placing literary cafes, craft stores, and restaurants in the abandoned arches of the viaduct. This redevelopment project is also successful thanks to the regained centrality of the district which, through the Luchtsingel elevated pedestrian path, allows you to reach the central station area, overcoming the disconnections caused by the infrastructural bundles (fig. 2b).
In our Country, a significant example of 'care' of public open spaces can be found in the city of Milan which, since 2011, has redeveloped more than 50 squares, both in the centre and in the suburbs. A process lasting more than a decade that has doubled the availability of pedestrian areas through a city design aimed at increasing well-being, quality of life, strengthening local neighbourhood identities, countering the isolation and stigmatization of peripheral urban centres, increasing pedestrian space and for soft mobility, increase the attractiveness, beauty and livability of the city, promote local trade and tourism, safety, sociability, cohesion and social inclusion [13, 14]. Milan, over the years, has "rediscovered" the public space thanks to new urban spaces, squares and meeting places which represent the symbolic element of the great regeneration interventions and which have affected the structural dimension of the city, enlarging its centre starting from pedestrian vocation (fig.3). The objective is to identify a series of places for the construction of a pedestrian-oriented network - identifying traffic calming and urban 'care' interventions that lead back to new qualitative values of the spaces - in coordination with the planning of public works and maintenance operations. A project that brings out local identities and facilitates settlement rules for small business and craft activities. The idea is to support the development and diffusion of natural commercial districts, limiting large sales structures and shopping centers with new prescriptions. These are places entirely dedicated to citizens, in which the quality of the project is aimed at increasing permeability and pedestrian and cycle paths. Attention to people and their psychophysical well-being therefore becomes a crucial factor in urban planning starting from the settlement morphology.

## 3. A cultural project for spaces to be "contaminated".

Starting from the national and international urban redevelopment experiences discussed in the previous paragraph, we present the research project “Spaces of cultural contamination. Creative places of sociality, integration, inclusiveness” (2). An ambitious socio-cultural program which, through urban regeneration interventions, the identification of new cultural and tourist itineraries and the creation of museum houses - integrated with the consolidated experiences of "*Strada degli Scrittori*" (3) - networks public spaces in 4 Sicilian municipalities: Porto Empedocle, Agrigento, Favara and Racalmuto (fig.4), native places of Camilleri, Pirandello, Russello and Sciascia.
These public spaces, described in the literary works of well-known writers, are privileged areas of cities to be re-inhabited and transformed into centres of attraction, socialization and cultural exchange.
Specifically, the research project investigates:
1 - "Chiesa Vecchia" square in Porto Empedocle (fig. 5), where Andrea Camilleri lived. A characteristic place in the historic centre of the seaside municipality, in which the eighteenth-century church of Maria SS. del Buon Consiglio, better known as “Chiesa Vecchia” (Old Church) stands out, closed to worship in the second half of the 1960s because it was uninhabitable and used as an auditorium since the 1980s. In former times, part of the buildings bordering the square were used as craft shops on the ground floor. Today, only a few faded signs remain, and the square is improperly used as a car park, losing its identity as a meeting and gathering place;
2 - "San Josemarìa Escrivà" square, in the southern edge of Agrigento's historic center, where Luigi Pirandello spent his childhood. An evocative place, with a panoramic view towards the African sea, where the church of San Pietro is located - built in the eighteenth century on a previous medieval church (fig.6). In this Church and in these spaces Luigi Pirandello sets the story "La madonnina", whose protagonists are the same inhabitants of the street from which it now takes its name;
3 - "Don Giustino" Square in Favara, where Antonio Russello used to walk, a place on the border of the historic center that in ancient times marked the boundary between the city and the countryside, today is

densely urbanized where particular critical issues caused by poor building quality and a lack of care for the urban context are noted (fig.7). Problems, all of them, dealt with in the texts of the Favarese writer;
4 - "Vittorio Emanuele" Square or "Largo Monte" in Racalmuto, where the young Leonardo Sciascia, observing the urban landscape, found inspiration for his literary works (fig. 8). The area, located on the hill of the ancient medieval village, is characterized by small houses-including the writer's house turned into a museum-house (4) - and a series of historic buildings of particular architectural value including the church/sanctuary Maria Santissima del Monte, the centre of the religiosity Racalmutesi.
Unfortunately, these squares - reflecting and embodying the "state of health" of cities, the work of local governments and the "goodness" of business ideas - are mainly used as parking lots. Therefore, these are degraded areas, poorly cared for by the administrations, and unattractive for citizens [9]. From an initial analysis of the places, in fact, it can be seen that, over time, the squares lived and narrated by well-known writers have been transformed by modernity with often invasive and impactful interventions, repaved with materials that have little configuration with the identity and history of places, invaded in their total spatiality by cars, which preclude their pedestrian use and moments of sociality. Today, these squares are the result of wrong, unsuitable actions and design choices, to which citizens approach with a sense of intolerance, no longer recognizing the social and aggregation role for which they were built.
It is therefore necessary to rethink these places as spaces for sharing, creating intellectual and creative stimuli. Public spaces to be revitalized, through targeted and specific activities, such as exhibitions and temporary exhibitions, open-air literary and cinematographic reviews, live music and artistic performances, weekly markets, celebration of religious holidays, cultural and/or entertainment events.
In this scenario, the proposals indicated in the research project aim - through adequate planning - to strengthen local neighbourhood identities, increase pedestrian space, encourage soft mobility, increase local commerce and crafts, develop tourism through the knowledge of the present material heritage and the valorisation of museum-houses. Indispensable interventions so that these public spaces can once again become places for meeting, socializing and cultural exchanges, restoring in a contemporary key those characteristics of attractive and privileged places in cities, well outlined in the works of the great writers who lived there many decades earlier, drawing from them a significant influence in literary production, in the formation of thought and in the way of living in the city. Public spaces are places around which the city is built, where life manifests itself between buildings, where individuals become "contaminated" groups and where being together determines well-being and forms citizenship, understood as a sense of belonging to a common good. Certainly, however, combining the city, health and well-being of citizens requires an overall vision. We need to insert a plot that can create interconnected and engaging open spaces, open and multiform specialized areas, and at the same time incorporate pre-existing places and buildings in the city, safeguarded in their identity, but related and used in an innovative way. Hence the awareness that the improvement of the urban and architectural quality of these areas encourages people to be together and makes cities more livable and sustainable.
The recent proclamation of Agrigento *Capital of Culture 2025*, which involves several municipalities in the province of Agrigento - including those of the squares identified in the research project - gives us hope. The benefits, not indifferent and not only of an economic nature, that the area will receive in the next few years, will make it possible to improve the living conditions and well-being of citizens, but also of potential users, by increasing exchanges and relationships between individuals, as indicated in the dossier of the same candidacy "*Il sé, l'altro e la natura. Relazioni e trasformazioni culturali*".
Agrigento, by 2025 will become the center of networks of cultural and digital connections, of sustainable mobility, of relational tourism, of traditional and innovative economic productions, in a circular economy system that places the individual - man and woman - in harmonic connection with nature and the environment. A great opportunity for growth for the Agrigento area, for the rediscovery of one's potential, for the enhancement of the tangible and intangible heritage, an important moment of good cultural contamination.

## Conclusions

The meaning and social role of public open spaces as places of aggregation and sociality have somewhat dissolved over time. The functions of those sharing places, today, are elsewhere. And, perhaps, cities lose their identity for this too. From the city center to the suburbs, from small towns to villages, the square has lost its distinctive elements almost everywhere.
Used, at best, as a location for street vendors and/or open-air markets, they are mainly used as car parks. The new squares, paradoxically, are the social networks, where people virtually meet, talk, play, but without meeting, without speaking, without really playing. Shopping centers have become the places in which to restore physicality to relationships.
But neither one nor the other have in fact replaced the squares, rather they have substituted their functions. The policies of recent decades have failed in this, not only the urban policies ones, but also the cultural and social ones. Too often the square has become a non-place.

The future challenge of cities will be to stimulate activities related to creativity by fully capitalizing on their heritage as a basis for building sustainable, inclusive and balanced development in economic, cultural, environmental and social terms. The public space returns to being a place of debate, aggregation, sociality, aware that the quality of the space of collective life is one of the main parameters by which the degree of cohesion of an ever-evolving community is measured. It is necessary to aim towards the rediscovery of the values of the city, of the urban space, towards a desire for sociality, participation, interaction between people.
Only in this way will there be a "healthy contamination".

**Notes**

(1) Environmental risks in cities have diversified and evolved with effects on health, it is no coincidence that the relationship between health and urbanization - where poverty and industrialization today can often overlap in many developing countries - indicates the perspective to which should tend: from advanced Smart City models to Healthy Cities (Table 1).
(2) The research project - whose scientific director is Teresa Cilona, professor of Urban Planning at the Palermo Department of Architecture - begins in 2021, in full continuity with the didactic-scientific elaborations of the Urban Planning courses held at the Degree course in Architecture of Agrigento. Various stakeholders are involved in the project including the University Center of the Province of Agrigento, the Municipalities of Porto Empedocle, Agrigento, Favara, Racalmuto, the cultural association "*Oltre Vigata*" of Porto Empedocle, the "*Centro Studi Antonio Russello* " of Favara, the cultural association "*CasaSciascia*" of Racalmuto, the association "*SS 640 Strada degli Scrittori*".
(3) The SS 640 Strada degli Scrittori is an itinerary about 72 km long which, from Porto Empedocle to Racalmuto - crossing the Valley of the Temples - passes through Agrigento and Favara up to Caltanissetta. A path that identifies unique places with theatres, castles, palaces, museums, breathtaking landscapes and that combines culture, tourism, architecture in Sicilian places that have seen the birth of writers such as Luigi Pirandello, Leonardo Sciascia, Andrea Camilleri, Giuseppe Tomasi di Lampedusa, Antonio Russello, Rosso di San Secondo and many others.
(4) The house where Leonardo Sciascia lived for a while is now a house-museum, recovered thanks to the sensibility of an enlightened Racalmutese intellectual, Pippo Di Falco (president of the *CasaSciascia* cultural association), who decided to buy the property and make it accessible to the community. In fact, there are numerous visitors who have been visiting casa Sciascia since September 2019. Here it is possible to consult unpublished texts and works by well-known writers, a place that collects memorabilia, letters that Sciascia exchanged with numerous illustrious figures of his time - politicians and other prominent personalities in the literary world - as well as many other objects and curiosities that are displayed and made available to all. A precious literary heritage and great teachings to make known to the new generations.


**Fig. 1 –** a) Copenaghen. The redevelopment project of the urban space of Superkilen;
b) Amsterdam. The Culture Park Wester gas fabriek.


**Fig.2 -** a) Lisbona. Interventions of the "*urban rehabilitation*" in the district of the historic centre called "*Mouraria*"; b) Rotterdam. The creation of an urban park above the viaduct of the old Hofplein station.

**Fig. 3 -** Milan. Examples of 'care' of public spaces.


**Fig.4 -** Map of territory. Identification of new cultural and tourist path in 4 Sicilian municipalities: Porto Empedocle, Agrigento, Favara and Racalmuto.

**Fig 5 -** Porto Empedocle. Planimetry and panoramic view of the "Chiesa Vecchia" square.

**Fig. 6 -** Agrigento. Planimetry and panoramic view of the "San Josemarìa Escrivà" square.

**Fig 7 -** Favara. Planimetry and panoramic view of the "Don Giustino" square.

**Fig. 8 -** Racalmuto. Planimetry and panoramic view of the "Vittorio Emanuele" or "Largo Monte" square.

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# Goal 1. No to poverty: a social community center for access to basic human needs for health, education, sanitation

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## Abstract
"*Joseph Dream*, casa di Giuseppe e Fratelli Tutti" is a social community center located in the Santa Lucia district in Naples for and with the homeless, a center to defeat poverty, a transversal poverty that concerns not only the lack of house but the generalized lack of services, spaces for treatment, spaces for attention. In 2023 the data regarding the number of homeless people reported a very significant increase compared to the previous year, more and more people are turning to Caritas. The Campania chief town is among that lead the ranking. Among the many facilities in Naples that offer services for the homeless, there is the one that belongs to the Santa Lucia a mare Church, which currently provides 80 meals a day. "If we have to begin anew it must always be from the least of our brothers and sisters" so he quotes the Encyclical of Papa Francesco, incipit of the project.
"*Joseph Dream*" is the title of the project developed for Santa Lucia a mare Church, in Naples, through the redevelopment of an abandoned building. The project is also a concrete response to goal 1 of the UN 2030 Agenda for Sustainable Development: "defeating poverty", countering the pandemic of indifference (Papa Francesco, 2020).

**Keywords**: social design, homeless, recovery of abandoned space, social community center, sharing meal

## 1. Incipit
"If we have to begin anew it must always be from the least of our brothers and sisters" so he quotes the encyclical of Papa Francesco.
Joseph Dream is the title of the initiative that saw the design of Casa di Giuseppe e Fratelli tutti, developed for Santa Lucia a mare Church in Naples, to respond to a plague that afflicts the community, so social exclusion. Fratelli tutti because it is the name of the Encyclical Letter by Papa Francesco, published in 2020 in which the Holy Father dealt with current issues, such as discrimination and marginalization. In 2020, the number of homeless people increased compared to 2019, and the data of new poor are also growing sharply, especially considering the historical moment we are going through. In Italy, according to ISTAT, there are over 50,000 homeless people, and the number of people who, in conditions of hardship, turn to Caritas, is growing. The Campania chief town is among the cities that lead the ranking; for this reason, located throughout the city of Naples, there are facilities that welcome and offer services for the homeless and people in difficulty. These concern the distribution of meals on the street, canteen service, night reception, cloakroom, listening desk, and shower service. Among the many structures that in Naples offer services for the homeless, there is the one that belongs to Santa Lucia a mare Church which currently, with the canteen, offers 80 meals a day.

The Church, located in Via Santa Lucia, one of the oldest and most prestigious districts of Naples, led by Father Giuseppe Carmelo, dean of the third deanery of the archdiocese of Naples, is the protagonist of many initiatives, aimed not only at the poor, but at the whole the community: children, young people, lonely elderly people, etc. Precisely for this reason, Father Giuseppe had the intuition to dedicate a space to them, a safe haven for people in difficulty, for the able and disabled, a social center for the community, where they can meet and be together and be able to play prophetic pastoral activity, with catechesis; royal pastoral activity, with charity for people in difficulty, and priestly pastoral activity, with worship and prayer.

**Il sogno di Giuseppe** Casa di Giuseppe e Fratelli tutti

# Social community center in Napoli

*"God loves each of us*

## PROJECT
## CASA DI GIUSEPPE

*Relationship between hurch and centre*

Through repeated site inspections, the presence of a wall emerged, on which to open a direct entrance to the new space. To connect the kitchen with Giuseppe's house, using the external space, it was decided to design a vertical connection reserved for volunteers, involved in the transport of food, who arrive at Giuseppe's house through a freight elevator from the kitchen.

*as if there were only one of us"* *Sant'Agostino*

PLANT GROUND FLOOR

PLANT UPPER FLOOR

**Casa di Giuseppe** is characterized by a large space used as a canteen, where people can meet, at least once a day, to **share food**. The distribution of space includes an area for **personal care**, an area where you can carry out various **activities**, and **relaxation areas**. There is also a small chapel, where the parish priest can **meet with the faithful**. Entering from the garden, thanks to the cordonata in via Orsini, it is possible to access the **hospitality area**, which with sofas and tables, can be used as a space in which to play, read or simply relax; walking along it, you arrive in the food sharing area, intended for the "canteen", where more than a hundred people can sit down and share meals. Connected to the food sharing area, there is a space where volunteers from the Church of Santa Lucia can organize meals.

## 2. Fabric

Overlooking the Church, as if it were its natural extension, located on the second basement floor inside Palazzo Visocchi, an elegant condominium built in the early 1900s, there is a building, neglected for years and left to neglect, of about 600 sqm, bordered by Via G.Orsini, via Falero and Via Santa lucia. Despite its condition, the fabric has a high potential both for its large size and for its position with respect to the chucrh; it has an independent access on via Orsini and through a cordoned it is possible to reach the main entrance located in a garden of about 100 square meters; while a secondary access is possible from the condominium. The masonry building, with an average height of 5 meters and with a round vaulted roof, develops with two main bodies, 31 and 41 meters long which run respectively along the corner of Via Orsini and Via Falero with window partially closed openings. An important strenght of the fabric is the close relationship with the church; from the courtyard of the building, going down some stairs, it is possible to reach an external space, onto which the rear side of the church overlooks, where the church kitchen is located. The problem of the failure to connect the kitchen located in the wing of the Basilica and the "Casa di Giuseppe" was solved by using the external space: a vertical connection reserved for those involved in transporting food through a freight elevator to reach Giuseppe's house from the kitchen. [Fig.1]

*(Silvia Buonomano)*


**Fig. 1:** Existing kitchen connection with the Center

## 3. Topological scheme

The distribution of the spaces has been designed following the logic of the paths: from the graded ramp of the access it is possible to reach the entrance, where is located the reception area, continuing on, one arrives at the area dedicated to the canteen, a space of 143 square meters, where more than one hundred people can meet, for the moment of sharing food. From here it is possible to reach a hallway that leads to the other areas, among these, there is the personal care space, of about 80 square meters, where are located all the services necessary for personal hygiene, with changing rooms and showers; there is also a toilet for the disabled with shower and laundry. Subsequently it's possible to reach the areas where you can carry out various activities such as training, after-school activities, playful and recreational activities, theatre, relaxation areas, and a small chapel, where Don Giuseppe can meet with the faithful, and finally the staircase leading to the upper floor. An innovative and fundamental aspect of the project is the flexibility of the space which can assume different configurations thanks to a system of movable walls, which can slide and gather at the side of the walls; for example, the food sharing area and the activities area can be modified, depending on the needs. The space for activities can extend up to 145 mq, while the food sharing can contain up to 140 seats, useful in the case of lunches or dinners during holidays or other events.

The diaphragms have been designed with transparent materials to offer spatial and perceptive continuity and are surmounted by glass rosettes with a steel structure, resting on double T-beams, to guarantee acoustic insulation.

Following the concept of transparent diaphragms, the staircase system was designed which leads to the additional attic, partly reserved for staff, and partly reserved for Don Giuseppe's study. Were used metallic carpentry materials with steps made with 4 L-shaped steel profiles in which there is an orsogril grid. The steps are anchored to the stringer thanks to two metal cables, in order to avoid movements and oscillations.

The structural system is made up of tubular steel sections, and composes a reticular grid which becomes not only a parapet and handrail, but extending up to the upper floor, it becomes an equipped wall on which small bookcase-containers are hooked to serve the relaxation area; these house the lighting system, with spotlights that illuminate the staircase. The staircase, with its reticular configuration, is light and capable of generating plays of light and shadow.

On the upper floor are the bathroom and dressing room for the staff, a relaxation area and Father Giuseppe's study, and is made up of two floors of different materials: the first, in concrete with joists, covers the area reserved for the staff, while the second, made up of a double sheet metal supported by a system of reticular beams hooked to beams, includes the relaxation area, the bridge and Father Giuseppe's study. The decision to use two different materials reflects the principle of transparent diaphragms and enhances the technological exposure of the structural elements, in order to highlight the aspect of distinguishability in order to understand the interventions carried out subsequently with respect to the construction of the factory. [Fig. 2] [Fig.3]

To the advantage of the feasibility of the work, a floating floor was used which contributed on the one hand to eliminating the architectural barriers, due to the irregularities of the factory's foot traffic levels, and on the other to obtaining the cavity for the air handling unit system. [Fig. 9]

A significant problem of the building is the absence of a natural air exchange, which does not allow the control of the internal air quality. For this reason, an HVAC system was designed, capable of controlling the temperature, relative humidity, speed and quality of the indoor humid air. To do this, the technical room was identified below the courtyard of Palazzo Visocchi, which, having air intakes, will house the Air Treatment Unit dedicated to Heating, Ventilation and Air Conditioning. *(Silvia Buonomano)*

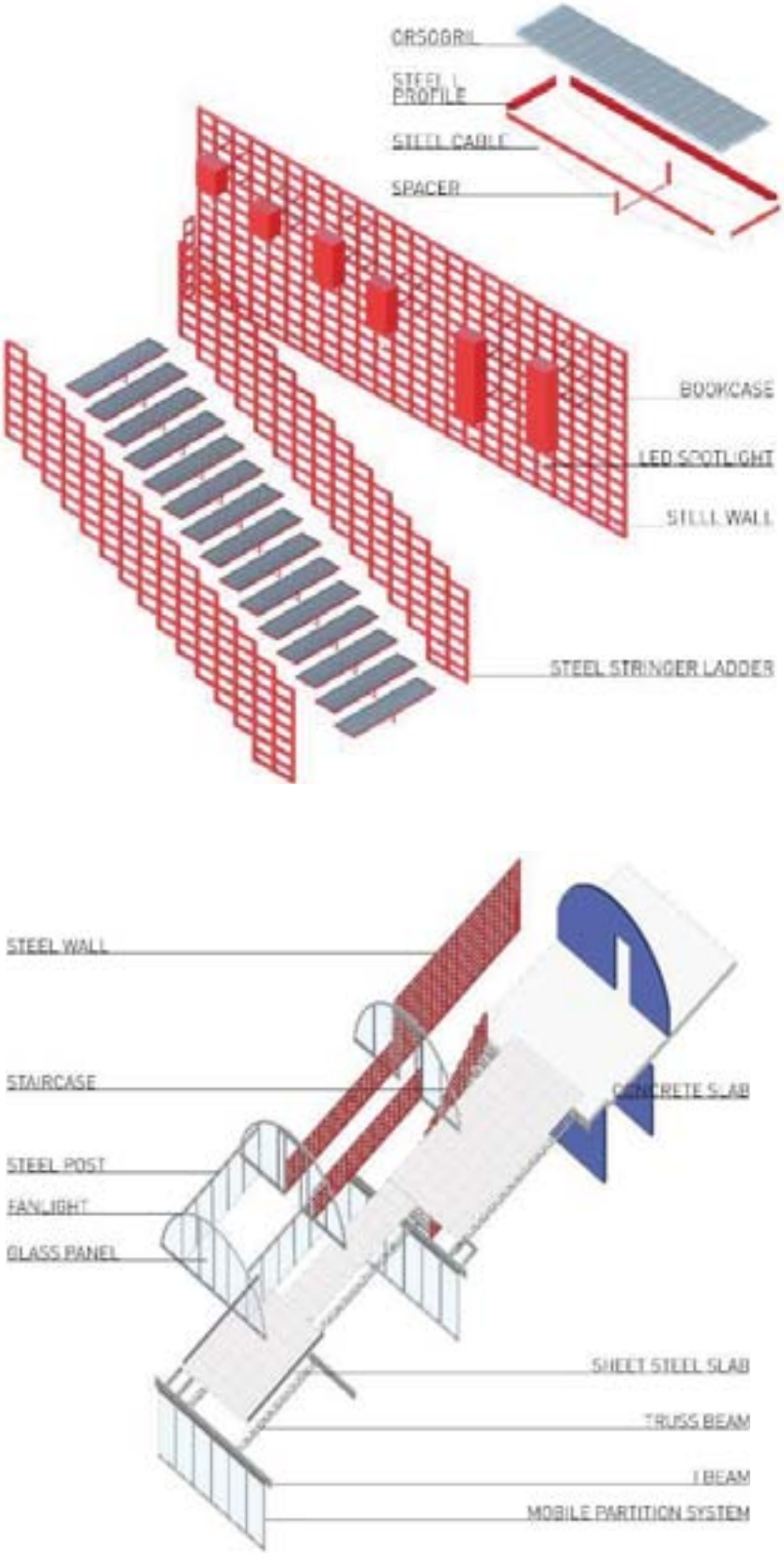


**Fig. 2:** Building system of stair and upper floor

**Fig. 5:** Upper floor

### 3.1 Saint Joseph Chapel

The Chapel, which develops on a rectangular plan, seems to be divided thanks to the presence of curved walls that circumscribe the space, which welcome the seats intended for the faithful.
A small marble altar is placed in the center of the semicircular seats and a table has been placed on the back wall, on which the luminous cross, obtained from a cut in the wall, develops. Also for the entrance to the chapel, the transparent diaphragm was used on which the phrase St. Augustine was engraved, "God loves each of us as if there were only one of us", translated into various languages of the world. [Fig. 6]
*(Silvia Buonomano)*

**Fig. 6:** Saint Joseph Chapel

## 4. Filux - Lighting system

Given the absence of natural light, it was necessary to deepen the topic of lighting.
The ambient lighting is guaranteed by cuts in the walls that run horizontally, at different heights, in which there are LED strips. Just as space is able to transform itself, light too follows these transformations. For this reason, "Filux" was designed, a new mobile lighting system, able to slide on a double cable connected to the walls, designed starting from the shape of the crozier of San Gennaro, the symbolic stick used by the bishops and linked to the figure of San Gennaro, patron saint of the city of Naples. Filux is made up of several modules that connect to form a rod surmounted by a spiral decorated with an LED sphere inside. The lighting is possible thanks to the use of a fresnel lens, inside which there is a light source, while in the final part there is a spotlight with the function of accent light. The fresnel lens, given its annular sections, is able to diffuse and amplify the light rays in the environment despite having a small section. Just as space is able to transform itself, light too follows these transformations. For this reason "Filux" was designed, a new mobile lighting system, able to slide on a double cable connected to the walls, designed starting from the shape of the pastoral of San Gennaro. [Fig. 7]
*(Silvia Buonomano)*

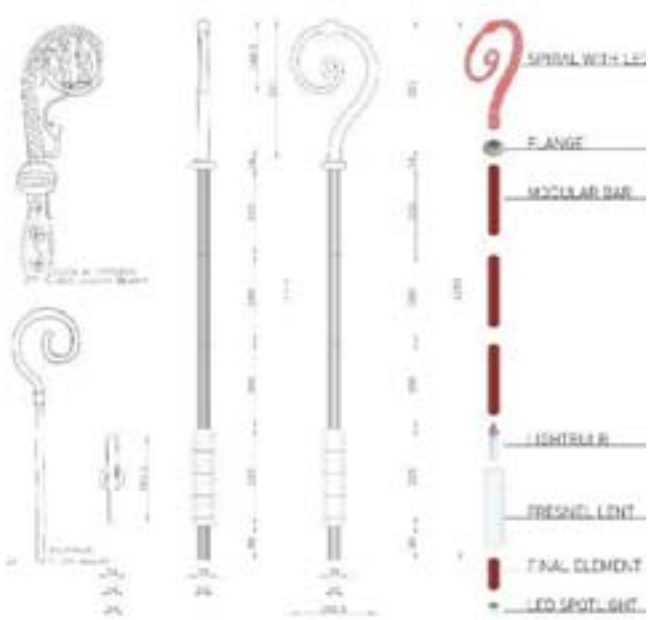


**Fig. 7:** Filux, mobile light system

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# Between image and logos: the paradigm of a visual language in the Valcamonica rock drawings

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## Abstract
Since the most remote moments of its history man has tried to discover, read and understand reality, interpreting its mysteries through a set of signs, shapes, colours, manifestation of that cognitive aspiration that has always prompted the human soul to act, trying now to record, now to change the surroundings. The artistic expression of prehistoric peoples represents a fundamental investigation element capable of highlighting the product of significant mental operations that express aspirations and intellectual processes. Introspecting prehistoric art, and relating the forms of expression to the cultures that produced them, certainly appears satisfactory from a historical point of view. But investigating such a great expression of the human spirit from the point of view of the image makes an even greater possibility: that of connecting areas of knowledge that are also very distant from each other but united precisely by the paradigm of representation which therefore arises as a reading tool since the first anthropic landscapes. The present study concerns the relationships between image and language and analyzes the aesthetic manifestations of primitive art as a construction of communication models. Particular attention is paid to the importance of semiotic systems developed in prehistoric times and to their possible pre-linguistic values. The area of analysis is assumed to be that of the rock art of Valcamonica, the first Italian site included in the UNESCO World Heritage list, by comparing the vast existing literature relating to interpretative studies. The fundamental objective is to bring semiological attention from the logos to the image.

**Keywords:** symbol, image, representation, prehistoric art, visual communication

## 1. Introduction
Visual perception represents the first moment of knowledge of reality. Through perception, the artist transposes the concrete phenomenon giving it a graphic interpretation. It is an ontological construction that arises from the impression of a visible appearance –a representation– from which springs the cognitive experience itself which constitutes the immaterial dimension of the physical act of seeing. The representation of a phenomenon can be both logical, entrusted to the word (logos) as a symbol that describes an idea of reality, and analogical, when it is placed in an analogical relationship with reality, imitating its forms (fig 1).
Although the logical representation immediately recalls the language and therefore a system of signs arbitrarily related to meanings, it should be emphasized that an image can also be a logical representation.
The images produced by prehistoric art are sometimes presented as analogical expressions of reality, other times with distinctly logical connotations. This antithesis between two models of representation (logical-analogical) was defined by the German physiologist Max Varworn with the terms 'ideoplastic' and 'physioplastic' [1] and later by Herbert Kühn with 'imaginative' and 'sensory' [2].

In the extraordinary season of Prehistory, figurative expression as a manifestation of a culture [3] and an implicit form of communication, alternated conventions based on the imitation of visual images with others, founded on systems that could be defined as conceptual. Such systems, often reductively traced to an aesthetic primitivism, if not a perceptive infantilism [4], constituted a communicative model and not just an aesthetic manifestation. What may appear insignificant to us must be historicised by considering that, in epochs other than our own, the image "...is delineated and functions otherwise, both at the level of individual experience and in the general communication process within the group and the operations of thought" [5]. In other words, the role of representation at a precise moment in evolutionary history conceals specific functions, needs and requirements and its concept itself cannot be considered univocal.
The common denominator of prehistoric art is the advent of image manipulation and sharing following a "... cultural transition based on the establishment of common conventions regarding forms of representation" [6].
But if for Palaeolithic art, and to some extent for Mesolithic art, the adherence to naturalism is evident, so much so that it is often considered a superbly veristic art - as witnessed by the numerous zoomorphic representations scattered in various areas of the globe (fig. 2) - representations from the late Mesolithic and Neolithic ages are surprising for their distinctly anti-naturalistic character (fig. 3).
In other words, there is a succession between two models of representation [7], or ways of mentally reproducing a vision that has already taken place, of creating an image (appearance) that allows the perceptual experience to be relived, even in the absence of the object that constitutes the sensory stimulus. In one case through graphic representations that adhere to the perceived datum (real or imaginary), in the other through semiotic systems with which aspects or parts of reality used for the exchange of information are determined and defined. In both, the representation is not merely mnestic, i.e. it is not linked to the optical visual image, as it never appears as a precise transcription of an event, but rather as its reworking. However, Mesolithic and Neolithic art shows the attainment of the use of the symbol in a communication process: it becomes a language that relates a signifier to a signified. The graphic symbol made socially shared becomes immediately comprehensible by linking the cognitive and mental dimensions to the material, informative, and cultural dimensions (fig. 4).

**Fig. 1**: Libya, Fezzan. Prehistoric cave engravings with animal themes.

**Fig. 2:** Paleolithic cave painting depicting, in naturalistic form, a hunting scene. Lascaux.

**Fig. 3:** A hunting scene depicted in a logical type. Cave of Porto Badisco. Puglia, Italy.

**Fig. 4:** Rock engravings. Left: human face. Right: Neolithic age house. Valley of Marvels, France.

## 2. Abstraction and symbolic communication. Camune rock art in Valcamonica

One of the most significant examples of the powerful abstract capacity of prehistoric man is represented by the rock drawings in the Val Camonica, which have been on the UNESCO World Heritage List since 1979 [8], and in which splendid examples of prehistoric symbolic expression from the Epipalaeolithic period to the Iron Age can be found. The structure of this splendid alpine valley is profoundly marked by the millennial work of the Quaternary glaciers and their sliding, which, at the time of the last glaciation, brought to light a smooth and uniform rocky surface, polished by abrasion. A veritable page of stone, extending some seventy kilometres, on which the Camuni, the ancient colonisers of the valley, were able to give rise with their engravings, thousands of years after the retreat of the glaciers, to the largest illustrated journal of prehistory.

There are countless rocks on which, some 4000 years ago, the Camuni told their story through images, patiently carving thousands of figures with stone and later metal tools. A varied and articulated set of petroglyphs constitutes an immense iconographic corpus of extraordinary scientific importance and for which the valley is today characterised as 'the valley of signs'.

**Fig. 5**: Some typical themes of Camuna rock art. On the left: a village and its inhabitants. On the right: praying men. Valcamonica, Naquane. Italy.

To date, more than 2,000 engraved rocks have been recorded in the area in about 180 locations, scattered among the various municipalities of the valley, with a repertoire that includes more than 140,000 symbols and figures produced over a period of time that spans about 8,000 years, between prehistory and history. The rock of Naquane alone, towards Capo di Ponte, with the hundreds of engraved figures that mark it, gives an idea of the greatness of this heritage and its importance for research into prehistoric art as well as the ethnology and sociology of that time.
The astonishing amount of images and symbols does not lend itself to easy exegesis, and the prevailing interest in the art form itself has often led to lacunae in interpretation. Studies aimed at linking figurative expressions to a broader vision of territorial and archaeological contexts, and settlement and socio-cultural dynamics, are only recent. But what makes the reading of the many signs even more complex is the extension in time of many of the figurative scenes through successive juxtapositions or superimpositions: a diachrony that in some cases leaves reasonable doubts as to the logical correlation of the signs, making it difficult to decipher intentions that are in any case plausibly narrative. Regarding the temporal scansion of the images, the typological and chronological sequence, conducted based on stylistic analysis, produced at the end of the 1960s by the archaeologist Emmanuel Anati [9] is still valid today, albeit with minor revisions over the years.
From a typological point of view, the depictions, carved into the surface of the compact sandstone using the 'hammer' technique, often alternating or associated with 'graffito' engraving, mainly contain scenes from daily life (hunting and farming), or ritual scenes linked to the spirituality of the colonising peoples.
From the enormous depictions of moose pierced by hunting weapons to the figures of the famous praying men (fig. 5) - one of the highest narrative scenes in Camuna rock art - whose arms and legs are bent at right angles and set against each other in an evident dynamism, perhaps representing adoration or a dance linked to a funeral rite, Camuna art elaborates a set of symbols and forms that pictographically tell an impenetrable fragment of human history. On the broad rocks filled with descriptions stand out figures of deer with long branched antlers and other animals, triangular daggers with a crescent-shaped pommel, threadlike men with outstretched arms, hunters and warriors, but also dots, rectangles and circles as signs in their own right or as symbolic attributes. And then celestial symbols, animals, weapons, ploughs, rows of human beings and other signs (footprints, paddle figures, labyrinths, the so-called 'rosa camuna') depicted in famous stone shrines (fig. 6).
With the rise of warrior societies, weapons appear as true objects of worship, as well as scenes of war, hunting and various symbologies in which the narrative thread often seems to get lost, but which all act as a corollary to a society increasingly based on virile strength. In such narrative exuberance, there is no lack of man's glance at the territory on which communities, having become settled, trigger their processes of modification: thus huts, fields, and human and animal shelters (fig. 7), provide inescapable subjects for architectural and proto-urban representations of antiquity [10]. A singular example of this is expressed by a group of rock engravings, recently reconstructed under Iron Age style IV, known as the 'the map of Bedolina'. In such figurative structuring, the main layout "... This is composed of 36 quadrangles, filled internally by regular lines of circles, and nearly all joined together by irregular lines. The whole has the look of a topographical representation and the common interpretation, and also the most probable, is a representation of cultivated fields connected by paths, streams or irrigation canals" [11]. In it, schematic representations of wooden huts appear in filiform graphics: representations, in an *ante litteram* orthogonal projection, that make visible through a few signs engraved with almost geometric precision, the sloping pitched structure of the construction, the wooden scores of the elevations, the piling support structures.

**Fig. 6:** Geometric symbols carved into the rock. Valcamonica. On the left: a labyrinth. In the centre: the 'camuna rose'. On the right: a wheel with spokes.

All the constructions are seen in the front elevation, looking towards the valley floor (fig. 8). " They are the “skeletons” of constructions, seen from an “X-ray” viewpoint … The base comprises a variable number of vertical lines (probably the representation of the main beams of the building) or a single central groove, with a rectangular base ... The central body consists of a rectangle, bisected by a vertical ‘beam’, present in all the different types of structures; The roof can be triangular or, more often, pentagonal, a shape, this, which also seems to be more recent; the roof may be triangular or more often pentagonal. The decorative or reinforcing elements are secondary elements, not always present; sometimes there are the ladders leading up the side of the main body. Usually the out-jutting portions of the roof beams are present, shown as reinforcing elements for the roof, and the ornamental elements placed on the joining of the main supporting root are frequent: beams, on the apex of the roof, or at the end of the cross-beams" [12]. However, as Turconi further notes, "... Above all the word ‘map’ in its modern meaning of representing cadastral territories is not a correct interpretation if referred to prehistoric representation of territories. I believe rather that this picture has abstract meanings, magical-religious, or ritualistic functions, practised to protect the territory from every type of calamity” [13].
In the complex expression stretching over millennia, the prehistory of mankind finds in Camuna art a paradigmatic example of the progressive passage from image to symbol and from symbol to sign. And it does not seem unjustified to glimpse, in the set of images that have come down to us, the presence of a visual code, or in other words, the definition of a pre-linguistic system of communication and expression based on a complex logical articulation, a reflection of the cognitive structure proper to the human being. In other words, it is a complex of associations of ideas that gives rise to a sort of universal symbolism and is reflected in the repetition of similar representative codes in various parts of the globe [14]. A replacement of the perceived datum with a representation of more rapid fruition is the prelude to the definition of an instrument of thought and communication such as language (fig. 9).

**Fig. 7:** Representations of houses. Left: Three stilt houses. Right:  house with external stairs. Valcamonica.

**Fig. 8:** Representations of the villages. Particularly significant is the map of Bedolina (on the left). Valcamonica.

**Fig. 9:** Valcamonica. Above: stylised human figures. Below: Camuno alphabet and inscriptions at Capo di Ponte.

## 3. Conclusions

Though not claiming to exhaustively investigate such a vast and significant patrimony for art in general, and for the science of representation in particular, the brief notes presented here are therefore intended as a moment of reflection on the symbolic and graphic value of those signs of the past. Signs, nonetheless, are extraordinarily topical, so much so that they could be the starting point for new graphic experiments in which, among other things, interesting cultural implications are inherent. The search for the profound meaning that those images hold, and which they translate into graphic signs thanks to an increasingly evident process of abstraction of form, makes it possible to define precise didactic paths that thus become exemplary of a mental and graphic process that is always inherent to project conception - as much about architectural design as, and perhaps even more so, to graphic design [15]. The engravings of Valcamonica are an example of primitive art that rises to logos in the process of constructing communicative models, transcending the temporal boundaries of the millennia that divide us from them, and imposing itself as an iconic reference in the elaboration of the complex semiotic systems proper to contemporaneity.

**F**

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# The project of public space.
# Towards adaptive infrastructures for more flexible and ecological cities

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## Abstract
The contribution aims to investigate, on the basis of projects and theories, the possibility of considering infrastructures and soil as a project material and as a new portion of public space. While on the one hand, new technologies allow forms of digital socialization, creating a strong disenchantment with the metaverse and estrangement from reality. On the other hand, the quality of public spaces still seems to be strongly compromised by overly specialized places and the result of a twentieth-century design approach according to which they are inadequate for contemporary urban social welfare. Among these places, the roads and large infrastructure nodes which in many cases are truly autonomous metropolitan landscapes, play a central role. Their iconographic incident within the city introduces a scenario that obliterates the urban habitat and does not establish any direct relationship with it. The survey starts from the recognition of the French experience of the TVK studio within which the E-40 Brussels project questions the future and the alternative role of infrastructure. The goal is to evaluate the feasibility of these scenarios that rethink areas of public cities trapped and colonized by infrastructures from a more ecological perspective.

**Keywords**: tactical urbanism, complexity, scripting, time, durability, resilience

## 1.Tactical Urbanism in Milan
The contemporary metropolis is itself an extremely complex phenomenon. The city is almost never entirely knowable, given the endless and extremely rapid visible and invisible transformations that characterize it. It has often been argued in the chaotic and polarized debate of the syndemic time we live in, that the future of the contemporary metropolis essentially passes through the management of density [1].

The city, especially the European within which we live today, is composed of fragments of modernity - as if abstract formal or stylistic traits had sometimes survived in it in its pure state, while instead the city planning (partly still operating), had failed. [2]

Urban space in its dynamic configuration is made up of a multiplicity of layers, some physical and some immaterial, "just as computer networks become faster and more efficient every day, so do the networks on which things travel in the physical world (...) The functioning of the world, that is of cities, depends today on a set of communication networks, some visible and others, the most important, invisible; and the resulting network produces a space that is not homogeneous but heterogeneous, not continuous but discontinuous, not isotropic but anisotropic, that is, not turned in the same direction. But homogeneity, continuity, and isotropism are the three fundamental qualities of Euclidean space on which all topo-cartographic representations, and therefore all images that serve the construction of the city, are still based today. It follows that the crisis of the topographical paradigm (i.e., the paradigm that represents the embodiment of every spatial practice of the past) means the crisis of our current possibility of understanding the urban fact."[3] Therefore, it is beneficial to build a conceptual framework on urbanity that favors creative and associative thinking over a linear one, which is riskier and more open instead of safe and static.

A new paradigm starts from the recognition of the "urban void" in the landscapes of monofunctional infrastructural nodes currently in a state of distress and obsolescence.
“It will no longer be obsessed with the city but with the manipulation of infra-structure for endless intensifications and diversifications, shortcuts and redistributions-the reinvention of psychological space. Since the urban is now pervasive, urbanism will never again be about the "new," only about the "more" and the "modified."[4] In this regard, it seems interesting to analyze the "Agenti Climatici" design experience that OMA and Laboratorio Permanente recently proposed for the Scalo Farini in Milan. The design methodology offers us two possible steps to reflect on: the first is related to environmental awareness in the rehabilitation of the rail yard. There is in fact a conflict between the fabric of the city and the railway yard, which is perceived as a physical and visual limit. OMA, therefore, envisions the redesign of environmental intensity, redefining an entire urban and landscape ecosystem. The second aspect of interest concerns an innovative approach with respect to the temporal management of the project. Temporality is understood as a resource: starting from the initial phase. In fact, future developments are conceived as positive moments in which to test the adaptive and reversible capacities of the entire area. In this sense, even the first phase, which consists only of environmental renewal, guarantees the reappropriation and use of an entire piece of the city. "The master plan was conceived as a "human smart neighborhood" which is a single system generated by the integration of natural and urban components, balanced with zero-impact active and passive energy inputs. Parks that function as environmental devices, ecological corridors, natural gardens, bioswales, and smart walls for air purification. Vegetative areas promote biodiversity and increase the comfort of urban space also through thermal buses which provide air conditioning of public squares and paths. [5]

A similar experience in Milan is represented by the redevelopment of the Scalo di Porta Romana for the design of the new Olympic Village, in view of the 2026 Winter Olympics Games. Similar to Scalo Farini, the masterplan for the Scalo di Porta Romana is part of a plan for the redevelopment of intermodal nodes in Milan promoted by the Municipality and the Italian State Railways. At Porta Romana, the Ground Up group [6] has redesigned an urban void by conceiving a master plan developed in multiple timeframes. The first phase of the project involves the construction of residences for the Olympic Village, at the same time as a central park, a suspended forest placed above the railway track on the east-west site, a series of eco-zones with planted trees, meadows, thematic islands, and wetlands. At the end of the elevated path where the East Gate is located there is a mobility hub of the project conceived as a large suspended gathering space that integrates the accesses to the subway and railway stations.
The second phase, as also proposed by OMA for Scalo Farini, favors the return of the entire area to the city, which will be used for social housing and to reconfigure a series of fundamental relationships and connections with the urban context that were previously completely nonexistent and impossible. Despite an approach tending more toward densification of the area. Ground Up has sought to innovatively integrate the needs of the city with the goal of transforming the current role of infrastructure, placing it within an environmental, combined, and dynamic vision.

## 2. Scripted Architecture. ’E-40 from TVK

In France, TVK studio has been pursuing compelling examples of tactical urbanism for a decade already; their design approach experiments with modes that see the project as an open-ended script [7] that is inspired by the way television series are scripted. Through the identification of "foundations" within a system of different "seasons," time is understood as a design tool, and the territory is conceived as something not fixed, complete or ideal. The project becomes a kind of temporal and hypothetical frame. It tries to shape a new urbanism, which no longer aims at stable configurations, but at the creation of fields that are capable of accommodating processes. Such processes refuse to be crystallized into definitive forms and reject boundaries which are not to separate and identify entities but to discover unnamable hybrids. [8]
The transformation of infrastructure, including expressways, into highly specialized urban components in which to test the design quality of public space, is one of the themes pursued by French studio TVK. Founded in Paris in 2003 by Pierre Alain Trévelo and Antoine Viger-Kohler, the firm pursues the goal of tracing new possible scenarios for the use of contemporary public space. From a theoretical standpoint, TVK has given new possible meanings to the term "durability"; in fact, starting from the much broader concept (in terms of the scale of application as well as its implications) of "ville durable," it has declined durability in infrastructure design, which also evident in the E-40 in Brussels.
The term durability is certainly linked to a temporal condition, indicating in fact "(...) quality and condition of what can last" [9]; durability can be perceived, experienced, and witnessed by the obsolescence of materials, the deterioration of initial conditions, or by a functional or formal transformation of parts of the work that compromise its initial design logic. However, if this view is reversed, durability can also be considered an integral part of the project, within which the temporal component becomes the absolute protagonist of the phases of transformation of architecture. After all, as argued by Trévelo and Viger-

Kohler, «The sustainable metropolis' transformation should be related to a metamorphosis, that's to say the advent of a new condition drawn from the former, by the awakening or the activation of dormant elements. Through this lens, the sustainable isn't amnesic but is anchored in history and the main landmarks it has produced. The concern is to reach a form of isotropy in the research into the notion of the sustainable city, including its whole territory, drawing on elements that compose and articulate its different spaces. The spatial and temporal scales, from the local to the metropolitan and even to regional territories, generate the frame within which the rebalancing of the developmental actions are at stake. The metropolis, the new scale of an urbanity with obsolete communal limits, is complex. Its development must integrate some new elements, already there but conceptually rendered "invisible" or simply "harmful". That is the case, for example, with the large transport infrastructures with which it is necessary to compose».[10]
According to TVK, durability is not expressed through logical temporal relations in which we can distinguish between past, present, and future [11]. Durability is transformed into a complex spatiotemporal condition marked by multiple variables. Foreshadowing of the future, therefore, occurs through the development of different stages which, at times, may overlap one another. The prefiguration of the project manifests itself, therefore, according to dynamics different from what Franco Purini asserted about the timing of the project. It is no longer just a matter of the architect's extraordinary intuitive ability to imagine the ultimate phase of his work (that of the ruin) [12], but rather of conceiving multiple scenarios, all plausible, each of which is diversified by the quality of the relationships woven by the spatiotemporal variables.
Conceived within this theoretical approach, the "Parkway de Bruxelles" masterplan defines three scenarios through which it is possible to convert a section of E-40 into a public space integrated into the landscape and urban fabric. The E-40 is one of the main access routes to Brussels and, to date, forms part of a supranational road route that connects Kazakhstan with the English Channel. TVK's masterplan was commissioned in 2014 by the ADT-ATO (Agence de Développement Territorial pour la Région de Bruxelles Capitale) as part of a very extensive plan to transform the city's expressways into boulevards.[13] TVK's main goal is to completely transform the citizens' perception of this road: from a monofunctional infrastructure cutting through the northeastern part of Brussels (between the Moyenne Ceinture and the Flemish region) to a multi-use public space. After all, "It's about imagining how the E-40 can serve the neighborhoods it passes through, and the city as a whole, towards a monumentality that will link the large scale and the local". [14]. The section area of E-4 is called a "supersurface", so as to emphasize the extent of this large public surface capable of undergoing a whole series of transformations to become a new type of public space. According to TVK, the supersurface is not a linear plaza as much as it is a "chambre verte," [15] an empty area in which it is possible to optimize the space dedicated to cars, without reducing the capacity of the highway. In fact, the first scenario (2016-2018) envisages the gradual reduction of car lanes (from 12 to 8, with a supersurface of almost 15 meters) so as to facilitate the deeper changes that will characterize the later and more experimental phases. The second phase (2018-2022) involves doubling the supersurface, limiting the speed of automobile traffic, and creating new green belts, placed along the outer limits of E-40, that expand toward the city. The green lung extends longitudinally (along the entire section of E-40 affected by the master plan) and transversely, characterizing the project section. The second phase establishes the conditions for the development of the third season of the project (2022-2025), in which the transformative potential of E-40 will be at its peak; the supersurface, as a new type of public space, will be able to accommodate future needs that, as of today, cannot yet be foreseen or hypothesized and that, therefore, remain "undefined" even in the script of the project. According to Trévelo e Viger-Kohler, "The transformation of the E40 will be built thanks to an active consideration of time and the periods or cycles that can compose it. Imagined and experimented by TVK in very different cases, the scenarization is neither an urban scenario (in the sense of a hypothesis rather than another), nor a storytelling but the construction of a continuity and a dynamic by the sequence of successive states. This way of thinking allows us to move forward by imagining periods (or "seasons") and by questioning the interactions from one period to another (the sequences but also the feedbacks)"[16].

## 3. The process of organic growth in the resilient city

The ability to resist and, thus, to survive changing, as the term resilience, is a characteristic of organic systems that is also proper to the city as a living organism.
Indeed, the city constantly adapts its form over time to environmental, social, cultural and, now more noticeably, climatic constraints.
This peculiar behavior sums up the resilience of the city and is the main factor in its evolution. The resilience of the urban form in this reference represents both a cure and an opportunity for growth for the city.

The theme of resilience also features in numbers 9 and 11 of the SDGs, Sustainable Development Goals: - 9. Build resilient infrastructure [17], promote inclusive and sustainable industrialization and foster innovation; 11. Make cities and human settlements inclusive, safe, resilient and sustainable.
In Goal G11 [18], which consists of seven targets and three letters, sub-goal 11.8 calls for substantially increasing the number of cities and human settlements by adopting and implementing integrated policies and plans for inclusion, resource efficiency, climate change mitigation and adaptation, and disaster resilience.
Given the homogeneity of relationship functions between humans, plant and animal organisms and the environment in which they live, an ecological study of these growth and adaptation patterns aimed at comparing urban and biological patterns becomes interesting.

## 4. Conclusion

These experiences of tactical urbanism define a new metropolitan iconography (could this be the only one possible?) and on the other hand the rearrangement, more or less controlled, of further fragments of public space. They show us, in fact, what, until a few decades ago, were simple gateways to the city, now become an opportunity to experiment with new forms of coexistence and an integrated human/natural habitat scheme. The examples of Milan and Brussels can be seen as an incipit for a different narrative of the project, well described by the non-chronological time scanning that allows us to consider the eventuality of variables (climatic and urban) necessary for a city facing global changes and challenges. As Koolhaas stated “new urbanism will no longer be concerned with the arrangement of more or less permanent objects but with the irrigation of territories with potential (…) it will no longer be about meticulous definition, the imposition of limits, but about expanding notions. (…) urbanism redefined as a way of operating on the inevitable will attack architecture, invade its trenches, drive it from its bastions, under- mine its certainties, explode its limits, ridicule its preoccupations with matter and substance, destroy its traditions, smoke out its practitioners” [19].

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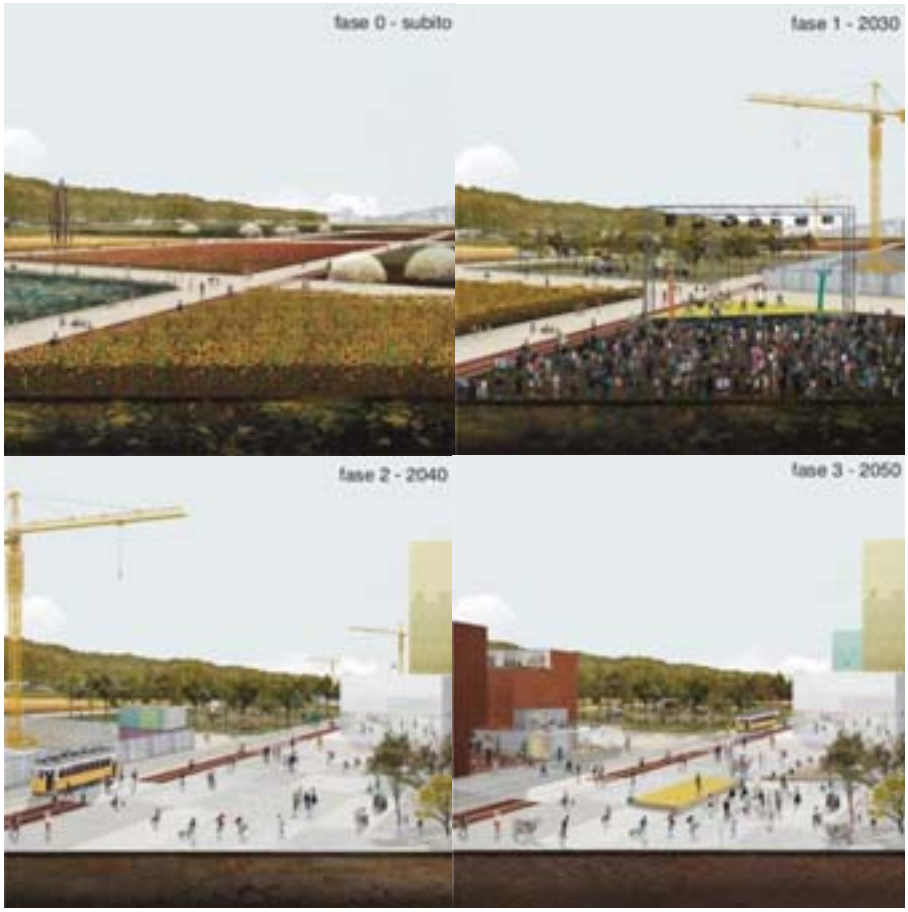


**Fig. 1:** The 4 phases of Scalo Farini. OMA and Laboratorio Permanente.

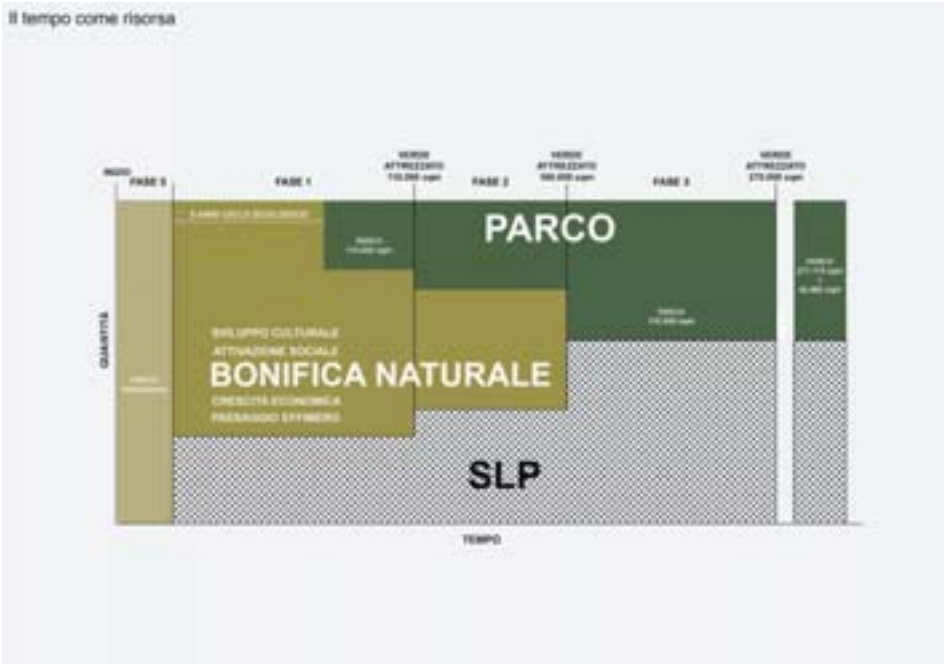

**Fig. 2:** Time as resource, Scalo Farini. OMA and Laboratorio Permanente.

**Fig. 3:** Scalo Farini. OMA and Laboratorio Permanente.

**Fig. 4:** Masterplan of Ex Scalo Porta Romana in Milan.


**Fig. 5:** Details of the Suspended Forest in Milan.

**Fig. 6:** Masterplan of E-40 of TVK.


**Fig. 7:** Season 3 in the masterplan of TVK.

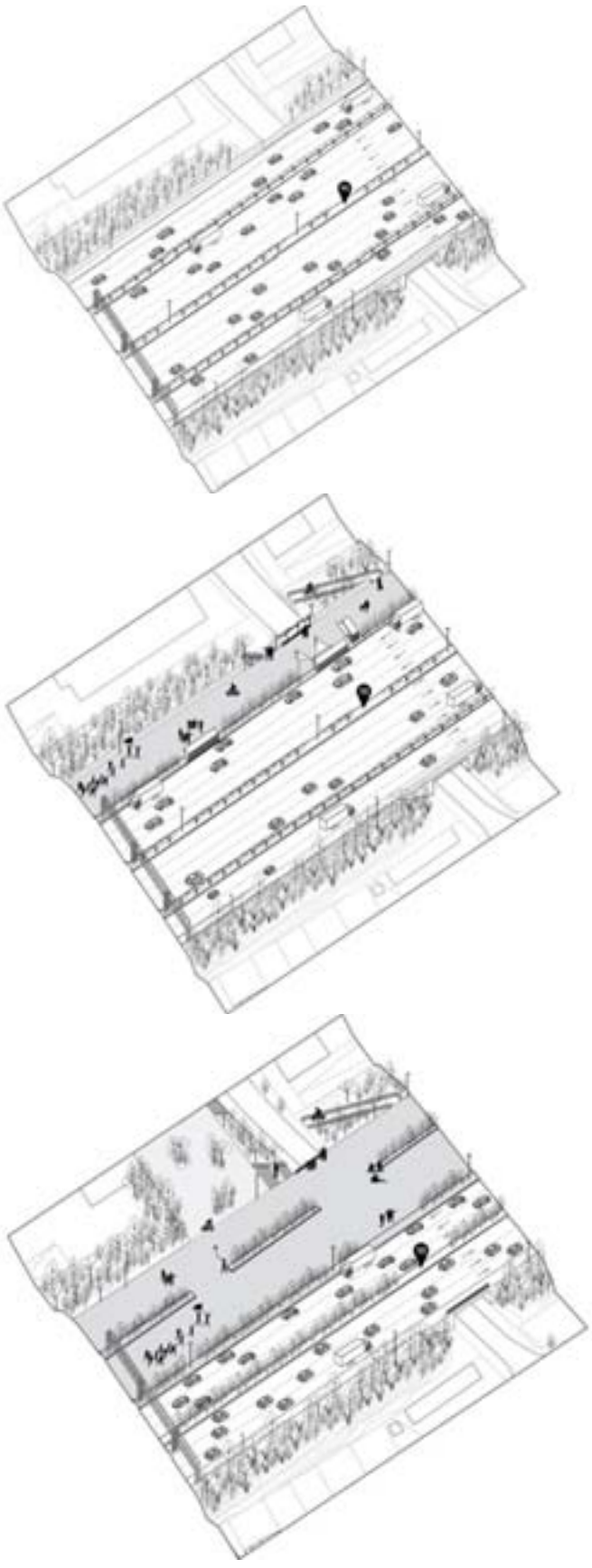

**Fig. 8:** Timing of the E-40.

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# BIM methodologies to support the regeneration of the existing building heritage

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## Abstract
Dealing with the enhancement of the existing heritage means improving the quality of life in the urban environment. In fact, promoting regeneration actions on heritage means recognizing social and cultural values but at the same time managing urban changes in the light of livability needs with a view to reducing consumption. In this sense, operating in urban areas certainly implies complex actions that require a new and advanced digital approach capable of providing detailed information on even very large areas to support decisions. Currently, most of the operations on existing assets generate a significant impact especially from an environmental point of view. Therefore, it is necessary to act in advance through interdisciplinary approaches that guarantee an optimal evaluation and management of the problem right from the origins. The following contribution proposes the use of the Building Information Modeling methodology as a design tool for redesigning the relationship between man and the environment in which he lives, in line with the indications on sustainable development promoted by the European Union within the Agenda 2030.

**Keywords:** Building Information Modeling, 3D models, Cultural Heritage, sustainability

## 1. Introducing
In recent years, there has been a lot of talk about sustainable development understood as a global process of managing resources, investments and technological choices capable of guaranteeing the well-being and improvement of the quality of life of all humanity, while respecting the needs of the current generation and future ones. In the Brundtland report, entitled "*Our common future*" and drafted in 1987 by the World Commission on the Environment and Development, the Norwegian premier who presided over this Commission [1] claims for the first time that: «sustainable development, far from being a definitive condition of harmony, it is rather a process of change such that the exploitation of resources, the direction of investments, the orientation of technological development and institutional changes are made coherent with future needs as well as with current ones". Attention, in this document, is also directed to the need for a more active involvement of citizens in the choices underlying sustainability, Bruntland believing that only in this way can a democratic system of participation in decision-making processes on an international scale be implemented [2]. The logic shared starting from this first report, and which will then return in all the documents subsequently adopted on these issues, is based on the consideration that sustainability must contemplate three areas of application. The three fields to which reference is made are economic sustainability, which concerns the possibility of guaranteeing a job and therefore an income for the sustenance of the entire world population; social sustainability, which includes policies to ensure the well-being of the community (on issues such as safety, health, education, justice and so on); environmental sustainability which pays attention to the protection of our natural habitat, with particular reference to the quality and reproducibility of natural resources (fig. 1)


**Fig. 1:** Graphic scheme of the individual components of sustainability and effects of mutual intersection (image taken from https://www.iilsindia.com/blogs/sustainable-development/. Accessed on 14 April 2023).

Therefore, if we imagine the fields as three circles, it first of all appears clear that only the intersection of all three fields - i.e. the simultaneous attention to social, economic and environmental aspects - generates sustainable development. The overlapping of two areas, on the other hand, determines subsets to which corresponds a sustainability referable to some more specific and less global operational aspects, and which respectively concern issues relating to "Equal Social Environment", "Economic and Social Development" and "Natural Environment and Built Sustainable". As part of this approach, any intervention on the building heritage linked to the evolution of urban territorial contexts or their regeneration participates in the guidelines of sustainability within a strategic vision of development of urban areas that guarantees integration of the territorial fabrics through flexible and innovative planning and management processes [3].
In the architectural and urban fields, some innovative information management tools are significantly anchored to sustainable urban development strategies (SUS). In particular, the use of Building Information Modeling, in the broader context of digitization of the built environment, shows enormous potential both in the creation and sharing of information and in collaboration processes. In the latter case, BIM can also be a tool to implement collaborative practices and shared management of real-time information (the so-called Social BIM) [4].
Starting from these considerations, the paper focuses on the role of BIM as a determining tool in the promotion of innovation, in the development of knowledge management systems on the built heritage and in the improvement of the exchange of information, highlighting its central function in favoring decision-making processes in the public sphere that avoid empirical analyzes [5]. In this sense, the results of the recent surveys on the sustainable transformations of urban areas in the industrial or post-industrial districts of European and Mediterranean countries are exemplary, which have shown the need to address possible new urban arrangements in the context of migration, climate change, of changing the global economy and adapting to the new situation with sustainable holistic solutions. Building Information Modeling and Management is here clearly a strategic tool, supporting all operational activities, also helping to manage the revitalization of the building stock during the entire life cycle [6].

## 2. Building heritage, legislation and sustainability

With reference to the above, it is necessary to dwell on an important aspect relating to our built heritage. Most of the Italian building stock is characterized by buildings dating back to the 60s and 80s. Many of these, after years of incessant use with inadequate maintenance, present sustainability problems and redevelopment works are needed. The introduction in Italy of interventions relating to the Superbonus 100% has generated further questions, since the approach used is of the conventional type and does not consider the sustainability requirements in its entirety. For example, for the demolition and reconstruction of existing buildings, a hypothesis contemplated by the legislation, in almost all cases an assessment was not made to understand the impact that the intervention as a whole would have had in environmental terms. Beyond the possibility offered by the superbonus to redevelop the buildings, there are also the interventions carried out on the existing assets that have been awarded funding from the PNRR which, unlike the previous ones, are evaluated according to precise criteria which constitute guiding elements along the whole process of implementation of the investments: from the conception

phase to the implementation phase of the intervention. In this sense, the administrations are called upon to guarantee these principles and the commitments made must be translated with precise warnings and monitored from the first acts of planning the measure up to the testing/certificate of regular execution of the interventions. Although in legislative terms there are references oriented towards respect for sustainability in Italy, there is however no methodology for the redevelopment of buildings that takes into account the various aspects characterizing the life cycle of the building. In fact, in 2016 the legislation on public procurement in Italy - Legislative Decree 18 April 2016, n. 50 Public Procurement Code – introduced the mandatory use of digital methods and tools and minimum environmental criteria. From 2017, then, the BIM Decree - "*Methods and times for the progressive introduction of electronic modeling methods and tools for construction and infrastructure*" - imposed the obligation, for the contracting authorities, to use "methods and specific electronic tools such as modeling tools for building and infrastructure" in relation to the "design, construction, management of the works and related verification phases". A further correlation between sustainability and digital procedures is given by the Decree of the Ministry of Ecological Transition, D.M. 23 June 2022 "*Minimum environmental criteria for the assignment of the design service for building interventions, for the assignment of works for building interventions and for the joint assignment of design and works for building interventions*", which refers to the concepts of *Life Cycle Assessment* (LCA) and *Life Cycle costing*: these notions constitute a response to the minimum environmental criteria, as they are able to predict the impacts of the single product and of the system over time. Furthermore, even if they do not represent a regulatory obligation, the various protocol systems that aim to evaluate the level of sustainability achieved by a building or a neighborhood should not be underestimated. Among these, the most significant, from a research point of view, is certainly the *Leadership in Energy and Environmental Design, LEED*® certification. The system, conceived by the United States Green Building Council (USGBC), refers to a system that assigns one point to each evaluation criterion, for a total of 100 points. Depending on the score achieved, it is possible to obtain basic (40-49 points), silver (50-59 points), gold (60-79 points) and platinum (80 points) certifications. The evaluation takes place following an articulated and complex process, focused on 8 macro-areas that affect different areas of the design shown below (fig. 2):

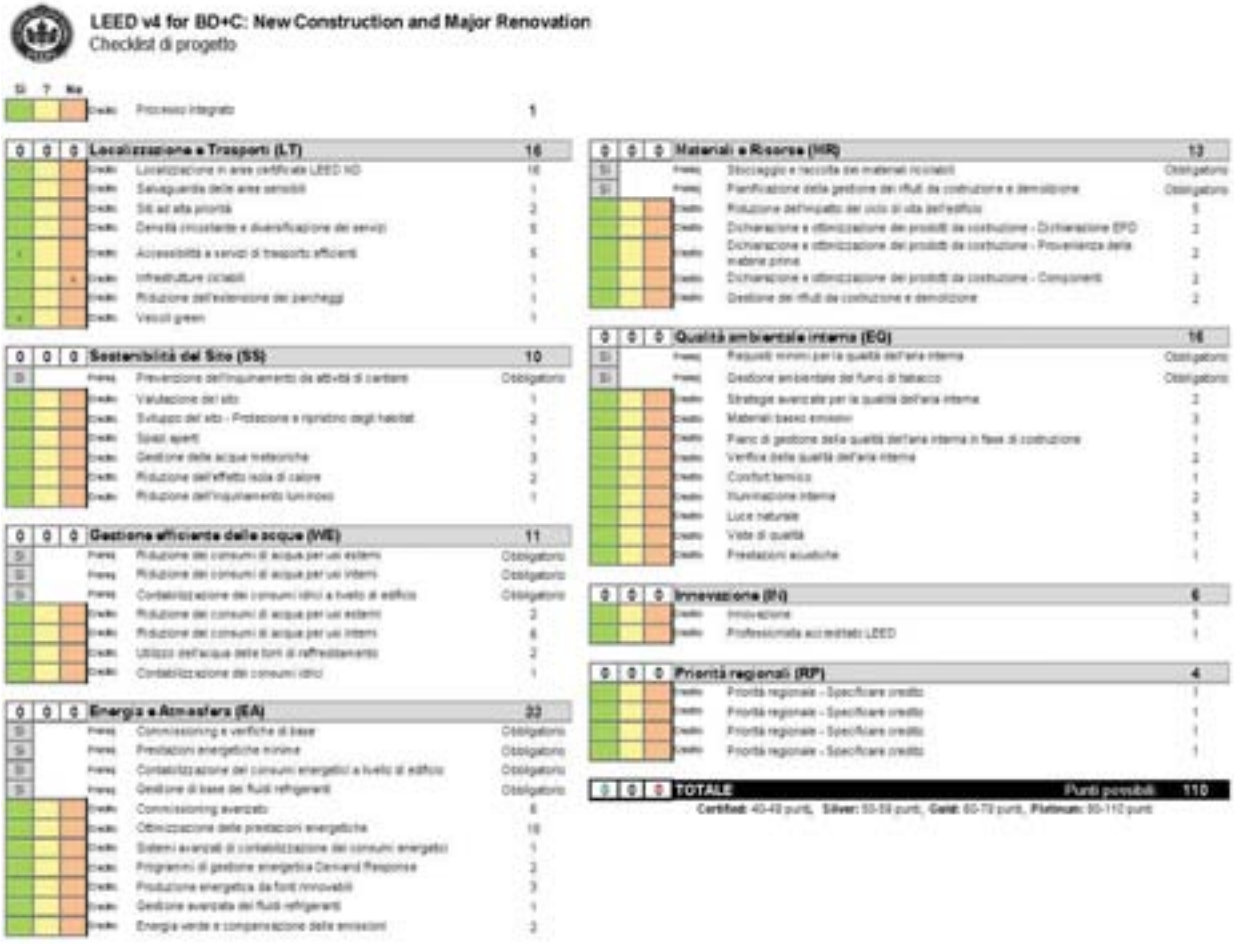


**Fig. 2:** LEED® credit evaluation criteria https://progettomanifattura.it/node/1955.

In detail, these are the points of attention:
• site sustainability: aspects related to the area in which the work will be built and the relationship between building and context;
• water management: data concerning the use, management and disposal of water in buildings;
• energy and environment: energy obtained from alternative and renewable sources capable of positively influencing the energy performance of the building;
• materials and resources: management of materials ranging from the choice for installation to the disposal of the abandoned ones, assessing the environmental impact of transport;
• indoor air quality: data relating to the healthiness, safety and comfort of indoor environments with attention to the energy consumed, air exchange and contamination;
• site and transport: reduction of environmental damage due to land development operations by encouraging eco-sustainable travel (walks, bicycles, etc.);
• innovation: design choices that present innovative aspects and application of design techniques capable of improving sustainability in the construction of buildings;
• design: characteristic aspects of the place where the building is to be constructed.
Each macro-category has sub-categories with mandatory and other optional elements and affects the final result differently. Therefore, in order to achieve a good score, it is advisable to start assessments of individual credits and then carry out a cost/benefit analysis. However, the calculation of the credits necessary to obtain the score is rather onerous with the traditional design. On the other hand, a Building Information Model, enriched with information and suitably displayed, can become a functional tool for highlighting complex technical information [7]. In this way, virtual models contribute to the management of regulatory constraints with reference to environmental, performance and economic characteristics, through information contents attributable to the elements of the representation that can be increased over time. The complexity of the topic and the enormous environmental responsibility require us not to rely on simplistic solutions, rather intervening through an osmotic dynamic of knowledge and technologies. Because it is only through a continuous knowledge process that it is possible to measure the state of environmental well-being and, at the same time, act as guarantors of the earth's quality. Therefore, in order to reduce the environmental and economic impacts of the construction sector it is essential to follow sustainable models in every phase of the design process, including the procurement of raw materials [8]. The evaluation and choice of which is the most appropriate approach to sustainable redevelopment is still an open question which, moreover, takes into account many multidisciplinary aspects.

## 3. Methodologies

In the last decade, the advent of digital modeling tools and in particular the rise of the BIM paradigm, has completely changed the approach to the representation, design and management of the so-called built cultural heritage. However, there are few studies that have analyzed the use of the BIM methodology during the entire life cycle of a building. The solution proposed in this contribution aims to optimize the impact of buildings on the environment, promoting a design approach capable of redesigning the relationship between man and the context in which he lives. In this sense, the workflow considered examines specific parameters that characterize the entire life cycle of a building. This is possible thanks to the integrated modeling which, differently from the traditional design process, allows to deal with some issues in a completely new perspective and, above all, before going to the construction site [9].

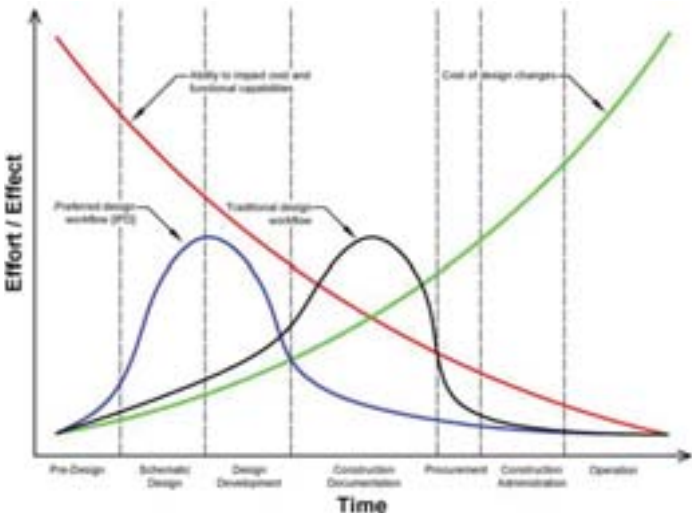


**Fig. 3:** MacLeamy Curve (image from Analysis of the Adoption Rate of Building Information Modeling [BIM] and its Return on Investment [ROI]).

These advantages are made evident in the well-known graphic representation elaborated by Patrick Mac Leamy, shown in figure 3. These curves show how the initial design effort for an integrated type design has a positive effect in terms of costs (reduction), compared to the traditional method which sees the completion and improvement of the project in more advanced stages with decidedly higher costs and lower quality.
In fact, while the traditional representation of the built environment is characterized by two-dimensional drawings based on objects without any integrated connection or relationship between them, with the elaboration of parametric 3D models it is possible to anticipate the shipbuilding reality through models that use intelligent objects combined together to create a single database containing all the information on the building [10]. In fact, the workflow requires that for each project models are created enriched by families of intelligent parametric objects. In this way it is possible to correlate various information relating, for example, to materials, construction techniques, physical properties and even degradation [11]. For each design discipline, a model is created that will always be updated, in real time and with every change made to the individual disciplinary models.

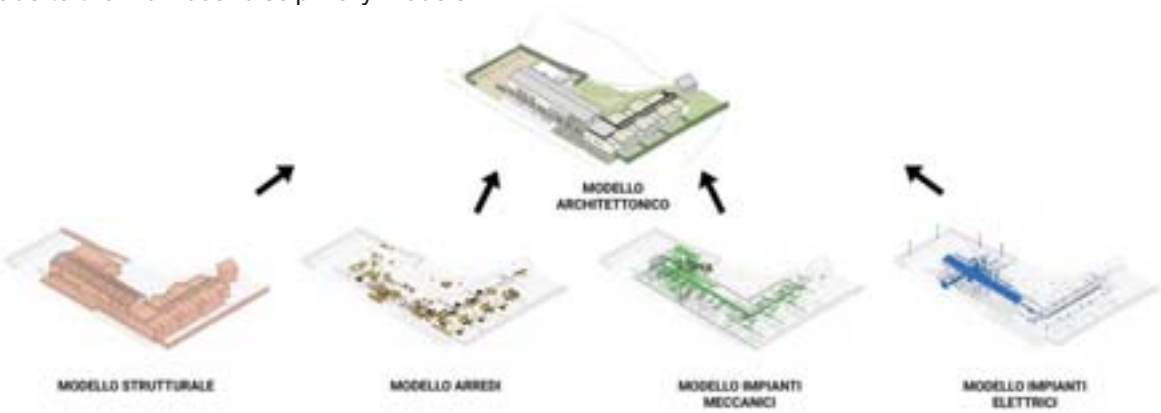


**Fig. 4:** Disciplinary BIM models of a building (image taken from https://reisarchitettura.it/it/bim/]).

From this point of view, and with reference to a concrete case study - the project of a nursery school in the Municipality of Baronissi (SA) - the use of the BIM methodology has shown great advantages leading to more appropriate choices than those initially formulated by the municipal administration that did not fully take into account the place of construction. In particular, the integrated methodology has made it possible to verify and analyze the energy performance of the building and to manage all the information on the materials. The implementation of the model with monitorable environmental data ensured compliance with the environmental parameters up to the completion of the work. Furthermore, it was possible to determine the correct positioning of the structure within the lot with respect to the path of the sun, by changing the orientation of the building and the classrooms (figure 5) with respect to the initial proposal.

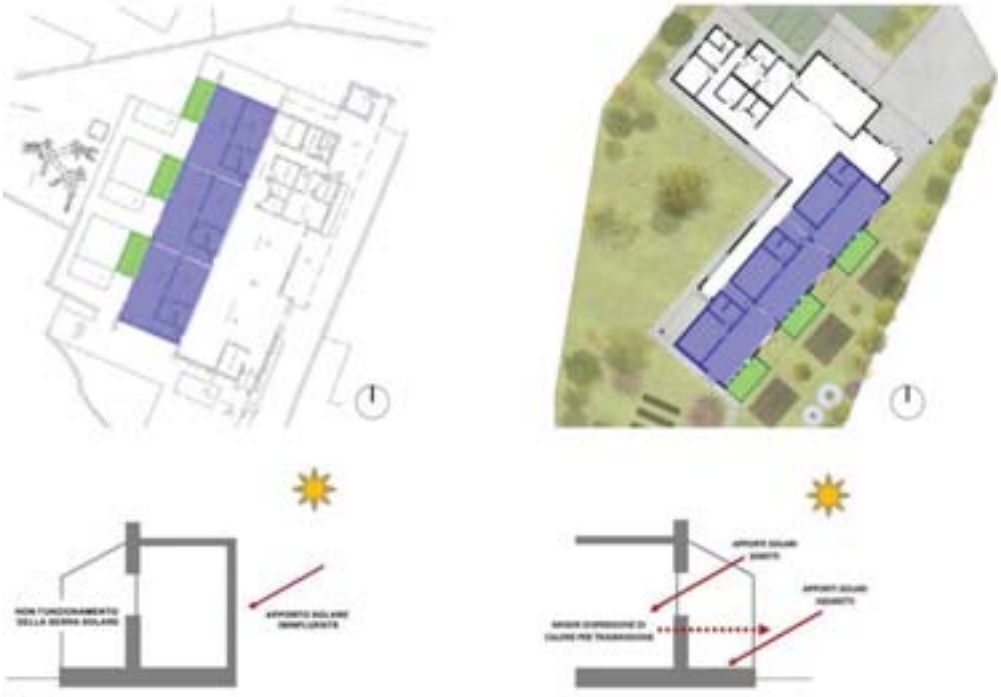

**Fig. 5:** Comparison between the state of affairs and the proposed design solution.


**Fig. 6:** Project for the construction of a nursery school in the Municipality of Baronissi: plan with indication of internal flows and relations with the outside.

The use of the BIM model has in fact allowed an accurate study of the amount of sunshine in the different equinoxes and solstices, ultimately providing for a distribution of the classrooms and solar greenhouses to the south/east (figure 6). This choice led to the activation of a series of natural mechanisms aimed not only at improving the natural lighting of the interior spaces and the temperature-hygrometric comfort, but also at reducing the building's energy consumption. The solar greenhouse facing south, in fact, activates the maximum capture of the sun in winter, with a consequent reduction in summer overheating, also ensuring correct levels of natural lighting and effectively determining mechanisms for capturing solar radiation functional to thermo-hygrometric well-being of the interior spaces. Following this choice, the internal distribution of the rooms arose almost automatically: the spaces intended for services, such as the canteen, kitchen, infirmary and changing room, were positioned to the north. One of the most crucial aspects of this integrated approach is that it manages the environmental impact of construction projects on the environment. In this sense, the current trend in design supports the idea that interdisciplinary thinking and skills are key elements of sustainability [12].
The digitization of the building required, among other things, the implementation of libraries of BIM objects representing each single element that makes up the building. By doing so, it was possible to incorporate performance information reported in the technical data sheets of each individual object into the virtual model. Although most designers are still unable to fully adopt the new BIM perspective, it must be borne in mind that – as the case study shows – the growing complexity of a building makes traditional design tools inefficient. The new demands in terms of needs and sustainability, the new regulations, the new technologies are expanding the panorama with which the designer is confronted, thus requiring tools that provide an adequate constructive approach [13].
As again evident from the building under study, another advantage of BIM procedures consists in the possibility of creating a series of models, and for each one specifying the most important stages that characterize the entire life cycle. For each stage, the geometric representation will be the same: the only difference is related to the information content, consisting of data sorted in special abacuses which can then be exported to Excel and in turn correlated to further data. In particular, the schedule management model contains all the information needed to coordinate the project teams. Furthermore, thanks to the VPL procedures, it is possible to automate and control the process of updating and reviewing the models, looking at the many aspects of a project in an integrated way. This question is fundamental today, if we consider that attention is increasingly focused on the evaluation of production processes, to the point of including elements that are not always taken into consideration, such as, for example, the monitoring of logistical distances for the extraction of raw materials, favoring where possible recycled and renewable materials. Interesting in this regard, a study on the recovery of materials conducted by the Department of Civil, Construction and Environmental Engineering (DICEA) and the Department of Architecture (DiARC)

of the University of Naples "Federico II" which concerns a recovery intervention of an urban area. The research work involves the modeling in a BIM environment of two buildings intended for demolition, subsequently creating parameters that take into account the current legislation on waste from C&D and the Sampling Plan (PdC) prepared for the area in question. In this way, parameters were defined that would allow for the immediate identification of waste to be destined for disposal or recycling [14]. It is therefore evident that the attention paid to the environmental impacts of a building intervention by public administrations, as clients, can trigger virtuous processes along the entire supply chain [15]. This aspect is fundamental and it is possible to evaluate it over the entire life cycle of the building through the use of the BIM methodology. In doing so, the BIM methodology lends itself well to the determination of design hypotheses that allow the evaluation of efficient and sustainable design choices. In particular, the proposed methodology intervenes in support of the LCA and LCC since, starting from a virtual model, a twin of the building in question, it is then possible to perform analyzes of various types by correlating data of different nature (architectural, structural, regulatory and for example) and, consequently, generating interoperable workflows through different software [16]. Finally, the proposed approach makes it possible to manage the Environmental Product Declaration, known as *Environmental Product Declaration* (EPD), thanks to which it is possible to verify information on the environmental impact that a given product generates during its life cycle. In fact, the declaration is based on the LCA and considers the amount of energy absorbed and released during the entire life cycle.
In this sense, the use of the BIM methodology, exploiting a non-linear design process, allows for the creation of a virtual building model, identifiable with an open relational database, in which every single object constitutes a digital entity. Finally, thanks to the open IFC format, it is possible to connect BIM models and supplementary data on the environmental impacts that each product has during the phases of the life cycle.

## 4. Conclusions

In conclusion, the paper intended to highlight the potential of a BIM-type approach aimed at monitoring and redevelopment of the existing built heritage, which finds its strong point in the interoperability and effective management of different types of data. In fact, if the sharing and exchange of information is important for the newly built heritage, it is clear that in a consolidated urban context the possibility of thinking holistically allows us to prefigure interventions capable of more effectively redeveloping the city and the territory. But the greatest importance enclosed in this technological tool lies in the ability to convey towards a digital transition of the built environment, which offers the possibility of collecting data on buildings and urban systems and making them available to generate predictive analyzes or simulations of interventions on neighborhoods, cities o functional areas, from small to large scale, in order to improve the quality of buildings and urban space - with reference to technological, construction, structural, energy and so on aspects - but at the same time and consequently to make the city more livable , generating territorial integration and at the same time social innovation. In this sense, BIM is configured as a strategic tool to guide and support design decisions and political choices which, from the point of view of sustainability, aim on the one hand at the concrete revitalization of the existing building stock [17], on the other at the triggering of processes of urban and social change thanks to which an inhabited context can acquire value, thus ensuring the well-being of the community.

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[1] Gro Harlem Bruntland, da cui il documento prende il nome.
[2] Così è riportato nel documento: «Lo sviluppo sostenibile impone di soddisfare i bisogni fondamentali di tutti e di estendere a tutti la possibilità di attuare le proprie aspirazioni ad una vita migliore (...) Una siffatta equità dovrebbe essere coadiuvata sia da sistemi politici che assicurino l'effettiva partecipazione dei cittadini nel processo decisionale, sia da una maggior democrazia a livello delle scelte internazionali».
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# Urban transitions. The city in the former Ophelia Asylum in Potenza

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## Abstract
The emerging themes related to the ecological, social and urban transition, necessary to “re-inhabit the earth”, are closely intertwined with the project of regeneration of the built environment. How to improve the existing while preserving the memory and identity of places? How to innovate the tools of the urban design in relation to the existing to be adapted to new needs? How to reconsider the interactions environment, society, economy, to compose regenerative forms and processes between ecosystems and communities? In Italy there are millions of service spaces, forgotten, fallen into disuse, or never come into operation. In many cases the regeneration of these places is supported by a cultural-based reactivation. This theme is explored here in a paradigmatic research case: the former “Ophelia” Asylum in Potenza, designed by Marcello Piacentini and Giuseppe Quaroni in 1905. It is a mental hospital complex that, right from the start, has undergone an urban transition process that has transformed it into a real part of the city. However, inside, there are some fragments, built spaces and urban voids, on which it is possible to support a punctual and, at the same time, general regenerative project of the city. The historic gallery “Covo degli Arditi” is rethought as a powerful urban relational device, part of a wider system of possible public spaces that connect existing urban centralities with potential future ones.

**Keywords:** Architecture, Urban Design, Transition, City, Asylum

## 1. Cultural reactivations
The emerging themes related to the ecological, social and urban transition, necessary to “re-inhabit the earth”, are closely intertwined with the project of regeneration of the built environment. How to improve the existing while preserving the memory and identity of places? How to innovate the tools of the urban design in relation to the existing to be adapted to new needs? How to reconsider the interactions environment, society, economy, to compose regenerative forms and processes between ecosystems and communities?
Sustainable development takes account of the needs of the present without compromising the ability of future generations to meet their own needs. Preservation, care, repair, maintain the heritage and legacy of the past, more or less recent, are the essential starting point on which to base this project. Sustainability and the culture of urban design have converging roots and, in recent times, have experienced an acceleration of mutual affinity of intent. The sustainability of urban settlements involves the reuse and requalification of existing buildings, the reduction of land consumption, the maintenance and prevention of urban decay, the protection of historical heritage, the design of flexible spaces adaptable to new needs, the sustainable management of resources and environmental problems. These are issues on which the culture of the project intertwines tools and techniques from multiple disciplinary fields, basing on the “project for the existing” the methods of architectural and urban regeneration, taking note that we inhabit a saturated interior where the urban future to be re-inhabited is given to a large extent by what already exists.
In Italy there are millions of health buildings, schools, industrial areas, barracks, cinemas, stations, theatres, service spaces, public or private property, forgotten, fallen into disuse, or never come into operation. They represent black holes in the territory of the city. The problem also concerns the cultural

heritage subject to historical and artistic protection, of the 110 thousand constructions of cultural value more than 60 percent are in a state of neglect or in a state of underuse [1].
In many cases the regeneration of these places is supported by a cultural-based reactivation. These are places that come back to life, responding to the needs of the communities that inhabit them, experimenting with new languages and crossing heterogeneous activities centred on the use of culture as a driving force for non only economic growth and development [2]. To sustain themselves, these projects make up hybrid spatialities resulting from the coexistence of different sectors as culture, welfare, services, manufacturing, agriculture, services, etc. “This is the most evident characteristic that distinguishes them from other places of culture in Italy, where the museum is only a museum, to give an example. Within these places there is a very strong mixture of activities. You can go and see an exhibition and maybe in the garden there is an urban vegetable garden, or the kindergarten for co-working. The hybridization of activities is a characterizing element as well as the hybridization of organizations that tend to develop hybrid governance and management models where the classic distinctions for profit and non-profit are less. In this way, the classical form of cultural organization is also regenerated” [2].
The various experiences – from the “Stato dei Luoghi” to “Culturability”, from “Farm Cultural Park” (Agrigento) to the “Centro per le Arti Opificio Siri” (Terni) – highlight a change in approach to the cultural-based regeneration of urban areas that have become fragile, but which once represented something important for settlement contests and then lost their vocation over time, leaving empty, deteriorated and insecure skeletons on the territory [3]. Regeneration and its project therefore concern a process capable of cultivating modern vocations for obsolete places, giving back to the community spaces, activities, and services able to interpret the past and project it alive to the future through the construction of a new contemporaneity.
This theme is explored here in a paradigmatic research case: the former “Ophelia” Asylum in Potenza, designed by Marcello Piacentini and Giuseppe Quaroni in 1905. It is a mental hospital complex that, right from the start, has undergone an urban transition process that has transformed it into a real part of the city. However, inside, there are some fragments, built spaces and urban voids, on which it is possible to support a punctual and, at the same time, general regenerative project of the city. Within this process, they lend themselves to being translated into containers of culture and productivity linked to the cultural industries, creative and re-elaboration, physical and conceptual of the city. Among these, the historic gallery “Covo degli Arditi” is a waiting space that, unlike the other pavilions of the former asylum that have been reabsorbed by the city, struggles to find a destiny. Within a project of architectural and urban regeneration, the gallery, which served as a link to the pavilions of the Asylum, is rethought as a powerful urban relational device, part of a wider system of possible public spaces that connect existing urban centralities with potential future ones.

## 2. Relational adaptations

There are about 70 former asylums in Italy [4], “modern asiliary” structures born from the need to unify the ex-novo construction of psychiatric facilities following the Unification of Italy [5]. They are part of those functional equipment that mark the “service city”, in Italy as well as in Europe, between the mid-nineteenth century and the first decades of the twentieth century [6]. The acquisition of the principle of isotropic distribution of social equipment, which perform the dual function of power lookouts and poles of urban development, makes today recognizable on the territory an urban “isolario” united by function, position and configuration.
The construction of asylums for the shelter of the insane coincides with a typological-morphological, constructive and technological-plant experimentation that advances in parallel with the specialized debate between engineers, architects and alienists to respond to two precise logics [7]. The first, of a social type, is declined in the function of guarding, isolating the crazy as in a prison without guilt. The second, medical, deals with non-transient care as in a permanent hospital. The renewed nineteenth-century psychiatry believes in the therapeutic benefits that isolation can bring to patients. It is believed that, with calm and silence, the tormented mind can purify itself and turn into a psychological tabula rasa, ready to welcome the new thoughts cured by the alienist. The asylum is considered in itself a place of care “kom” of madness “mania”, effective for the sole fact of being rigidly separated from external reality.
In a peripheral position with respect to the city center, necessary to achieve its isolation, the asylums are conceived as independent urban parts, cities on a reduced scale on the edges of the city “of the healthy”, and as a medieval city are equipped with fences, gates, paths, buildings (for hospitalization, management, services, etc.), green spaces, production facilities and agricultural colonies, according to an idea that refers to the concept of urban “heterotopia” theorized by Michel Foucault [8].
The citadel of the asylum hinges on the progressive and utopian principles of post-industrial revolution urban organization: the human individual as a type, the open space as necessary for hygiene, the rigorous classification of space by function. The medicine of alienists defines the number of patients, the extent and location of the area, the position of the ground, flat or slightly sloping, the presence of

water, the purity of the air, the good exposure and the panoramicity. To these elements are added the separation between men and women, the distinction between curable and chronic, the subdivision of the alienated by social classes [5]. To the division by pathology is soon preferred a distinction based on the index of dangerousness of behavior, from the quiet, generally positioned in the pavilions closest to the entrance, to the agitated, in a progressive departure from the front of access corresponding to the lower possibility of healing and exiting. According to a direct link between function and form, the characteristics of the asylum architecture are conceived as instruments of cure and the asylum, intended as a specific geographical and relational place, becomes itself the psychiatric care [8]. An emblematic example is the “Am Steinof” Psychiatric Hospital in Vienna, a city for the mentally ill that came into operation in 1907. The project by Carlo Von Boog and Franz Berger, little modified by Otto Wagner, composes a “garden city” with pavilions scattered in a large park, all rigorously and symmetrically subordinated to a central axis that starts from the main entrance and ends with the church designed by Otto Wagner.

In Italy, assistance to the mentally ill has long represented a specific field of action of the Provinces which, according to the Municipal and Provincial Law No. 10 of 1865, each had to equip themselves with an asylum of competence. The Giolitti Law No.36 of 1904 strengthens the practice of internment and determines the development of modern asylum architecture, unifying the types and construction criteria of psychiatric facilities. The project of the “Italian asylum” becomes an architectural-urban theme, from the competition organized by the Accademia delle Belle Arti di Milano for a large asylum of a great capital in 1850 [8], to the competition announced in 1905 by the Provincial Administration of Potenza won, with the motto “Ophelia”, by Giuseppe Quaroni and Marcello Piacentini [9]. The different expressions with which the Italian asylum project is approached - program-type, project-model, asylum-model, asylum-type, project-type - reveal an attempt to define guidelines for the general form and its parts [7]. It is possible to distinguish five structuring typological aggregations: “approached pavilions” which ensures the continuity of the connection between the various parts of the structure through porches and covered paths, set on a geometric path with parallel tripartite bands; “spaced pavilions” characterized by isolated buildings, can both freely adapt to the morphology of the terrain, as well as respond to rigid distribution schemes by proposing the division into tripartite parallel bands; “mixed type pavilions” which contemplates the coexistence of buildings partly gathered and partly spaced; “pavilions scattered in a village” which can be organized according to an organic or geometric layout, is similar to the model with spaced pavilions, of which it incorporates the distribution schemes reproportioning them according to more dilated dimensions, integrating with territories with considerable natural resources; “isolated buildings” which concerns that part of the psychiatric building built between the 30s and 60s of the twentieth century, according to a rationalist and then functionalist variant of the spaced pavilions, characterized by the increased distance between the built parts and the replacement of the pavilion with the building [4]. The fenced structure, the large amount of gardens and open spaces, the settlement principle with differently articulated pavilions, the urban proximity, are therefore among the main elements that define the asylums as originally autonomous parts of cities and that characterize the possible recompositional adaptations for urban transitions over time.

The disposal of active asylums in Italy lasted from 1978 to 1998. These structures have been progressively abandoned, most only partially, others totally. Currently, about a fifth of the former psychiatric complexes and defunctionalized are abandoned, with only some residual functions inside, about half of the complexes [10]. Almost all of them are still owned by the Local Health Authorities and subject to important constraints by the Superintendents that guide their transformation. There are numerous examples of recovery of buildings with projects related to health functions, especially for mental health, and university (Varese, Pesaro, Agrigento, Potenza) and conversion into multifunctional “City of Health” or integrated centers of territorial health services (Trapani, Messina, Imola, Udine, Sassari, Mantua, Cagliari, Ragusa, Novara, Genoa). Other examples show the reinvention of former asylums with functions not only related to health care, such as military, judicial, school, cultural and associative, provincial directional (Reggio Calabria, Salerno, Trento, Milan, Palermo, Bergamo, Treviso). Projects are being developed for the “New Health Pole” in Padua, the new hospital in Syracuse and the “Parco della Salute” in Rome and Udine, the “Cittadella della Cultura” in Teramo, in Gorizia the entire area is currently the subject of a protocol for urban regeneration, in Naples they would like to create cultural centers to be entrusted to the Mediterranean countries, in L’Aquila an accommodation facility is planned and the recovery of other buildings within the Abruzzo Masterplan.

The only case in which the structure has been completely transformed is the one on the island of San Clemente in Venice which houses a luxury resort. Many of the large green spaces of the former asylums have become public parks (Genoa, Voghera, Trieste, Gorizia, Collegno, Lucca, Aquila, Rovigo) which, in some cases, also host spaces of memory and museums of psychiatry (Venice, Palermo, Reggio Emilia, Rome). Even when refunctionalized, in many cases fragments of waiting spaces remain within the former asylums, potential voids that preserve the mnemonic and identity characters of the past and that lend themselves to further punctual adaptive reuses and, at the same time, composition of the new urban relationships of the parties in the city.

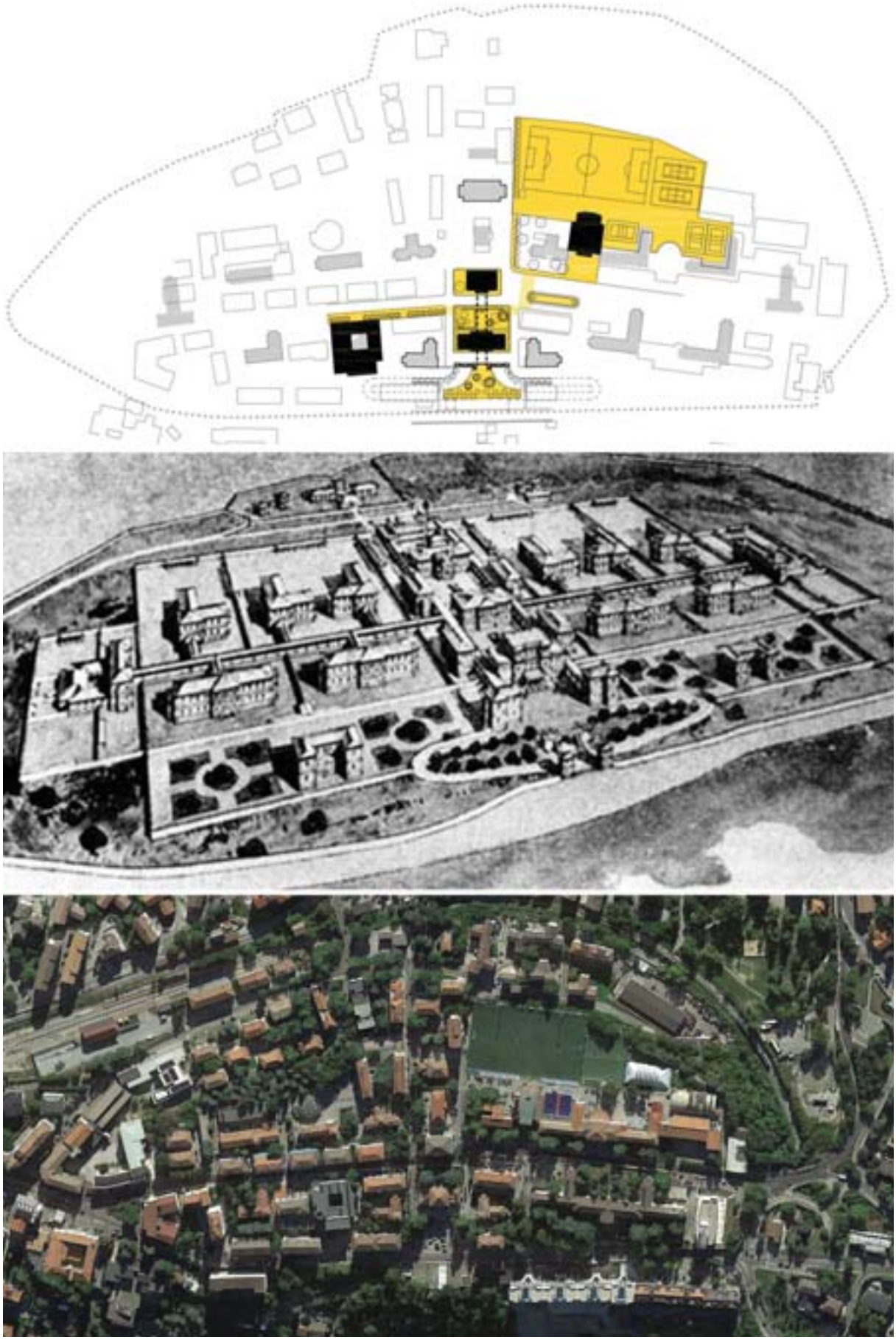

**Fig. 1:** L. Zecchin, “Covo degli Arditi” Project, 2018: urban relationships. G. Quaroni, M. Piacentini, “Ophelia” Asylum Project, 1905: perspective view. Potenza, 2023: aerial view.

## 3. Regenerative transitions

The construction of a new provincial psychiatric hospital at Potenza responded to the need to reduce the cost of hospitalization of mentally ill patients in Aversa and to the need to redistribute the high number of patients in Basilicata. The site chosen for the asylum is an area not yet urbanized in the city of Potenza. In 1905 a competition of ideas was launched won by the engineer Giuseppe Quaroni and the architect Marcello Piacentini with the Project “Ophelia” whose name is inspired by the character of Hamlet who in Shakespeare’s tragedy becomes crazy and drowns.

The project had to meet two requirements: to be a common health hospital in which people are hospitalized and, at the same time, to be similar to a prison since all patients had to be supervised to prevent escapes or suicides. What would have happened if patients had become aware of their “state of captivity” [11]? To avoid this, the solution adopted seeks to make the admission of patients more “pleasant”, opting for the separation of patients in pavilions surrounded by gardens and tree-lined avenues.

The project included eighteen pavilions, with particular attention paid to the appurtenant green spaces. The pavilions, all of the isolated block type, corresponded to the wards for: quiet, semi-agitated, agitated, and furious, filthy and epileptic, paralytic and infirm, children and idiots, contagious, demented criminals. The quiet and semi-agitated patients were placed in buildings near the station and the agricultural colony where they could cultivate the land or do manual labor.

To improve the ventilation of the whole complex, the project forces the orography of the land, settling with the new plant at an altitude about five meters higher than the entire neighboring city located to the east. This choice allows the creation of underground service connections and the impediment of the view of what happens within the walls from the outside.

The psychiatric hospital is organized according to two main axes: the horizontal one, from east to west, called the “axis of the various departments” and the long one, from north to south, called the “axis of services” [11]. The project, symmetrical with respect to the axis of services, has a development of 220 meters with respect to it and a length of 450 meters on that of the departments. The attention to the connection systems and services of the structure leads to the definition of two straight tunnels, crossed by a “decauville”, which becomes the element of the project. The installation of this narrow-gauge railway allowed all pavilions to be supplied and served.

The entire complex is symmetrical with respect to the axis of the services with the buildings for the common services, while on the transverse axis the departments are aligned. The main entrance is at the intersection of the service axis and the provincial road, and the secondary service entrance is located at the intersection of the service axis and the road leading to the station to the south. The main entrance is characterized by a staircase and two ramps on the sides of the underground gallery, which allowed you to reach the square above. Here was the Administration and the visitors’ rooms. The area was bounded by the pavilions of the Women’s Acceptance to the east and the Men’s Acceptance to the west. Behind the Administration building was the Kitchen, the only building of the type in line, with warehouses supplied directly from the underground gallery. Separated by a large courtyard, there was the Church with on the sides the Emporium, the House of the priest, the Laundry, and the Wardrobe.

With a view to making all the pavilions independent, each building has everything necessary for staff and the sick (bathrooms, offices, kitchen, residences) [11].

Each pavilion is on two levels: ground floor with pantry, kitchen, dining room, doctor’s office, nurses’ room, bathrooms and toilets; first floor with dormitories, nurses’ rooms, room with wardrobes for linen. Further away from the whole complex, the Agricultural Colony, the Contagious Section, the Morgue and the Disinfestation building.

The architectural elements are simple: “It was not appropriate here to show off architecture, unnecessary decorations, moldings of style. It was only a matter of giving a convenient and uniform form to a series of buildings that rise to cure suffering humanity” [12].

The estimated amount for the project was 1.100.000 Lire, which had to be spent to build the main departments within five years. In 1907 the first stone was laid, but work began only in 1910. Soon the project will be measured with the economic problems and is therefore scaled down. Of the eighteen pavilions planned, only twelve were built and soon the Provincial Council decided not to allocate the buildings to the asylum. Until 1920 it was planned to transform the complex into a Military Hospital. Meanwhile, the buildings were used as grain warehouses during the First World War. The decision in 1923 was to convert some pavilions into homes (in the Administration Palace, in the pavilions of the Acceptance of Men and Women, in the two infirmaries, in the Wardrobe Building, in the Agitated and Agitated Pavilions). In the same years, the Opera Nazionale per il Mezzogiorno received and rented the premises for the Tranquil, Epileptic and the Contagious Department. The pavilions are adapted, with the addition of a central body, to an orphanage. At the same time the Chronic pavilion is used as a Polyclinic then annexing the pavilion of the Semi-agitated man and thus giving rise to a single nosocomial center. The bombings of Potenza in 1943 saw numerous damages to the city and to the Semi-agitated woman pavilion that housed the Provincial Museum since 1921, the bombed chapel was replaced by a residential building. The Agitate pavilion was sold to the municipality of Potenza, which

demolished it, creating the Royal Industrial School and an elementary school. On the ground of the Chronic pavilion stands the Provincial Museum and on that of the Epileptic pavilion the military warehouses of the state property are built [13].
The current Santa Maria district, completed in the 50s and 60s of the twentieth century with the inclusion of public housing, is paradigmatic of the urban transition that took place from the construction of the asylum to today. The area is in fact marked by a widespread mixite and maintains the identity of a "garden city" composed organically.
The underground gallery, never completed, in 1934 is used as a museum of the Fascist Revolution and renamed "Covo degli Arditi". After becoming a parking lot and a warehouse, it is currently abandoned and is in a precarious state of conservation. This place represents a waiting void, a space of memory that in 2018 becomes the subject of a competition for the ideas of "urban regeneration and acupuncture". The theme concerns the part of settlements in urban areas, which can be rethought as containers of culture and productivity linked to the theme of Cultural and Creative Industries. The idea is to redefine the urban fabric, verify the potential and critical issues in terms of services, public spaces, green areas, places of aggregation, cultural containers, quality of urban residences. The theme of "urban regeneration and acupuncture" concerns the physical and conceptual re-elaboration of areas of the historic center of Potenza and adjacent areas characterized by the presence of historical and artistic sites. The project area identified by the competition of ideas is the "Covo degli Arditi".
The winning project of the competition (Luca Zecchin, Project "Covo degli Arditi. Creative Urban Center", 2018) explores the urban structure of the mental hospital complex that time, stratification and reuse has transformed into a significant part of the city of Potenza.
The underground gallery, which served as a connection to the pavilions of the asylum, represents a powerful urban relational device, a Creative Urban Center. From the large square to the south to the garden to the north, the gallery can be reinvented as a covered, crossable and usable public space, part of a wider system of public spaces that connect the existing urban centers (the Museum, the Church, the sports facilities) with the potential future ones (the abandoned "Ophelia" buildings waiting for recovery and reuse).
In line with the objectives of "urban regeneration and acupuncture" set by the competition, the project proposes to: restore a good degree of coherence with the original layout and with the current urban spaces, ensuring a coherent and effective permeability of the space as an essential prerequisite to ensure the effectiveness of recovery and reuse operations of the "Covo degli Arditi"; ensure maximum simplicity and clarity in the unitary design designed to allow the complete functionality and usability of the spaces, rethinking the "Covo degli Arditi" as a container of culture and productivity linked to the theme of "cultural and creative industries"; recompose the architectural and landscape continuity by working for minimum stratifications within a project-structure achievable for successive parts (the reuse of the gallery, the square-garden to the south, the square-garden inclined to the north).
The image of the project is defined as palimpsest, delicate stratification, and minimal result of the sum of existing buildings, architectural grafts, landscape devices. For the existing buildings, interventions are planned for the recovery and consolidation of the construction parts present, without reconstructions, dedicated to removing the phenomena of degradation and counteracting those of instability. The interventions are designed to ensure the preservation of memory without the physiological signs of time being obliterated, providing for the gallery and the underground spaces only the repainting with visible systems and essential finishes.
The new architectural grafts are minimal elements designed to ensure complete accessibility and usability of the spaces (the inclined square-garden with ramps to ensure complete accessibility of the gallery even from the north; ramps and connections between the gallery and that of the redesigned side spaces such as laboratories, coworking, event room, conference room, bathrooms). Elements of recognizability of contemporary stratification are relational architectures, devices to connect, access, see, micro appendages to "re-inhabit" at a different scale.
Open spaces are defined as landscape devices, rearranged in their configuration and operation through the design of green, horizontal and vertical, and paved surfaces. The design of the furnishing elements is minimal: circular and linear seats, green inclined planes covered with low-maintenance grass essences (pennisetum alopecuroides, glauca fescue), essences of horse chestnut, cedar and field maple.
Within a project of architectural and urban regeneration, the underground gallery is therefore rethought as a relational place, part of a larger system of places in the city. Within the transition that from the beginning has characterized the city of Potenza in its former asylum, the fragments of voids, with their mnemonic and identity bearings, lend themselves to further punctual regenerative adaptations and, at the same time, compositional and activators of the urban roles of the parties in the city.

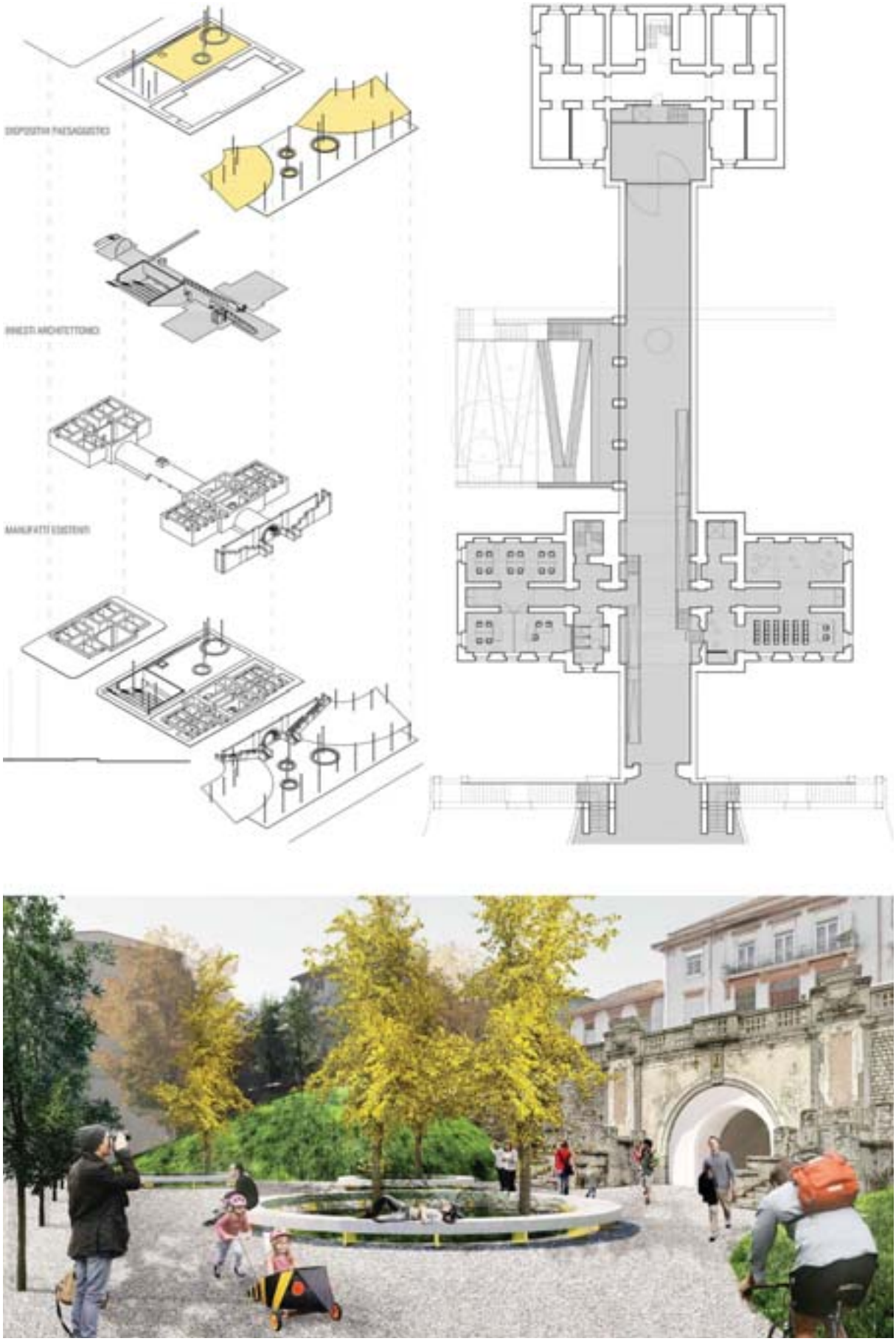

**Fig. 2:** L. Zecchin, “Covo degli Arditi” Project, 2018: urban composition of landscape devices, architectural grafts and existing elements.

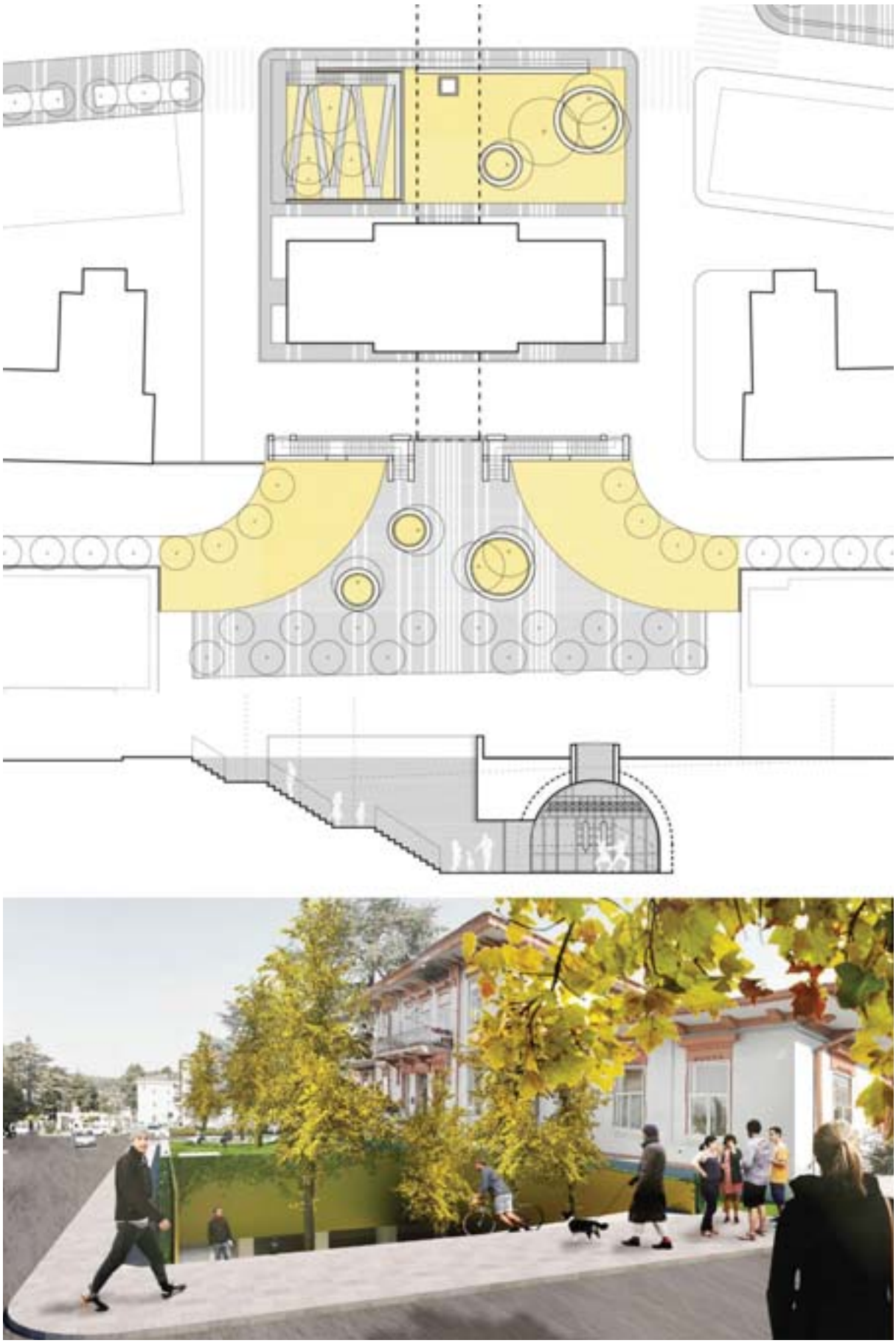

**Fig. 3:** L. Zecchin, “Covo degli Arditi” Project, 2018: the creative urban center.and the garden-squares.

**Fig. 4:** L. Zecchin, “Covo degli Arditi” Project, 2018: the creative urban center.and the underground gallery.

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# Advancing Sustainable Building Envelope Systems through LCA: A Comparative Analysis of Natural Stone and Concrete Envelopes towards Circular Economy Principles

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## Abstract
Faced with the depletion of non-renewable resources in the construction, the latest strategy "Climate ambition 2020" proposes to reduce the use of concrete by using natural and biomaterials.
Stone offers advantages such as durability, low maintenance requirements and lower levels of greenhouse gas emissions during production. Nevertheless, concrete remains the first material used for construction, offering advantages such as low cost and high availability.
To revalue the use of stone as a construction material for structural building envelopes, this paper proposes a comparative LCA analysis to evaluate the sustainability of France's two common structural envelopes: ashlar and concrete wall. The cases studies present the same geometric characteristics, considering the different production processes of these two technologies. This allows us to highlight the impact of the choice of the material and different production procedures in the evaluation of the life cycle analysis of a technological system. Through this comparison, this paper seeks to provide insights into their sustainability and opportunities for improving the potential for circular economy principles.
The conclusions of this paper can contribute to a shift in perception towards natural stone as a viable and sustainable option for building envelopes. The reinterpretation of use of stone today can help reduce the reliance on energy-intensive materials such as concrete and promote more sustainable construction practices.
**Keywords:** Building envelope, circular economy, life cycle assessment, natural stone, concrete, sustainable building, circularity potential.

## 1. Introduction
The building envelope plays a crucial role in the overall energy performance and environmental impact of a building. Stone and concrete are two common materials used in building envelopes due to their durability, thermal and mechanical properties, and aesthetic appeal.
Stone has been used in building envelopes for centuries and is known for its durability, resistance to weathering, and low maintenance requirements. Studies have shown that stone masonry buildings have a longer life span compared to other building materials, such as brick and concrete, due to their resistance to weathering and decay [1] .In addition, the thermal properties of stone can contribute to the reduction of energy consumption in buildings [2].The mechanical properties of stone also make it a suitable material for structural applications, leading to a reduced use of additional structural materials [3].
Concrete, on the other hand, is a widely used building material due to its strength, versatility, and relatively low cost. However, the production of concrete is a significant source of greenhouse gas emissions, primarily due to the use of cement in its production process [4]. This has led to increased efforts to reduce the environmental impact of concrete production and use through the development of alternative binders and the use of recycled materials [5].

Life cycle assessment (LCA) is a widely used method for assessing the environmental impacts of building materials and systems. EN 15804 is a European standard for the environmental product declaration of construction products and includes requirements for the LCA methodology used in the assessment [6]. The use of standardized LCA methodologies enables the comparison of the environmental impact of different building materials and systems in a consistent and transparent way.
Several studies have applied LCA to building envelopes, including stone and concrete envelopes. Almeida et al. (2016) conducted an LCA of a stone and a concrete envelope and found that the stone envelope had a lower environmental impact in all impact categories considered, mainly due to its lower energy consumption during its lifetime [7]. Similarly, Bartesaghi-Koc et al. (2019) compared the environmental impact of stone and concrete envelope systems in Italy and found that the stone envelope had a lower environmental impact in all categories except for particulate matter emissions [8].

In addition to LCA, circularity is becoming an increasingly important aspect of sustainability in the building sector. The circular economy aims to minimize waste and maximize the reuse, repair, and recycling of materials, thereby reducing the environmental impact of resource use. The European Waste Catalogue (EWC) provides a framework for the management of waste materials in Europe and includes categories for both stone and concrete waste [9].

The circularity of stone and concrete in building envelopes can be evaluated through the assessment of their potential for reuse, recycling, and landfilling. The European Commission has set targets for the recycling and reuse of construction and demolition waste materials, including concrete and stone [10].

## 2. Review of LCA Stone and Concret envelops comparaision

Building envelopes are a critical component of any building, providing thermal insulation and protection from the elements. Natural stone and concrete are two commonly used materials for building envelopes, each with unique properties and benefits. However, both materials also have potential environmental impacts throughout their life cycle. As a result, there has been growing interest in conducting comparative LCAs of natural stone and concrete building envelopes to better understand the environmental impacts of these materials and inform sustainable design and construction practices.

One of the earliest studies on this subject was conducted by Pauliuk et al. (2011), who compared the environmental impacts of concrete, steel, brick, and natural stone facades in Switzerland. The study found that natural stone had lower environmental impacts in several categories, including GWP and AP, compared to the other materials. However, the authors noted that the results were highly dependent on the specific context and assumptions used in the analysis [11].
In contrast, a study by Yılmaz and Şahin (2015) compared the environmental impacts of natural stone and concrete facades in Turkey and found that the natural stone facade had higher environmental impacts in several categories, including GWP, AP, and EP, due to the energy-intensive extraction and transportation processes required for natural stone [12]. Similarly, a study by Wang et al. (2016) compared the environmental impacts of natural stone and concrete cladding systems in China and found that the natural stone system had higher environmental impacts in several categories, including GWP and EP [13].
However, not all studies have found natural stone to have higher environmental impacts than concrete. A study by Vilches et al. (2017) compared the environmental impacts of a natural stone facade and a concrete facade in Spain and found that the natural stone facade had lower environmental impacts in several categories, including GWP and EP, due to the lower energy requirements and emissions associated with natural stone production and installation [14].
More recently, a study by Agapiou et al. (2020) conducted a comparative LCA of natural stone and concrete building envelopes in Cyprus and found that the environmental impacts of natural stone and concrete were similar in several categories, including GWP, due to the low-emission electricity grid in Cyprus and the use of renewable energy in natural stone production [15].
Other studies have focused on specific aspects of the life cycle of natural stone and concrete building envelopes. For example, a study by Zanetti et al. (2017) compared the environmental impacts of different methods of natural stone extraction and found that the most sustainable method was diamond wire cutting, due to its lower energy consumption and reduced waste generation [16]. Similarly, a study by Zhang et al. (2019) compared the environmental impacts of different methods of concrete production and found that the use of fly ash and slag as partial replacements for cement could significantly reduce GWP and other environmental impacts [17].
The quality and availability of data are important considerations in comparative LCAs of natural stone and concrete building envelopes. A study by Chevalier et al. (2013) compared the environmental impacts of natural stone and concrete facades in France and found that the results were highly sensitive to the choice of data sources and assumptions [18]. Another study by Zhang et al. (2018) identified a

lack of data on the environmental impacts of natural stone extraction and recommended further research to address this gap [19].
Several studies have also highlighted the importance of considering the specific context and conditions of the materials and processes being analyzed in comparative LCAs. For example, a study by Garcia-Sanchez et al. (2018) compared the environmental impacts of natural stone and concrete facades in Mexico and found that the results were highly dependent on factors such as the transportation distance, fuel consumption, and energy mix of the region [20]. Similarly, a study by Bakas et al. (2021) conducted a comparative LCA of natural stone and concrete building envelopes in Greece and found that the results were highly dependent on factors such as the transportation distance, the energy mix of the region, and the water consumption of the natural stone quarry [21].
Overall, the literature on comparative LCAs of natural stone and concrete building envelopes suggests that the environmental impacts of these materials are highly dependent on the specific context and conditions of their production and use. While some studies have found natural stone to have lower environmental impacts than concrete, others have found the opposite. The quality and availability of data are important considerations in conducting comparative LCAs, as are the specific context and conditions of the materials and processes being analyzed.

Therefore, this study aims to conduct an LCA of a stone and a concrete envelope using the OneClick LCA software and the FDES database from the INIES platform. The environmental impacts of each envelope system will be assessed based on the requirements of EN 15804. The circularity of the two envelope systems will also be evaluated through the assessment of their potential for reuse, recycling, and landfilling, based on the EWC categories for stone and concrete waste. The results of this study will contribute to the understanding of the environmental and circularity implications of using stone and concrete in building envelopes.

## 3. Methodology

In this study, we conducted a life cycle assessment (LCA) of a stone envelope and a concrete envelope using the OneClick LCA software. We used the French national database of environmental and health declarations for building products (FDES) from INIES as the main data source for the environmental impacts of materials. The study was carried out in accordance with the European Standard EN 15804 for the environmental product declarations of construction products.

The scope of the study included the extraction, transportation, processing, and assembly of materials, as well as the use and end-of-life phases of the building envelopes. Three end-of-life scenarios were considered for both envelope types: reuse, recycling, and landfill. The scenarios were selected based on the European Waste Catalogue regulations for stone and concrete.The European Waste Catalogue (EWC) is a classification system for waste types in Europe, and it provides a standard system for classifying waste materials [9]. The EWC has been developed to ensure consistency in the management and disposal of waste materials, and it provides a comprehensive list of waste types with a specific code assigned to each waste type. By selecting the scenarios based on the EWC regulations, this study ensured that the end-of-life scenarios for stone and concrete envelopes were consistent with the regulations set by the European Union for waste management. This approach also provides a standardized methodology for evaluating the environmental impact of different building envelope materials, which is crucial for making informed decisions about sustainable building practices.
To calculate the environmental impacts of the building envelopes, we used the ReCiPe 2016 midpoint (H) method, which is recommended by the OneClick LCA software.

To evaluate the circularity of the stone and concrete envelopes, we calculated the percentages of the materials that could be reused, recycled, and landfilled at the end of their life. We used the guidelines of the European Commission for the calculation of the circularity indicators.

The results of the LCA and the circularity assessment were compared between the two envelope types to identify their environmental and circularity performance.

## 4. Case Study

In this section, we present four case studies comparing the environmental impacts of stone and concrete envelopes as shown in figure 1, and investigating the impact of end-of-life scenarios on circular economy. All case studies were conducted for the Parisian region, and transportation for each material was calculated for the Parisian destination from the providers.


**Fig. 1:** Stone and concrete envelop layers.

### 4.1. Concrete Envelope

The first case study examined the environmental impact of a concrete envelope with a functional unit of 1 m2 over a period of 100 years. The concrete envelope consists of a load-bearing wall, 200 mm thick, with a density of 448.2-2241 kg/m2 and C25/30 grade. The wall also included additional layers, such as a polypropylene roofing membrane, PUR (polyurethane foam) insulation panels, a polypropylene vapor membrane, and a partitioning wall system**,** as shown in Table 1, transportation accounted for 60 km, with a trailer combination having a capacity of 40.

| Resource of materials | Quantity | CO2e | Kilometers | Transport Methods | Capacity |
|---|---|---|---|---|---|
| Concrete load bearing wall, 200 mm, 448.2-2241 kg/m2, C25/30 | 1 m² | 57kg 76% | 60 | Trailer combination | 40 |
| | Layers | | | | |
| Polypropylene roofing membrane, French average, 0.2 kg/m2 | 1 m² | 3kg 5% | 430 | Trailer combination | 40 |
| PUR (polyurethane foam) insulation panels | 1 m ² x 15 mm | 0,33kg 0,5% | 430 | Trailer combination | 40 |
| Polypropylene vapour membrane | 1 m² | 2,7kg 4% | 430 | Trailer combination | 40 |
| Partitioning wall system | 1 m ² | 8,7kg 14% | 60 | Trailer combination | 40 |

**Table 1:** Concrete envelop material details.

### 4.2. Natural Stone Envelope

The second case study compared the environmental impact of a natural stone envelope with the same functional unit as the concrete envelope. The natural stone envelope consists of a load-bearing wall, 255 mm thick, with a density of 423 kg/m2. The wall also included additional layers, such as a polypropylene roofing membrane, French average, 0.2 kg/m2, PUR (polyurethane foam) insulation panels, a polypropylene vapour membrane, and a partitioning wall system as the conceret envelop, with the majority of emissions coming from the load-bearing wall (38%). Transportation accounted for 60 km, with a trailer combination having a capacity of 40.

| Resource of materials | Quantity | CO2e | Kilometers | Transport Methods | Capacity |
|---|---|---|---|---|---|
| Natural stone load-bearing wall, 250 mm, 423 kg/m2 | 1 m² | 91kg 38% | 60 | Trailer combination | 40 |

**Table 2:** Stone envelop material details.

### 4.3. Reuse Scenario for Natural Stone Envelope

The third case study investigated the environmental impact of a natural stone envelope with the same layers as in Case Study 2. However, in this scenario, the end-of-life scenario was defined according to the EWC regulations, with a reuse percentage of 40%, recycling percentage of 60%, and landfill percentage of 0%.

### 4.4. Recycle Scenario for Concrete Envelope

The fourth case study investigated the environmental impact of a concrete envelope with the same layers as in Case Study 1. However, in this scenario, the end-of-life scenario was defined according to the EWC regulations, with a reuse percentage of 20%, recycling percentage of 70%, and landfill percentage of 10%.

It is worth mentioning that these case studies were conducted for the Parisian region, and the transport for each material was calculated from the providers to the final destination in Paris. The transportation distances and methods were considered in the LCA analysis, as transportation can significantly contribute to the environmental impact of a building material. The results of the LCA analysis for each case study will be presented and discussed in the next section.

## 5. Results

In this section, we present the results of our study, which aimed to compare the environmental impacts of stone and concrete envelopes in the context of the Parisian region, taking into account their end-of-life scenarios in line with circular economy principles. The life cycle assessment approach was used to assess the environmental impacts of the envelopes across different life cycle stages, including materials production, transportation, maintenance and replacement, waste transport, waste processing, and waste disposal. The results obtained were then analyzed and interpreted in light of the scientific literature on the environmental impacts of building materials, the Parisian region's specific context, and the principles of circular economy.

### 5.1. Comparaision of Stone and Conceret Envelops

The environmental impacts of stone and concrete envelope systems were evaluated using the Life Cycle Assessment (LCA) methodology in accordance with ISO 14040 and ISO 14044 standards. Some stages of the LCA calculation were excluded based on the norm EN 15804 due to a lack of relevant data and uncertainties in assumptions. Stages A4 (module D, "Transport to the construction site"), B6 ("End-of-Life stage"), and B7 ("Modules D, E and F: Processing of secondary materials, Disposal of residues and Transport of modules D, E and F to recycling plant") and Stage D were excluded, while stage C1 ("Manufacturing of the product") was already accounted for in the datasets used in the study. The remaining stages of the LCA (C2, C3, C4) were considered for the calculation of the environmental impacts of the stone and concrete envelope systems.

In this study, the environmental impacts of stone and concrete envelope systems were compared using the Life Cycle Assessment (LCA) methodology. The results of the study showed that the massive stone envelope system had a significantly lower environmental impact than the concrete envelope system in all impact categories as shown in Fig 2.


**Fig. 2:** Comparison of Environmental impacts base EN-15804, of LCA Stone and Concrete envelops.

The comparison of the environmental impacts between the stone and concrete envelope systems revealed that the stone envelope has lower impacts in terms of Global Warming Potential (GWP),

Eutrophication Potential (EP), Ozone Depletion Potential (ODP), and Total use of primary energy ex. raw materials, while the concrete envelope had a lower impact in terms of Photochemical Ozone Creation Potential (POCP). However, one possible reason could be related to the production process of concrete, which typically involves high-temperature kilning of limestone to produce cement. This process releases large amounts of carbon dioxide, which contributes to global warming, but it does not typically release volatile organic compounds (VOCs), which are a major contributor to POCP. In contrast, the production of natural stone may release VOCs from processing and transportation, leading to a higher POCP impact. However, without further information, it is difficult to know for sure why the concrete envelope had a lower impact in terms of POCP in the specific study mentioned.

Specifically, the GWP impact of the stone envelope was found to be almost half that of the concrete envelope. This is due to the fact that the production of concrete involves significant amounts of carbon dioxide emissions, while the production of stone involves less emissions. Similarly, the lower impacts of the stone envelope for EP, ODP, and Total use of primary energy ex. raw materials are attributed to the lower embodied energy and production impacts associated with stone. On the other hand, the higher POCP impact of concrete is due to the emissions of volatile organic compounds during the production of concrete. Overall, the results suggest that the use of stone envelope systems can lead to significant reductions in environmental impacts compared to concrete envelope systems.

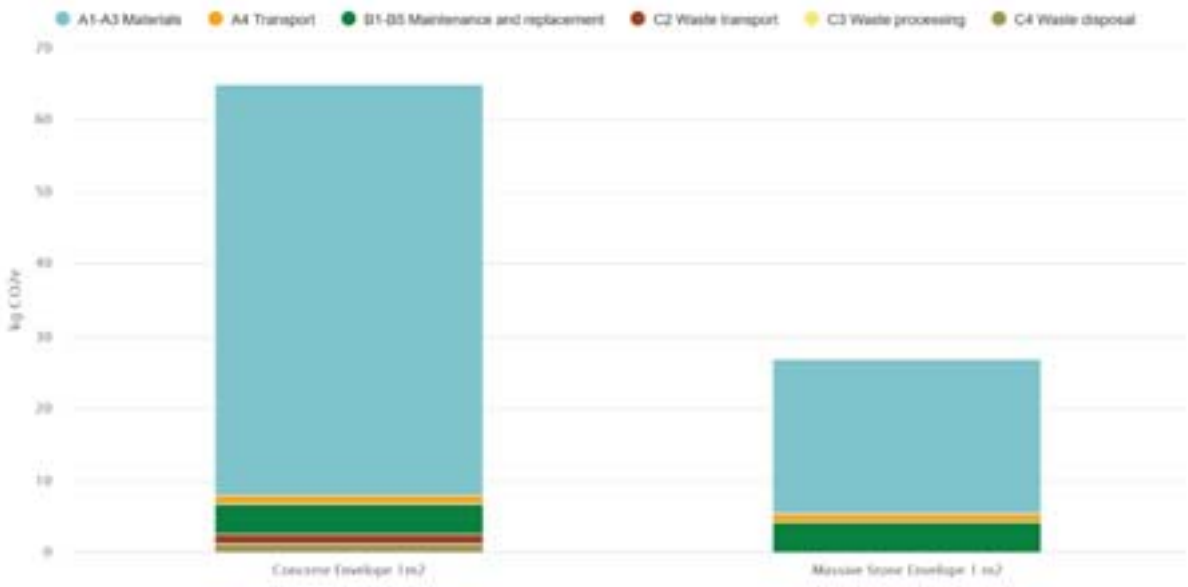


**Fig. 3**: Life-cycle assessment, EN-15978 - Global warming, kg CO2e - Elements and life-cycle stages of Stone and Concrete envelops.

In stage A1-A3, the environmental impacts of stone and concrete envelope systems were significantly different. The concrete envelope had a higher global warming potential (GWP) of 57.03 kg CO2e per m2 compared to the massive stone envelope's GWP of 21.54 kg CO2e per m2. The difference is attributed to the materials used in each envelope, as the concrete envelope required more energy-intensive materials in its production.

In stage A4, the transportation of the materials to the construction site was the same for both envelopes, with a distance of 60 kilometers and a trailer combination of 40t capacity. Thus, there were no significant differences in environmental impacts between the two envelopes in this stage.
In stage B1-B5, the maintenance and replacement of the envelopes were found to have a similar environmental impact for both the concrete and massive stone envelope systems.
In stage C2, the waste transport stage had a minor impact on the overall environmental impact of both envelopes, with the concrete envelope having a slightly higher impact due to its higher weight and volume. In stage C3, the waste processing stage had no impact on the overall environmental impact of both envelopes since no waste was generated during their use. In stage C4, the waste disposal stage also had no impact on the overall environmental impact of both envelopes, as the waste generated during their use was negligible.

In conclusion, the results of this study indicate that the stone envelope system has a lower GWP compared to the concrete envelope system. This result can be attributed to the fact that stone requires less energy in its manufacturing process and can be reused more easily compared to concrete.

### 5.2. Circular Economy Analysis of Natural Stone and Concrete Envelopes

The circularity percentage represents the proportion of material that is kept within the circular economy through reuse and recycling, rather than being disposed of in a landfill. In the context of these case studies, the circularity percentage indicates how much of the material used in the building envelope is able to be reused or recycled at the end of its life, thereby reducing waste and promoting sustainability.

The results of the different end-of-life scenarios for the four building envelope types are shown in the table below.

| Envelope Type | LCA (kg CO2e) | Economic Circularity (%) |
|---|---|---|
| Concrete Envelope | 65 | 0% |
| Massive Stone Envelope | 27 | 0% |
| Recycled Concrete Envelope | 61 | 25% |
| Reused Massive Stone Envelope | 19 | 58% |

**Table 3:** The result of LCA and Economic circularity for four case studies.

The economic circularity percentages for the recycled concrete and reused natural stone envelopes are quite significant, with 25% and 58% respectively. This indicates that these materials have the potential to be used in a circular economy, where resources are kept in use for as long as possible, waste and pollution are minimized, and natural systems are regenerated.

One advantage of reusing natural stone is that it can significantly reduce the environmental impact of construction. The carbon footprint of the reused natural stone envelope was found to be only 19 kg CO2e/m2, which is much lower than the other envelope types. Additionally, reusing natural stone can save on raw material extraction, processing, and transportation, as well as landfill space.
Similarly, recycling concrete can also offer environmental and economic benefits. By diverting concrete waste from landfills and reusing it in new construction projects, the need for virgin materials can be reduced, which can save on energy and greenhouse gas emissions associated with material extraction and processing. Additionally, recycling concrete can help reduce the amount of waste sent to landfills, which can save on disposal costs and reduce the environmental impact of waste disposal.
Overall, the economic circularity percentages and LCA results show that reusing natural stone and recycling concrete can be effective strategies for reducing the environmental impact of construction and achieving a more circular economy.

## 6. Discussions and conclusions

The present study aimed to evaluate and compare the environmental impact and circularity potential of various building envelope materials, using a life cycle assessment approach. Four case studies were analyzed, including a concrete envelope, massive stone envelope, recycled concrete envelope, and reused massive stone envelope. The results demonstrated that the massive stone envelope had the lowest carbon footprint, with a value of 27 kg CO2e/m2, while the reused massive stone envelope had the highest circularity percentage of 58%. Furthermore, the reuse scenario for the natural stone envelope reduced its carbon footprint to 19 kg CO2e/m2.

The findings of the study underscore the potential of circular economy principles in the construction industry, emphasizing the importance of incorporating circularity into building design and construction practices. The results suggest that the reuse of materials can significantly reduce the environmental impact of building envelope construction. This approach not only reduces waste and the consumption of virgin materials but also reduces emissions associated with transportation and manufacturing.

Additionally, the study reveals that natural stone has a lower environmental impact compared to concrete and has a high potential for circularity due to its durability, recyclability, and reuse potential. These results imply that the design and construction of sustainable buildings should consider the use of natural stone as a viable alternative to concrete. Policies and practices aimed at reducing the environmental impact of the built environment should take into account the potential of circular economy principles and the use of natural and recyclable materials in building design and construction.

In conclusion, the present study highlights the importance of incorporating circular economy principles in building design and construction practices. The results emphasize the potential of material reuse and

recycling in significantly reducing the environmental impact of building envelope construction. Moreover, the study suggests that natural stone has a high potential for circularity and should be considered as an alternative to concrete in sustainable building design and construction. The implications of these findings for policy and practice include the need to encourage the use of circular economy principles and the incorporation of natural and recyclable materials in building design and construction.Architects and building designers can promote the use of natural stone in sustainable and circular building practices. Further, policies and regulations can facilitate the reuse and recycling of natural stone and other construction materials to encourage a circular economy in the construction industry. It is vital to consider the full life cycle of construction materials and the potential for circularity in reducing the environmental impact of the built environment.

However, it is important to note that the comparison of natural stone and concrete depends on the context and the region. The study's focus was on a specific geographical region, and only a few end-of-life scenarios were considered. Further research is required to determine the environmental impact and circularity potential of natural stone and concrete in different regions and under various end-of-life scenarios. Nevertheless, this study contributes to the growing body of knowledge on sustainable and circular building practices and underscores the importance of considering the full life cycle of construction materials.

## 7. Acknowledgements

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# Adaptable architecture for climate change

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## Adaptable design

Climate change is one of the most important challenges of the modern era. The consequences of greenhouse gas emissions and air pollution are increasingly evident, from extreme heat waves to devastating floods. In this context, climate change adaptive design is emerging as one of the most promising solutions to mitigate the effects of climate change. Climate change adaptive design is a methodology that aims to develop built environments that can withstand extreme climatic conditions and long-term variations. Adaptable design requires a holistic approach to design, including understanding climate context, risk assessment, designing climate-resistant buildings and infrastructure, and spatial planning. The goal of climate change adaptive design is to create built environments that can withstand and adapt to long-term climate change. This means developing solutions that are flexible, modular and able to adapt to different climatic conditions. Developing architectural solutions that are flexible, modular and able to adapt to climate change means creating architectural projects that are able to respond dynamically to the constantly changing environmental needs. This requires a design that is flexible and able to adapt to climate changes, the needs of residents and the different conditions of use. In other words, a building that is able to change according to the needs of the surrounding environment, its users and the climate. The use of sustainable materials, the adoption of bioclimatic construction and design techniques, such as natural ventilation, solar lighting and thermal control, can help create buildings that are able to adapt to climate change. Moreover, the adoption of modular solutions can facilitate the adaptation of the building to various needs.. This requires a paradigm shift in the way buildings are conceived, focusing on sustainability and the ability to adapt to the needs of the environment and users.

**Keywords:** adaptability, module, changes

## 1. The module in Architecture

Modular architecture is an innovative solution to design flexible and adaptable buildings to the needs of the context in which they are placed. Thanks to the ability to create prefabricated components, which can be assembled together as a puzzle, you can build a custom-made building in record time.
Modular elements not only reduce production costs but also allow greater energy efficiency during the construction and use of the building. In fact, the use of eco-friendly materials combined with the integration of advanced technologies makes modular buildings highly efficient in terms of energy savings. The modularity also allows greater versatility in the management of the interior spaces of the building. This feature becomes particularly important when talking about the need to redevelop existing buildings with the aim of making them more environmentally sustainable.
For this reason, more and more architects are embracing this trend to create new projects that guarantee maximum structural flexibility that takes into account the climate challenges of the future. As climate change increases, architecture is under pressure to be able to adapt to unexpected situations. Designing with interchangeable modules is a smart and efficient way to be prepared. This technique allows you to build with greater speed and flexibility. The modules can be produced in advance and then assembled in the place where construction will be carried out, reducing assembly and finishing time on site. Moreover, since the modules are interchangeable, they are easily customizable for different sites or purposes. This means that you can quickly adapt them to a new environment or application without too

much effort. Designing with modules is an option that has several advantages when it comes to embracing climate change. Modular technology is an architectural process that allows the construction of buildings of any size and complexity, often by mounting interchangeable components on a basic structure. This means that it is easier to make buildings sustainable in terms of both construction and planning.Using tailor-made modules, architects can design ecologically and create buildings resistant to climate change or emergencies. Modules can be designed to adapt to changes in climate, something that you can't normally do with traditional construction. For example, modules can be reinforced to withstand hurricanes or earthquakes, creating a safe environment for people even in the event of unforeseen climate change.

## 2. The challenge of climate change

The challenge of climate change is one of the greatest that our planet is facing. Global warming, deforestation and pollution are causing a significant impact on our natural resources and the lives of human beings.The scientific community has already sounded the alarm and warned us about the possible negative effects of these climate changes, such as rising sea levels, extreme heat waves, extreme weather phenomena and a decrease in the availability of fresh water.

It is clear that we must act immediately to protect our natural environment for ourselves but also for future generations. Sustainable architecture can help mitigate these negative impacts by providing solutions based on bio-climate criteria.

The use of naturally insulating or energy efficient materials can significantly reduce the energy consumption of buildings. Moreover, the modular elements are perfect to allow the building to be highly adaptable over the years, avoiding costly demolitions that would further burden the surrounding natural environment.In short, the challenge of climate change requires immediate action on our part to preserve our planet. The use of sustainable architecture with modular elements is an important tool through which you can contribute to the creation of a more responsible and careful company to the preservation of its building heritage.

## 3. The benefits of modular climate change design

Modular design can help architects build structures that can withstand climate change. Modules provide a foundation for explosion-proof buildings that can withstand fires, earthquakes and floods. The main advantages of modular design include:

• More flexibility: Modular design offers the possibility to customize the design of structures, depending on geographical distribution or regional and environmental standards. In addition, modular processes are faster to complete because the components are already pre-planned.

• Increased safety: Pre-assembled components made of impact and weather resistant material contribute to the overall safety of a building by providing privileged support for the final stages of construction.

• Shortened constructions: construction times are reduced because partitions are assembled pre-assembled before

## 4. How modules can be used in construction and infrastructure

When it comes to tackling climate change, modular solutions can help architecture be ready for disaster. Modules can be used in various ways in construction and infrastructure.

Modular structures:

The modular structures are built with pre-assembled elements, designed with a standard shape and size. They can be built in advance and then mounted if necessary. This makes them useful for post-disaster reconstructions quickly and efficiently. In addition, they are cheaper than traditional construction methodologies, since materials can be recycled or reassembled after use.

Renewable modular energies

Modular renewable energies can increase environmental resilience by offering clean and environmentally friendly alternatives to the currently available traditional centralized energy generation systems using fossil fuels.

## 5. The importance of sustainable architecture

The importance of sustainable architecture cannot be underestimated in the age of climate change. The use of recyclable materials, the integration of renewable energy sources and the reduction of emissions are just some of the solutions that architects are adopting to build more sustainable buildings.

Designing low-impact buildings requires collaboration between architects, engineers and customers. Together, they can choose the right materials and innovative technologies to create structures that are functionally efficient and environmentally friendly.Another important aspect of sustainable architecture is its impact on human health. Poorly designed buildings can cause respiratory problems, allergies and

other health disorders. On the contrary, sustainable buildings aim to improve indoor air quality through adequate natural or mechanical ventilation systems.
Finally, the economic impact of sustainable buildings must be taken into account. Although they may have a higher initial cost than traditional constructions, in the long term they represent a profitable investment thanks to the increase in real estate value and the reduction of costly maintenance.
In summary, the use of innovative architectural techniques such as modulation combined with sustainable urban development, is an effective solution to prepare for changes of all kinds.

## 6. The advantages of the module

Modulation is a construction technique that uses interchangeable prefabricated elements to create highly flexible and adaptable buildings. This methodology offers numerous advantages over traditional construction. In this paragraph, we will see what the greatest advantages of modulation are.
The first big advantage of modulation is the speed of construction. By using prefabricated modular elements in the factory, the time needed to complete the building structure can be drastically reduced compared to traditional construction on site.
Greater control over the quality of the materials used during the assembly of the various modular elements is achieved. This means that modular buildings can be designed to last longer and require less maintenance over time.
Another huge benefit offered by modulation is the high flexibility in managing the spaces inside the building. Thanks to the possibility to easily add or remove individual modular elements, owners can customize the space of the building according to their specific needs.
Finally, the interchangeable nature of the elements also allows easy replacement of damaged or obsolete parts without having to demolish the entire building structure.
In summary, the advantages of modulation include increased speed of construction, control over the quality of the material used in production, flexible management of interior spaces and easy replaceability. In addition, the use of modules makes structures more flexible: in case of climate change, you can quickly add, remove or replace modules without having to completely rebuild the building. In addition, this type of architecture also allows structures and properties to shelter themselves from climatic eventualities or natural disasters more quickly and efficiently.

## 7. The design of modular buildings

Modular building design is one of the most innovative solutions to prepare for climate change. This type of construction, in fact, allows to create buildings adaptable to the different needs of the climate and the surrounding environment.
The modularity of the elements used in this type of construction allows greater flexibility in the design and assembly of buildings. The possibility of replacing or adding new elements makes modular buildings extremely versatile and adaptable.
The choice of materials to be used in the design of modular buildings plays a fundamental role both in environmental and economic terms. The materials used must be eco-sustainable and have a low environmental impact in order to reduce the impact of the construction on the surrounding environment.
The choice of materials i must also take into account the durability over time of the modular building, ensuring greater resistance to atmospheric agents such as wind and rain.
Finally, the design of the internal systems and the modular structure is another important aspect in the prevention of energy waste. The correct installation of innovative technologies such as photovoltaic panels, advanced thermal systems can lead to significant energy savings in the management costs.

## 8. “Emergency architecture” what does that mean?

Emergency architecture refers to the design of structures intended for use in emergency situations that may be caused by extreme climatic events. The architecture designed this way is intended as a temporary but well-designed solution that supports essential services until the affected area can be restored to its pre-disaster condition. This architecture may present specific challenges such as:
• Fast construction: Production and construction must be fast so as to better adapt to the emergency needs of the type of specific natural disaster you are facing.
• resistance: The building must safely withstand adverse weather conditions and extreme weather phenomena, such as strong winds and torrential rains.
• Possibility of extension: Modules must allow for quick and hassle-free modification of the original design if necessary, in the future, ensuring efficiency in future construction.
• Easy to disassemble

## 9. Conclusion

Ultimately, modular architecture is an innovative and sustainable solution to address the challenges of climate change. The use of modular, interchangeable and adaptable elements allows you to design buildings that can easily evolve and respond to the environmental needs of the future.
The modulation allows to reduce the costs in the phase of construction and maintenance of the buildings as well as to guarantee a greater control on the quality of the final product.
For these reasons, it becomes increasingly important to promote the implementation of modular architecture in all its forms. Only in this way will it be possible to build a better future for our planet and to prepare properly for the current climate change.

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Quotations and Bibliographical References will be included as a list at the end of the paper. It will be used the schemes listed below, based on the UNE 50-104-94 (equivalent to ISO 690:1987). Fields marked with * are optional. References will be indicated with a number in brackets.

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# Architectonic conceptual paradigms - from vernacular to digital architecture

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## Abstract

The article intends to analyze the changes produced in the act of architectural conception by the different tools and processes of representation. Architectural artifact´s ideation presents methods and idiosyncrasies specific of the architectural knowledge, representation processes are the gears to crystallizes them.
The dialectical between ideation methodology and representation methods (autographic or allographic) entails morphological, spatial and consequences in the tectonic.
Different representation methods produce different design practices, that enables and inform the exercise of architectural ideation, with strong influence in the architectural artefact.
The analysis of the representation processes allows to decode the project methodologies, that are associated with it, allowing identify weaknesses and potentialities of the design act.
The awareness of the architect's own acts and of the methodological processes allows the demystification, of the discourse produced by other disciplinary areas, such as history and anthropology, which use the architect as a case study.
we observe the strategies used by the architect for the elaboration of his projects based on the theoretical foundation and on the operational framework, that the different processes and tools of expression/conception offer.
It is possibly understanding the impact of the representation of autographic and allographic we understand construction process and how this conditions the development of the idea and the expression of form and space.
The new representation processes pose new challenges to the professional practice of architects, digital design obliges to innovations on the teaching methodologies.

**Keywords:** representation processes, autographic, allographic, project methodologies, vernacular architecture, digital design.

## 1. Introduction

Architecture as a discipline involves the spatial conception and the constructive definition of the architectural artefact, these two moments define the architect's universe of action, further substantiating the disciplinary content of Architecture.
The ideational process of architecture largely results from the method used to express the idea, so the representation media informs and mark out the conceptual architect´s methodology, with consequences for formal expressiveness and spatial definition.
William Mitchell (1944-2010) on the relationship between drawing and construction states that “architects tend to design what they can build, and to build what they can design” [1]. This dialectic, that could see as a reductive and insurmountable, it has particular importance for the architect's practice, because when there are transformations in terms of representation or tectonics inovations, there are

evolutions in the relationship between design methodology and in the construction process, with large implications for the spatial and morphological definition, expanding the architectural possibilities enormously and increasing the respective potential.

## 2. Thinking Through Action - Autographic Representation

The master constructor, medieval professional equivalent of contemporary architects, concentrated in themselves the functions of architect, engineer, artist and even scientist [2]. In this view, the architect can also be seen as the initiate, as opposed to profane.

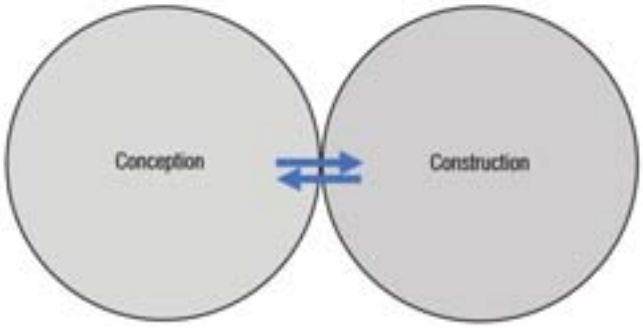


**Fig. 1:** Autographic representation scheme - representation made directly on the materials.

Their training follows the medieval tradition, learning is done in workshop context through a practical process, a master/apprentice relationship, which had as disciplinary subject, construction, painting and metallurgy. This formation process could be illustrated by Fillipo Brunelleschi (1377-1446), Michelangelo (1475 -1564) and Leonardo da Vinci (1452-1519).
The master constructor operates based on tacit knowledge, this operating inputs results from knowledge acquired through experience, resulting not only from the senses, but also from know-how. Due to its markedly empirical character, its systematization becomes unfeasible, and it is not possible to describe this knowledge through the use of words or mathematics. On the contrary, propositional knowledge results from the knowledge expressed by a proposition and not from the subject's experience.
For Peter Dormer, as closer a craft is to art, as more difficult it becomes to systematize it, through a proposition.
These professionals gave physical expression to their mental model of the building, intervening directly in the execution and coordination of the work [3].
The work method explained, expresses an autographic model of representation (Figures 1), in which those who conceive also build. Therefore, the ideation of architectural artifacts is informed by technology. The morphology results from knowledge and the immanent potential of materials and their transformation techniques. Master constructor confers rationality and poetics to the material, adapting the technique to the physical manifestation of the architectural artefact.
In this methodological model, the technique is seminal, the morphology is intrinsic to the technological condition, its definition is intrinsic to the tectonic potential [4].
The Conception process has a technological predominance and is a direct consequence of the representation methodologies, it presents a constructivist focus, in which the shape follows the tectonics. That strongly contrasts with the logic and functionalist conceptual design of the Modern Movement, in which “form follows function”.
These two conceptual methodologies that result not only from different technological conditions, but above all from different representation processes, produce different morphologies, but also different logics and space´s appropriation.
We have numerous cases of buildings like convents, in which they easily accommodated other functions, while the functionalist logic reveals great difficulties in their appropriation for other uses.
In the conceptual process of the master constructor, representation and construction share the same space and time of action. The manual means stand out for “thinking through action” (Figures 2), even being the only true link between intention and expression [3].

**Fig. 2:** Autographic representation, master constructor materializes his idea directly, representation and construction coexist.

## 3. Building Trough the Drawing - Allographic representation

The advent of drawing in the ideation process of architecture redefines project methodology, implying new cognitive processes with implications for the expressiveness and morphology of the architectural artefact, they start to be represented before being built.
The drawing assumes the character of mediator between the idea and the construction. This makes it possible to abandon the practice of the master constructor, who found in materiality the vehicle for the expression of his idea.
With drawing, the material and the technique that transforms, it is no longer ancillary in the process of designing architectural artefacts, geometry and its methods operatives take their place, assuming an working character in the development of the idea.
The paradigm shift results from changes in representation media, with implications for changing ideational, methodological processes, with consequences for workflow, representation processes, modes of learning and thinking architecture.
The creation of a new representation process gave rise to the profession of architect, which results from the knowledge developed and announced by the Renaissance. The process of representation, scholastic training and project methodology, distinguishes them from the exercise of master constructors.
The new profession results from the introduction of drawing in the design process. The conceptual process of the architect is based on the thinking/drawing binomial, while the master constructor uses the thinking/building binomial, tectonics no longer has a component of ideational expression, starting to have only a role of manifestation of the architectural artefact. Kolarevic classifies it as “a history of dissociation”, the removal of the architect from construction site broth a new way of thinking designing and construction the architectural artifact [5].
Leon Battista Alberti (1404 -1472) one of the top references of the new design methodology gives an important contribution to the disciplinary foundation of architecture, with the seminal text “De re aedificatoria”, published in 1485.
The architect's practice is already a reflection of the new times, adopting what would become the Enlightenment concept, based on a classical education and the culture of design, as a conceptual basis, moving away from the practical and empirical unsystematic approach.
Alberti defends two-dimensional drawing as a tool for representing and designing architecture. Drawing should be considered as the gear of the new paradigm of conception/construction in architecture, being a mediation element between these two stages of architecture.
The rigor and accuracy of technical drawings served to communicate ideas to construction teams. Alberti argued that “the drawing of the building is the original, and the building their copy”. To illustrate the new methodological process, Carpo even definite “what cannot be represented will not be transmitted, and what is neither represented nor transmitted cannot be imitated”; nor remembered can be added [4].
The practice of architecture becomes supported by theory, teaching becomes systematic and treatise-based, moving away from empirical knowledge; for Kolarevic “theory served to provide the essence of architecture, and not the practical knowledge of construction” [5].
The conception is based on the act of representation that the drawing provides, allowing the description of future buildings, its rigor and accuracy determines the effectiveness of the building's description and the transmission of design intentions into construction, becoming the interconnection link between design and construction.

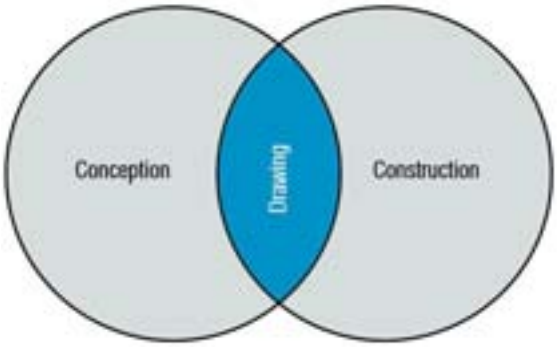


**Fig. 3:** Allographic representation scheme - representation made through drawing.

The need to communicate ideas for the material execution of the architectonic artifact use the drawing perspective and all of graphical convections as a tool of representation, that configure an allographic approach, distancing the architect from the work site [4]. This moment marks the separation of drawing from construction, since both can now occur in distinct cycles, with different subjects, who may have different scopes of action and even be independent of each other.
The separation of tasks led to the separation of professions, with the craftsman taking care of the physical construction of the mental image that the architect has of the architectural piece.
In the allographic process, the Drawing is the vehicle that interconnect the immateriality of the idea and leads it to the materiality of the construction, not only serves as an element of communication of the solution, but also crystallizes the conceptual process and its evolution, allowing the analysis and development of the project. The architectural idea carries in itself a material dimension, the ideation of the architectural object anticipates construction, encompassing those tasks that consubstantiate the physical manifestation of the projected object.
Drawing is paramount in this process, in Pye's words, "a declaration of the ideal form of the object to be made" through which, according to Albertian principles, the craftsman's merit would be gauged by the degree of approximation of the manufactured object to the original idea of the architect (figure 4) [6].

**Fig. 4:** Allographic representation scheme - representation made through drawing, construction is done by workers.

The allographic model emerges with the drawing processes made available by evolution of graphic developments. This intellectual positioning is supported by through the graphic representation for the production of the object.
The process of representation mediates the ideational act, allowing the person who conceives not to build and, in this way, the technological dimension of architecture may tend to move away from the ideational act, something that effectively begins to occur.
In this methodological paradigm, whoever conceived the architectural object doesn´t takes part in its execution and know-how is replaced by scholastic knowledge. This implies that the act of doing can, in some contexts, be replaced by the act of thinking.
Empirical knowledge based on experience is replaced by treaty knowledge. Handing effort is replaced by intellectual effort. The master constructor – a skilled worker, becomes an architect – "intellectual". It is true that the emphasis on the act of thinking cannot be seen, exclusively with a negative connotation, however, the fact that it starts to exist disconnected from the constructive context removes the architect from the, maximum interpreter, the domain and, hence his ability to express the abstraction of (his) idea through tectonic materialization.

In this context emerge also de constructor, whose practice becomes merely constitutive, devoid of any ideational act, the conceptual dimension becomes the architect's body of action.
The architect's departure from the work site resulted in a loss of knowledge in the domain of the construction cycle. This distancing was equally negative in the structural chapter; in fact, the lack of contact with the construction process limited the understanding of the phenomena arising from the handling of matter and the expressive potential of architectural forms. The architect, when losing knowledge of the constructive process, thus lost knowledge of the structural functioning.
The development of graphic resources and the architect's scholastic training introduced entropy into the conceptual process, resulting into methodological displacement of design from the construction cycle, consequently generating a methodological cycle, with little or no interaction with materials and its transformation process.
Furthermore, the entropy and distancing create a progressive gap in time between thinking/design and building/manufacturing, thus making it more disjointed, time-consuming, inefficient and prone to errors and omissions.
Because the person that conceives is far from the constructive reality, the architect therefore loses the ability to think immediately, of the material consequence of the represented idea to materialize the conceived space.
when he represents it, he only expresses a localized reality of the object, whose generalization may encounter inadequacies; pay attention, for example, to the cut of a facade, which may not be integrated or extrapolated to the rest of the constructive reality of the architectural artefact.
Carpo warns about shapes that are difficult to draw and measure used to be difficult or impossible to build" [4].
Complex geometries, designated by Rafael Moneo as "forgotten geometries" because their drawing´s representation difficulties, have been frequently used throughout history to break with established canons of Beauty and proportion [5]. Its structural, spatial and plastic potential contrasts with the difficulties, conception, representation and construction, making this workflow expensive and time-consuming [4].
Carpo adds "if (the architect) cannot design what is in his mind, in a way that others can do it for him, he can always try to do it himself".
Antoni Gaudí (1852 - 1926) developed a way of representing that is at the same time, a space geometric manipulation and structural optimization, he was inspired for a method developed by the architect Heirich Hubsh (1795-1863) who applied the graphic process of Giovanni Poleni (1683-1731) to architectural project [7].
Le Corbusier to support the creative process of the chapel of Ronchamp (1954), because of its formal complexity, takes up practices and logic of representation that resemble autographic processes. It was through the creation of a model that it was possible to represent the space that was intended to be built.

## 4. Digital Master Constructor

The new evolution embodied in the appearance of computers, the growth of digital information and communication technologies, had an impact on relationship between representation and construction, defining their own methodologies and workflow Indeed, the emergence of the "Information Age,…" "…like (in) the preceding Industrial Age, challenges not only how we design buildings, but also how we manufacture and construct them" [5].
The introduction of digital media produced changes in the design and communication of the project, drawing is no longer the only mediating vehicle between the idea and construction. It becomes possible the digitalization of mockups and physical models, to incorporate this information into the design cycle. Therefore, we stop we start talking about Representation and no longer only in drawing [8].
The process known as Representation (drawing, physical and digital models) has produced profound changes in the design cycle in Architecture, as the introduction of digital tools in the conception, representation and construction processes allows for the establishment of a new paradigm.
The new representation resources make it possible to expand the simple geometries formal universe to the use of complex geometries, that drawing processes have great difficulty in achieving. Also, the draw Cartesian Referential processes were abandoned to star using Topological Referential supported by Computational methods - (heuristic and iterative processes).
Associative Design Formation and Generative Design allowed Topological Formation allow a conceptual approach that goes beyond the "shape" of a single object, to reach a conceptual process that embraces the "Formation" that is informed by shape grammar.
All these conceptual changes were possible because of the new representation tools, having implications in spatial morphologies, they have impacts in the construction of the architectural artefact.
The design and production of buildings based on drawings on paper is now carried out using digital information. William Mitchell notes that buildings are currently designed, documented, manufactured

and assembled using digital support, which thus allows characterizing the architecture of the digital age **[1].**

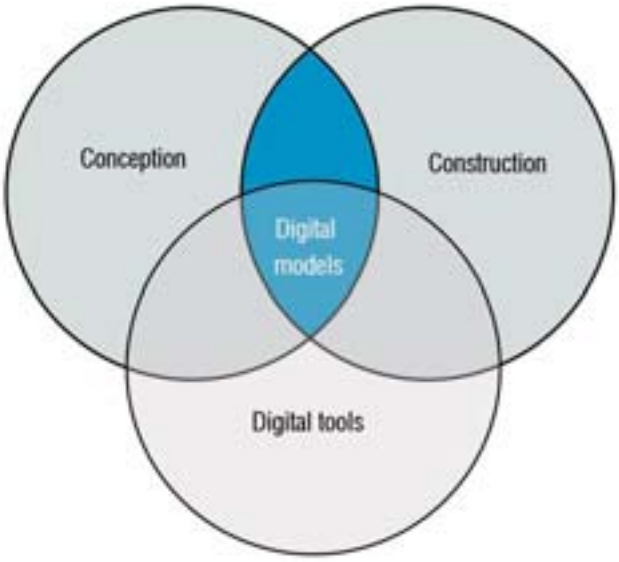


**Fig. 5:** Digital allographic representation scheme - representation made through digital tools, building an information model.

The evolution of representation tools turns possible the digital execution of the architectural object, turning a tool that produces lines to a tool that build a digital model, with profound consequences in the operative, mental, cognitive processes and methodological, with huge impact in the expressivity, morphology and space. we move from representing the idea to constructing of the idea, in a digital context.

In the previous process, based on an allographic representation, the cycle started with the idea, moving on to the graphic exploration, through sketches and ended up in a phase of rigorous two-dimensional graphic representation, (maxime, work drawings) thus enabling the materialization of the project, i.e., the architectural object.

In the new cycle, generated by the digital means associated with the project, configurate a “new autographic process” is possible (figure 5), which is defined from the idea, moving on to the respective representation, through graphic exploration, from this moving on to the sketch and, from there to the sketch digital and physical model digitalization. The next step takes us from here to the construction of a digital model of the architectural object, from this to digital prototyping and, with the management of graphic information from the digital model, to the work site drawings, finally reaching the materialization of the project through technological condition that could be manual, mechanical or digital.

In the allographic model, the representation of the idea is done through a punctual construction characterization, using graphic representation processes, so the piece was thus communicated in a generic way. In the digital materialization of the idea, there is no convention or graphic support process, the whole idea is constructed, only that, in a digital environment, it is no longer graphically represented in a two-dimensional way to start to be built three-dimensionally in support digital; in this way, drawing as we know it ceases to have the exclusivity of communicating the idea. The “digital continuous” breaks with the allographic model of representation since the communication of the mental idea is done through a digital construction of the idealized object.

The person who conceives also builds the object in a digital environment, not being a representation, but rather an idea that is expressed through a digital materiality, from which emerges a digital tectonic and a new conceptual model, therefore, no longer allographic but autographic.

The methodological process provided by CAD/CAM, is able to integrate through digital tools, the modelling, production and construction. It made possible in real time to model an object and establish the respective tectonic process and materialization.

The “digital continuous” once again changed the relationship between drawing (now representation) and construction, or, as Carpo explained, the processes defined by this paradigm “evoke an ideal and original autographic state” [4].

The architect returns to the pre-Albertian model, as the integration of CAD/CAM technologies now allows the act of drawing (understood as conceiving) and the act of building to result from the same agent that conceives and builds digitally.

The relationship between the representation and the physical manifestation of the object can be defined as Albertian given that the digitally created architectural piece is the primordial revelation – the original object, the physical revelation of the architectural artefact being a copy.
The new paradigm makes the architect of the sec. XXI a digital master constructor, in part like the master masons of his predecessors. There are, however, differences arising from the production processes.
The flexibility and dexterity of this process allows the design and construction of objects with a high degree of complexity in an economical and efficient way, without resorting to standardization. Complex shapes can be visualized and analyzed before manufacture, in a digital environment, thus making it possible to optimize them. As Kolarevic said “variety no longer compromises the efficiency and economy of production” [9].
The operational framework formed by digital tools not only opens up new possibilities, but also changes the architecture design cycle. This ceases to be a sequential process, to be a process that develops in simultaneity and interaction. The design interacts in real time with the analysis and construction, thus allowing a parameterized design, as well as the readjustment feed-back of the designed solution.
This framework requires methodological solidity from the architect, an open mental framework and, above all, knowledge to support and catalyze his creativity.
The conceptual practice that supports his performance in architectural composition, is verified in a disarticulation between the generation of the idea, the processes of representation, the understanding of the respective structural functioning, the tectonics and its construction. This praxis hinders, in some cases, the conceptual and constructive soundness of the idealized work.

**Fig. 6:** F. Gehry shows a high commitment to research of the potential of different digital tools, shaping high complexity of geometries, free from stylistic formalisms.

The difference between these methodologies and digital representation tools stems from the ability to interconnect design and materialization, an operative reality that digital architectures early present during the conceptual cycle. These experiences set bases for the use of integrated computational systems, within conception, representation, production and construction.
For Oxman, the revolutionary character of the digital project does not result from its morphological character, but rather from the diversity, variety and evolution of the act of design, which the application of digital tools to architecture allows to support [8].
In this way, the architect has the possibility of abdicating conventional solutions, supported by the theoretical solidity of the cannons, which the representation processes based on the drawing respond with efficiency.
Reproduction or repetition were the normative elements of the mechanical technological condition that supported the era of industrialization.
The representation processes that digital tools applied to architecture allow to implement non-standard, non-normative and non-repetitive design. This theoretical body is expressed by the concept “NonStandart Architectures” [10]. The theorized paradigm emerges from the new instrumental framework, which allows personalization and individualization, in summary, seeks the creation of a language of its own, which can be that of the designer, the consumer, of an era or for an era.

## 5. Conception versus Evolution

“Architecture crystallizes its time” because of that is a preferred vehicle of memory, constituting an object of study, which attracts historians and anthropologists, they produce a analyze and perspective over the architecture using their own methodologies. they do not take into account the axioms and methodologies of the architectural designing process.
These distinct disciplinary training results of the methodological framework and he professional focus, do not contemplate the conceptual and constructive architect´s goals. An analysis made with other assumptions, distorts the perception of the operational and conceptual architect´s principles.

The conceptual design and constructive principles that are the project´s purpose, are different from the analysis focus of the historians and anthropologists. They look at the immaterial values that architecture intrinsically carries, using architecture as an object of study to know and understand the way of life and thinking of the several civilizations, which characterize successive historical periods. This focus could distort and cause Architecture´s wrong analysis. Already the architects have as designation the material definition of the project idea, which only ascends to the condition of architecture through material Revelation.

Compering vernacular architecture with contemporary architecture is an example of the misconceptions can be generated by an analysis done without proper methodological references.

It is easy to understand that the different historical times present significative variants, this cultural and technological background has strong consequences on the space and morphology of the architectural artefact.

It isn't possible to compeer or analysis by these two architectural manifestations, in beyond different representation processes, that as we have seen, influence the generation of space and form. The processes that inform their generation are different. Vernacular architecture is an evolutive process carried out spontaneously, referring to trial and error as a mode of evolution, not observing the acts proper to architecture. Contemporary architecture, or any other, made by architects is supported by a conceptual process.

In vernacular architecture, the conceptual dimension is very mitigated, it results essentially from a constructive aspect, that has adapted to a specific context. It does not result of a conceptual process, it is based on a trial-and-error process, extended in time. Its merit results from a cycle of experiences that finds the "Kairos time" for its model´s physical manifestation.

More than an act of conception, it is possible to speak about "evolution", in the sense of the general theory of systems - (primary adaptation), that is, an individual who belongs to an environment, evolves in the sense of adapting and responding to this physical, geographic reality.

Bertalanffy designates regulation as the adaptation of organisms to their ecosystem environment, could be subdivided into two types [11]. Primary adaptation that results from a static adaptation of form to its environment, it is the result of thousands of years of evolution. Secondary adaptation is dynamic and relates to secondary feedback mechanisms, it is a real-time answer to the ecosystem.

The morphology, skin and texture of some fruits allows them adapting to the environment, being an example of a static adaptation. The same thing is the search for the best solution in architecture.

Vernacular architecture is the result of a static adaptation to a morphological specific definition, resulting from the improvement of a model, that time has refined.

The Mashrabiya trusses are an example of the static adaptation, these fixed elements used in of Islamic architecture characterize the facade of buildings and allow to control light and ventilation, functioning as thermal moderators of the space. The use of movable elements, the curtains or even the shutters, utlist a dynamic adaptation of the architecture, these elements can be adjusted according to the momentary conditions.

By static adaptation the trial-and-error process formalized a specific model for a particular context, turn possible to find an adjusted and sustainable solution, a respecting economic, environmental, social and cultural point of view of.

Vernacular Architecture doesn´t use a representation process, because doesn't exist a conceptual moment, this architectural manifestation uses an established model, that adapts to the construction site. The conceptual act cannot be sanctioned by time, because does not present a material manifestation. Project anticipates "time" and the material reality of the architectural artifact, by foreseeing, predicting and solving what is not materialized, limiting or even avoiding the error, by managing the passage from the abstraction of the idea to the objectivity of the architectural artefact.

Architectural ideation presupposes the passage from the conceptual plane to the material plane, accepting two cycles, conception and construction [12]. In vernacular architecture that does not happen, this results rather from the mimicry of a model that adapts to a context. It does not present a conceptual development phase and a material definition. The process only applies techniques and spatial solutions that have already been tried. Since its context/ecosystem is stabilized the model also stays immutable. The architect's practice, supported by its own methodology, defines a conceptual process that presents the ability to find innovative and proficient solutions, for a reality characterized by the constant evolution of "Time Chronos", its ideation process produces architectural artifacts capable of responding quickly to different contexts and to its foreign ones.

Another of the mistakes generated by an analysis based on anthropological or historic principles results in a romanticized view of vernacular architecture. This is often associated by local people as something ancestral outdated in time, no less often associated with times of difficulty and poverty, as this rejects its materials and its form.

An example is the project carried out by Phillipe Block in the project SUDU - Sustainable Urban Dwelling Unit, Addis Ababa, Ethiopia, 2010. The organic expression of the buildings that results from the constructive process had to be linearized in order to be seen as a more contemporary architectonic

achievement. The collective of Portuguese architects Blaanc in the project Casa Firme, Mozambique, 2014. The user contested, when they elected material like rammed earth, bamboo reeds and wood, as a constructive solution for their housing project, this solution was perceived by the inhabitants as something backward.
It is simply impossible to compare informal character of the vernacular architecture, with an architectural systematic produced by architects (erudite architecture). They are the expression of different methodological processes, logic and modus operandi.
The so-called erudite architecture made by architects, anticipates and manages the different axioms that define the physicality and spatiality of the architectural artifact, therefore anticipates time, the project results from the preview of the physical object, its qualities and its viability.
The glorification of vernacular architecture pointing to it as an example of excellence and consistency, when compared with architecture made by architects is simply disjointed as it does not understand the different character of these architectural achievements.
Likewise, the discourse produced on vernacular architecture by some architects is not comprehensible, it reproduces the discourse of other areas of knowledge, with other theoretical bodies and disciplinary practices - Sociology, Anthropology and History, does not take into account the act of designing, which constitutes the essence of architecture discipline.
Architects defending vernacular architecture, is the same as a painter with academic training practicing naïve painter. This innocent and simplistic enchantment is still dangerous for the profession, as it devalues the systematic and academic training of the architect, strengthening an informal architecture, with many of the gaps that it presents.
Vernacular architecture constitutes a case study that provides us with tested and sanctioned solutions, which is why it is a source of knowledge.

## 6. Conclusion

The present investigation allows us to understand the relationship between the representation and the methodological process, which produce impact into the morphological and tectonic definition of the architectural artefact.
The autographic representation allowed the domain of the material and its constructive processes, in the intrinsic methodology and in this way of representation, the construction is an integral part of the conceptual process.
The allographic representation finds its form of expression in drawing, it is the mediator between design and construction, this mutation produced changes that resulted in the emergence of two new professions, the architect and the builder, whose functions result from the sharing of the duties of the former master builder.
Architect ceases to participate directly in the construction of the architectural artefact, his learning process takes on a scholastic character and the constructive methodology starts to have drawing and geometry as its operative bases. The Revelation intrinsic to the physical manifestation of the object is often missing.
The application of digital tools to architecture has once again changed the method of representation, drawing has no longer the exclusivity for the idea´s communication. The instrumental framework alters the connection logic, which haven´t a representative character and becomes the construction of a digital model.
The possibilities of customizing and manipulating the form are exponentially increased, allowing to explore and respond more effectively to the diversity and programmatic complexity of Architecture. The concept “NonStandart Architectures” that emerges allows personalization and individualization, seeking the creation of a language of its own.
Architecture has its own methodological body whose assumptions must be present in the analyzes the adoption of other disciplinary references can cause mistakes
Vernacular architecture is the result of a process of evolution, it does not result from an act of design, it is understood as such the act of predicting the different qualities of the idealized space - (functionality, light, ventilation, thermal behavior, etc.), managing the constructive solutions, manipulating the structural systems of the object architectonic foreseeing the physical manifestation of the architectural artefact.
the model results from an evolutionary process produced by trial and error, which adjusts to a context, the already tested model is repeated and adapted to the place of construction.
The application of digital tools to the architecture brings new challenges, changing the way of thinking, teaching and doing architecture, change the cognitive process and the expression possibilities. The academy and the architecture theory must to analyze all these mutations in order to produce knowledge able to support the new practice. Giving the subtract for the correct use the new tolls in order to produce a solid and proficient process of designing architecture.

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# Eco-equipped Production Areas: The Italian way of Eco Industrial Parks

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## Abstract
The eco-sustainability of productive settlements is a relatively new topic: only since the 1990s have experiences aimed at reducing the environmental impact of productive activities become widespread. Communities of production and service enterprises that try to improve their sustainability by implementing environmental, economic and social performance can be identified as **E**co-**I**ndustrial **P**arks in application of what was theorized by Lowe, Moran and Holmes, in the publication *Fieldbook for the development of Eco-Industrial Parks* (1996). To achieve eco-sustainability, it is fundamental to plan/design/manage the new and/or renewed production area either through a new project or by upgrading the existing areas, but the morphological configuration/reconfiguration of the area is combined with the rethinking/reorganization of the functions resulting from the new production chains and modes (Lowe, 2003). Achieving EIP status requires both a coordinated planning/management process at the urban and building scale and the coordinated organization/management of each participating enterprise. This paper, after framing the topic in green economy and industrial ecology from the international literature on EIPs, will explore the ***A**ree **P**roduttive **E**cologicamente **A**ttrezzate (*Eco-equipped Production Areas), which represent the Italian EIP formula. The article will analyze the regulations in force in Italy with the intention of identifying some general Eco-Planning criteria that characterize these types of settlement aimed at drawing up guidelines to support urban planning choices and the implementation of the planned interventions.

**Keywords:** Eco-Planning, green economy, industrial ecology, EIP, APEA

## 1. The Green Economy
The notion of ecological economics was developed by the mathematician and economist Nicholas Georgescu-Roegen and his student, Herman Daly [1] internationally recognized as one of the leading experts on sustainable development. The connection between the economic and ecological disciplines concerned a kind of repair of neoclassical economics (based on prices, production and income through supply and demand) in a way that also considered natural resources. Herman Daly's theories move towards a biophysical and ecological analysis of the economy in the belief that only by returning to the biophysical foundations of nature and the moral foundations of society can the economy meet the challenge of ecological complexity and sustainability. The idea of the green economy stems from the Stern Report [2] that proposes an economic analysis and assesses the environmental impact of recent climate change. To respond to the economic and financial crisis that has also produced social and environmental impact, the notion of the green economy, or green economy with a low environmental impact that considers the environment as an investment, is spreading. Fundamental elements for implementing this type of economy are technology and scientific knowledge. The green economy, also known as ecological economy, is a model of economic development that includes a certain production regime and specific attention to environmental impact. This is where the strengths of this economy come

into play, namely alternative energies, especially renewable energies such as wind, solar, hydroelectric and biomass. The green economy is a sustainable and inclusive economy, it tries to reduce energy consumption and implement strategies to reduce pollution, the new theories of sustainable development and ecological economy place a new paradigm in front of us: no longer an economy based on two parameters, *labour* and *capital*, but an ecological economy that recognizes the existence of three parameters, *economic capital* (investment and revenue), *natural capital* (primary resources, i.e. the set of natural systems, agricultural products, fishing, hunting and the artistic-cultural heritage present in the territory) and *social capital* (labour and welfare), just as sustainable development is based on the three dimensions: economy, society and environment. While in the early phase the definition of the green economy tended to be identified as a small part of the economy referring to the so-called environmental industry and the renewable energy sector, today it is recognized as a tool to be applied in all sectors of the production of goods and services, as well as for the conservation and sustainable use of natural resources. Herman Daly writes: *For the management of renewable resources there are two obvious principles of sustainable development. The first is that the rate of extraction should be equal to the rate of regeneration (sustainable yield). The second, that the rate of waste generation should be equal to the natural absorption capacities of the ecosystems into which the waste is emitted. Regeneration and absorption capacities should be treated as natural capital, and failure to maintain these capacities should be regarded as consumption of capital and therefore unsustainable* [1]. The problems and principles of ecological economics provide a foundation for sustainability. The reflections and research of ecological economics, cross-fertilized with those of other disciplines, have led to the definition of certain fundamental principles that characterize the notion of sustainability. Herman Daly enumerates the following: the scale of human intervention in natural systems should be limited to a level that is within the carrying capacity of the systems themselves, technological progress for sustainable development should be based on increasing efficiency and use, not on increasing the input of raw materials and energy into the economic process, rates of utilization of natural systems should not exceed rates of regeneration of the systems themselves, waste emissions should not exceed the assimilative capacity of natural systems, and non-renewable resources should not be utilized except at a rate that is equivalent to the creation of renewable replacements. On the international scene, there are numerous green economy definitions, strategies and roadmaps from various international and supranational bodies. Among the most authoritative are those of UNEP (United Nations Environment Programme), the OECD (Organization for Economic Co-operation and Development) and the EU (European Union). The various definitions basically agree on the fact that the green economy aims to improve the quality of life of all mankind, reducing inequalities in the long term and not exposing future generations to worrying environmental risks, even if the OECD speaks of green growth and not green economy, these definitions should not be read as opposing each other, it should also be pointed out that the definition of green economy does not replace that of sustainable development, but becomes a necessary transition. Sustainability remains a key long-term goal, and to achieve it a green economy will make a fundamental contribution. UNEP's definition of a green economy stems from a thorough analysis that considers all natural resources from which the human species benefits without paying any compensation. The analysis is based on a fair economic consideration of natural capital, the only way to compensate countries in trouble. The OECD promotes green growth, a development model capable of guaranteeing, also for future generations, the environmental resources and services on which our well-being is based. Green growth gives an extremely important role to technological innovation, which can decouple growth from dependence on natural capital, the main driver of the transition to a green economy. The EU identifies scientific and technological cooperation as the only way to define an international framework for solving collective problems of global significance such as climate change, the supply of energy and raw materials, and the use of chemicals and hazardous substances. The European strategy proposes innovative finance, supported by incentives, in which new financing instruments play an innovative role in policies in areas such as climate change and biodiversity, and an improvement in international governance through a strengthening of sustainable development strategies, starting with policies for the environment.

## 2. Industrial ecology

The notion of industrial ecology was introduced in the early 1990s by Robert Frosch in *Industrial ecology: A philosophical introduction* [2]. By analogy with natural ecosystems, an eco-industrial system, in addition to reducing waste production in processes, must maximize the efficient use of waste materials and end-of-life products as inputs for other production processes. Such a system can only be triggered if there is the interaction of numerous actors working together to solve an appropriate number of potential problems. The main objective of industrial ecology is to promote sustainable development on a global, regional and local scale. Paul Hawken in *The Ecology of Commerce* [3] states that industrial ecology provides for the first time an integrated management tool that designs industrial infrastructure as if it were a series of interconnected industrial ecosystems interfaced with the global ecosystem. Through the analogy with natural ecosystems, the notions of *industrial metabolism* and *industrial symbiosis* are

introduced. Industrial metabolism [4] refers to the chain of physical processes that transform raw materials and energy, as well as labour, into products and waste. One of the aims of the discipline of industrial metabolism is to investigate the flow of materials through society to better understand the sources, causes and effects of emissions. Industrial symbiosis [5], as part of the emerging field of industrial ecology, pays attention to the flows of matter and energy through regional economies. Industrial symbiosis involves traditionally separate industries with an integrated approach aimed at promoting competitive advantages through the exchange of matter, energy, water and/or by-products. Key aspects enabling industrial symbiosis include collaboration between companies and synergy opportunities available in an appropriate territorial setting. Industrial ecology therefore involves several sectors and several integrated competencies including environmental and technological, organizational and logistical, cross-systems and network analysis skills using, for example, MFA (**M**aterial **F**low **A**nalysis) and LCA (**L**ife **C**ycle **A**ssessment) of products and services. This is a discipline that integrates several tools with the aim of maximizing the closure of resource, energy and service cycles within industrial and local systems. Within the scope of actions that can be implemented to approach an eco-industrial system Frosch includes, among others, product design for recycling/reuse at end-of-life, internalization of waste disposal costs for products and processes, producer responsibility. Industrial ecology addresses environmental issues (and their implications in economic terms) using a systemic approach from two different points of view: from the point of view of the product/service and from the point of view of production sites, technologies, production processes. Industrial ecology therefore involves several sectors and several integrated competencies including environmental and technological, organizational and logistical, cross-systems and network analysis skills using, for example, MFA and LCA of products and services. This is a discipline that integrates several tools with the aim of maximizing the closure of resource, energy and service cycles within industrial and local systems. Within the scope of actions that can be implemented to approach an eco-industrial system Frosch includes, among others, product design for recycling/reuse at end-of-life, internalization of waste disposal costs for products and processes, producer responsibility. Industrial ecology addresses environmental issues (and their implications in economic terms) using a systemic approach from two different points of view: from the point of view of the product/service and from the point of view of production sites, technologies, production processes. The first approach includes product policy tools, including LCA, LCD and DFE (**D**esign **F**or the **E**nvironment). The second approach includes, among others, clean technologies, BAT (**B**est **A**vailable **T**echnologies), industrial metabolism and industrial symbiosis. Considering that the success of the green economy depends directly on the effectiveness of the behavior and technological measures that can be adopted and their economic impacts, the importance of all these tools is crucial for the sustainable development of the region. The principles of industrial ecology point to the closure of cycles and to this end pursue the following strategic environmental performance objectives: efficient use of resources, reduction of environmental impacts and management of interactions between the environment and surrounding communities. The birth of Industrial Ecology has provided a fundamental impulse to the spread of new ways of conceiving industrial production and the organization of production settlements. The environment constitutes the foundation at the basis of possible planning and development hypotheses, which require the definition of a specific strategy to reduce anthropic impacts on resources and natural matrices, taking as a model the recycling phenomena of matter present in the ecosystem. The suggested approach offers a valid alternative for achieving sustainability objectives in the industrial field, adopting the principle of prevention and precaution from pollution and abandoning the end-of-pipe approach [6] typical of traditional linear production systems. The first systematic investigations into the interrelationships between industry and the environment date back to the early 1970s and consisted of a collection of principles, practices and proposals that companies adopted to green their processes. However, it was not until the late 1980s that the notions underpinning industrial ecology led to the formation of a real scientific discipline; the contribution of Frosch and Gallopoulos [7] who proposed a new strategy for manufacturing industry: the traditional model of industrial activity, whose production processes generate products for sale and waste for disposal, must be transformed into an integrated model: an industrial ecosystem. This system optimizes the consumption of energy and raw materials to the point of using the residues of one process to feed other processes. In the same year, R. Ayres introduced the notion of industrial metabolism [4], which describes the flows of raw materials and energy that are used by industries and subsequently transformed into finished products, by-products and waste. From the balance between the inputs and outputs of the industrial system, inefficiencies can be calculated, which are what produces pollution. Industrial ecology contributes to applying the principles that determine the functioning of ecosystems or non-human biological systems to industrial systems and their transformation and production cycles. The objective is to reduce the dissipative characteristics of production activities. The notion of waste is reconsidered in a systemic vision, up to its revaluation as an intermediate product. Every waste is re-introduced into circulation, either to produce energy or as a raw material, to initiate another process essential to maintaining the global balance. According to which, industrial ecology is the science of sustainability. It requires that an industrial system be considered not

in isolation from its neighboring systems, but in close relationship with them. It imposes the adoption of a systemic point of view, which tries to optimize the entire life cycle, from the acquisition of raw materials to the production of artefacts, its components, objects, until the moment those artefacts become obsolete, then the responsibility to take care of those products at the end of their use.

## 3. Eco Industrial Park - EIP

The question of sustainable development has led to the need to identify innovative visions capable of combining economic aspects with environmental and social ones. The evolution of production methods, the result of increasingly driven and pervasive technological innovation, is bringing about profound transformations in the layout and organization of traditional industrial production areas: a series of new production areas are thus being configured, such as science and technology parks, the research park, the business incubator, and the business park, which in turn take on a highly articulated series of intermediate declinations. The question of the environmental qualification of production facilities made its debut in the 1990s in the United States, where voluntary experiments aimed at building production parks with a view to minimizing their impact on the environment became widespread. The integrated systemic approach, as theorized by Lowe in the EIPs, seeks to achieve collective benefits that are greater than those that would result from the sum of the individual benefits that each company would gain individually from optimizing its specific performance. Achieving this goal requires the redesign and/or upgrading of production area infrastructure, reducing pollution, improving energy efficiency and maximizing cooperation between companies. Lowe's [8] historical definition of EIP to which many international organizations active in this field refer is as follows: *A community of manufacturing and service enterprises located together on a common property. Member companies pursue the best environmental, economic and social performance through collaboration in the management of environmental and resource issues. Working together, the business community pursues a collective benefit that is greater than the sum of the individual benefits that each company would realize by optimizing its individual performance alone*. Different denominations and definitions are used by various organizations around the world to refer to EIPs or relatively similar notions by naming with various terminologies settlements that refer directly or indirectly to the concept and/or practice of EIPs such as: Eco-Industrial Park, Sustainable (Special) Economic Zone, Low Carbon Technology Area, Green Investment Group, Circular Production Property. In the international context, the definition of industrial park is affirmed, which refers to a production settlement consisting of a *large tract of infrastructured land used by several companies at the same time, it is distinguished by its shareable infrastructure and the proximity of the companies* [9]. A few authors [10] point out the need to refer to the typology of EIPs according to definitions that are capable of distinguishing, within a heterogeneous category, settlements of different types, they affirm the need for a non-differentiated use of the term EIP, with reference to the recent use of the term, which is often extended and associated with the notion and evolution of PIE practices, This distinction emerges from the analysis of some PIE projects that aim at two fundamental objectives one focused on *technical performance*, the other on *social aspects*. This makes it possible to distinguish between large industrial complexes and so-called EIPs. If for the former it is possible to refer to the industrial complexes of the classical tradition, namely large areas of heavy industry, for the latter type we refer to those that host a variety of small and medium-sized enterprises, communities of manufacturing and service enterprises as theorized by Lowe, Ewans and Holmes [11]. These companies are linked by common management and try to improve their environmental, economic and social performance through collaboration in dealing with environmental issues and the use of resources (including energy, water and materials). This integrated approach pursues the achievement of collective benefits. The path to this goal requires the planning of the production area, the redesign or upgrading of existing infrastructure, cleaner production, protection from pollution, energy efficiency and cooperation between companies. There can be various approaches to industrial ecology and consequently various morphological-functional configurations of production sites. An initial analysis of the technical literature shows that they can be grouped into three macro-categories (Fig. 1) [12]. **E**co **I**ndustrial **P**ark: an industrial park (group of companies usually located in adjacent areas and operating as a community) developed and managed as a real estate development company (single management) seeking high environmental, economic and social benefits. The approach is top-down the eco-industrial park is planned, designed and managed based on the principles of ecology and industrial symbiosis. The **B**y **P**roduct e**X**change: a group of companies exchange their waste (energy, water and materials) with each other to reduce resource consumption, pollution, cut procurement costs and often increase revenues. The exchange can take place both within an industrial park, between neighboring companies, but also regionally. The construction of such a network does not constitute an Eco-Industrial Park per se. The approach is bottom-up, the system of relations between companies arises independently of specific planning but, over time, based on successive agreements for the exchange of materials, energy or services, a non-project made by a non-organization. The **E**co **I**ndustrial **N**etwork: a group of companies belonging to a specific region, working together to improve their environmental, social and economic performance. It represents more than just the exchange of waste products and can also

include training programmes or other services, include EIPs or simply be a network of individual companies. In general, common services can be as diverse as environmental management systems for individual production cycles, logistics, the exchange of secondary materials, recruitment of new companies, external promotion, training, emergency teams, and services of a more common nature, such as catering, cleaning or green area management.

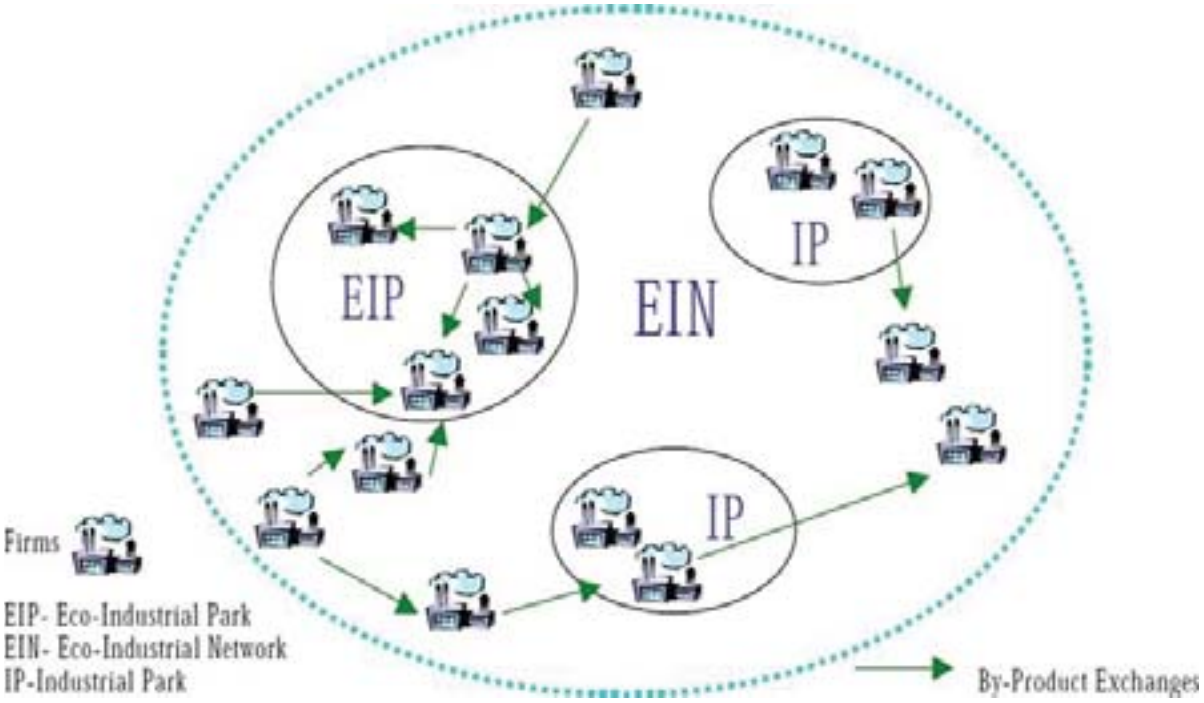


**Fig. 1 -** Scheme of IP - EIP - EIN - BPX

Lowe's definition of EIPs has been developed and revised over the years to better reflect the importance given to the three pillars of sustainable development: environmental, social and economic.
The main environmental aspects that EIPs include are: Global and national climate change commitments; Presence of relevant policy mechanisms (e.g., taxes and market mechanisms such as carbon pricing); Greening the supply chain and reducing the number of resources withdrawn, aimed at better resource management and conservation; Ensuring that infrastructure is as little as possible affected by higher resource costs and adapting to climate change risks; Responding to environmental and social concerns of consumers; Increasing demand to improve efficiency and growth. Evidence suggests that frictions between communities and industrial parks can occur due to poor preparedness to deal with emergencies, concerns about operating standards, and the increased intrusion of industrial areas into areas increasingly close to residential areas. In addition, industrial parks often depend on labour-intensive work, the supply of resources from surrounding local communities, adequate social infrastructure and, in some cases, more extensive housing and social services. This requires a carefully planned and appropriate framework and processes to address social problems. The main social aspects that EIPs include are: More work on better terms; New local jobs; Improved gender equality; Improved security and crime prevention; Provision of social infrastructure for workers and communities; Support for local community welfare and awareness raising; Provision of vocational training; Improved occupational health and safety; Transition towards a more sustainable use of land. EIPs can offer a wide range of socio-economic benefits they often involve the creation of an enhanced social infrastructure, which is particularly important for developing countries. Examples include medical facilities, vocational training opportunities and expanded community services. Indirect benefits are often difficult to quantify but are increasingly important for the long-term economic sustainability of the park and its resident enterprises. The main economic aspects of EIPs include: New direct and indirect employment; Enabling - retraining of the workforce; Linkages between industrial park enterprises and small and medium-sized enterprises (SMEs) and communities outside the industrial park; Transfer of technology and knowledge through foreign direct investment; Demonstration effects from the application of international industrial best practices and regional development approaches. An EIP framework enables Government authorities, industrial park developers and industrial landowners to adopt a positive marketing opportunity by introducing more sustainable industrial operations that provide environmental

protection, climate change mitigation, resource efficiency and higher social quality standards. These factors play an important role in driving industrial development increasingly towards EIPs.

## 4. Eco-Equipped Production Areas - APEA: the Italian way of EIP

Until a few years ago, the environmental management of production areas was based on experiences conducted mainly abroad, and it was difficult to imagine an application to the Italian reality in the absence of both a regulatory reference and a cultural inclination favourable to the application of this new conception of production settlements. Taking those international experiences as a reference, the situation in our country has rapidly evolved, a sign of evident political and administrative attention and interest in the question of management, not only environmental, of production areas. These, in fact, are important tools for the economic and social qualification of a territory but, at the same time, a potential source of pressure on the environment and surrounding communities. The notion of Eco-Equipped Productive Area (in Italian **A**ree **P**roduttive **E**cologicamente **A**ttrezzate) was introduced into the Italian legislative system by Legislative Decree 112/98, art. 26 of which states that the Regions and the Autonomous Provinces of Trento and Bolzano shall regulate, with their own laws, industrial areas and APEAs equipped with the infrastructures and systems necessary to guarantee the protection of health, safety and the environment through the valorization of existing settlements, even if they are totally or partially disused. Originally, the objective was to simplify the administrative formalities connected with the location of enterprises in production sites, using the natural presence of collective services and infrastructures for the management of some important environmental aspects (water, waste, soil contamination, etc.) valorization of existing settlements even if totally or partially disused. The legislative decree regulates the forms of unitary management of the infrastructures and services of the ecologically equipped areas by public or private subjects and the modalities for the acquisition of the land included in the industrial areas, where necessary also by expropriation. Production plants located in APEAs are free from the acquisition of authorizations concerning the use of the services therein. The legislation assigns to the Regions and Autonomous Provinces the task of identifying the areas, choosing them as a priority among the areas or nuclei that already exist, even if they are totally or partially disused; this procedure also takes place through the participation of the local authorities concerned, many of which have legislated [13] on the matter by issuing guidelines and the presence of areas with APEA projects in progress. The Campania Region has implemented the decree's indications with DGR n. 4459 of 30 September 2002, Guidelines for Regional Territorial Planning (approval BURC no. 24 December 2002) and LR n. 19/2013 *Assetto dei Consorzi ASI*, stoprovide that the ASI Consortia (Fig. 2) of Campania may apply for one or more industrial agglomerations to be recognized as APEAs. Article 25, paragraph 2, letter g) of Legislative Decree 112/98 provides that in the authorization procedure for the settlement of production activities, if the settlement project is against an urban planning instrument, a services conference may be held, the determination of which constitutes a proposal for a variant, on which the Municipal Council must make a final decision. Among the implementation urban planning tools are the Plans for Productive Settlements (Fig. 3), which can perform a dual function: stimulating productive expansion in the municipal territory by increasing the supply of areas for the settlement of productive activities, and ensuring a coherent development of the Municipal Urban Plan's forecasts by means of an orderly urban organization of the area in which the new complexes are to be located, or, in the case of redevelopment, a more appropriate organization of the existing settlements. APEAs are defined by Legislative Decree 112/1998 as production areas equipped with the necessary infrastructure and systems to guarantee health, safety and environmental protection. The network of regions of the Cartesio Network, whose aim is to promote a cluster approach in the territories, has drawn up the Charter for the development of Eco-Equipped Productive Areas in Italy, to define a common vocabulary, shared minimum criteria for the recognition of APEAs, create a register of APEAs, develop administrative simplifications and convergent and synergic territorial policies for the sustainability of productive areas. Production facilities located in eco-equipped areas are exempt from the acquisition of authorizations concerning the use of services there. The minimum criteria that must necessarily be met to obtain the APEA definition are subdivided according to three different levels of intervention: urban-planning, building, infrastructure and management. The flexible criteria, unlike the minimum criteria, apply to all types of area, each requirement is associated with a score, to obtain the APEA designation the sum of the scores obtained must be equivalent to or exceed one hundred points. The advantages of APEAs can be summarized as follows: Synergy between companies with the recovery and recycling of raw materials and production waste. This reduces the amount of waste produced and, at the same time, creates cost reductions for companies by saving on raw material costs of water and energy; Administrative simplifications are achieved. The existence of a single managing entity means that it can acquire environmental authorizations on behalf of all the companies belonging to the APEA; Possibility of exclusive or priority access to financing for productive infrastructures; Achieving APEA status enables important indirect savings to be secured; in fact, companies can be relieved from obtaining some of the necessary environmental authorizations the managing entity can acquire the single environmental authorization on behalf of the companies themselves; The improvement of companies' environmental

management, minimizing the risks of environmental accidents, optimizing the use of energy and resources; The achievement of environmental certification of individual companies and the monitoring of the environment; Ensuring healthiness for operators and users; Supporting territorial competitiveness, respecting European regulations (aid to enterprises) and enhancing environmental quality; Innovation in territorial planning, with the creation of a shared and participation.

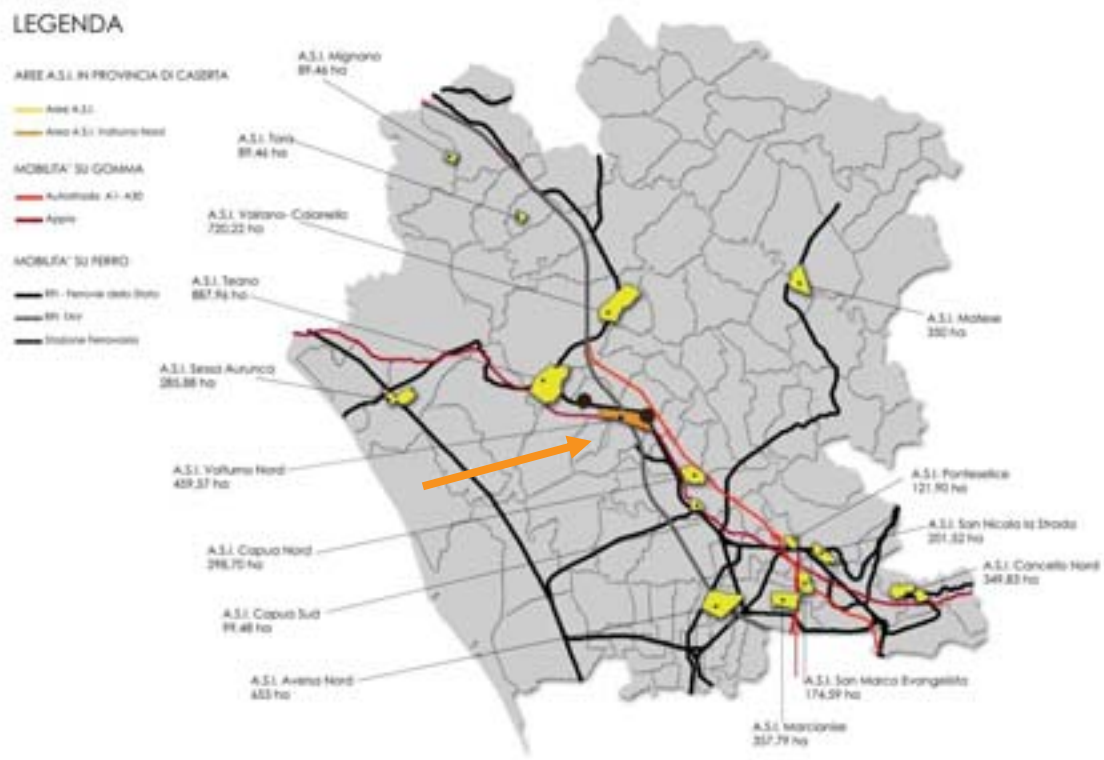


**Fig. 2 -** The Municipality of Sparanise (Ce) (indicated with the orange arrow), which is concerned with the Volturno Nord ASI area (459.57 ha) in the context of the ASI areas of the province of Caserta (5,139.36 ha) in which an APEA has been planned in zone D of the PUC. Technical-scientific advice of the Department of Architecture and Industrial Design of the University of Campania *Luigi Vanvitelli* for the drafting of the PUC of Sparanise (Ce) technical-scientific supervisor Prof. Arch. Claudia de Biase

The definition of APEAs is used to describe areas in which the concentration of companies and workforce makes it possible to plan a unified and integrated management of infrastructures and services useful to guarantee the sustainability objectives of local socio-economic development and to increase the competitiveness of the companies established, while respecting the environment. Eco-production areas become relevant both for sustainable spatial planning (regional or local) and operational management, where the cooperative aspect in the management of environmental aspects is enhanced. In these areas, there is the possibility of applying regulatory and administrative simplifications, implementing green marketing policies in favour of established companies, pursuing industrial policies oriented towards eco-innovation and the development of the green economy. These are all solutions that lead to the rationalization of business costs, an increase in the added value of the production of the supply chains present in the APEAs, and greater competitiveness for both businesses and the territory. The planning and implementation of an APEA should be the result of two paths, an eco-oriented design involving both the settlement and individual plants as well as the production and product life cycle. It

follows that achieving APEA status requires a detailed planning and programming process, both on an urban and individual company scale, but also in terms of time and economics.

**Fig. 3 -** PIP - APEA of Terzigno (Na) in force. The system of public equipped green/blue infrastructure. Technical-scientific advice of the Department of Civil Engineering Building Design and Environment of the Second University of Naples today Engineering Department University of Campania *Luigi Vanvitelli* for the drafting of the PIP-APEA of the zones D2 and D3 of the PUC of Terzigno (Na), technical-scientific supervisor Prof. Ing. Salvatore Losco

The approaches to the model of APEAs adopted by the various regions are quite different; however, some common elements can be highlighted: The planning coherent with the territory; The presence of a contact person for the production area (the Managing Authority) that implements an Environmental Programme shared with the local authorities; The participation of companies in the management of their production area. The innovativeness of environmental management therefore does not derive exclusively from planning and infrastructural aspects. Shared environmental management, dialogue with the Local Authorities and the participation of companies in the process are elements for the launch of innovative territorial governance, which directs and supports an environmental policy of sustainability of production settlements. The APEA can therefore be described as a place of environmental dialogue in which experiences, resources and objectives of all the actors involved in the process of its formation, development and activities are shared. It is a place where actions are experimented and implemented in a partnership form, aimed not only at compliance with regulations but, more generally, at satisfying the environmental needs and expectations of the settled companies and local communities. Through the management of collective infrastructures and services, sized and concerted with the community of resident companies, it is possible to generate those scale economies that enable the resolution of shared environmental issues between several actors in a more effective way. A productive area in which companies, in addition to finding advantageous settlement opportunities, can be involved in a context that can make them improve their environmental performance in exchange for lower charges, is one of the lines of principle guiding this path. The APEA model should therefore not be viewed by the stakeholders (businesses, local authorities) as an external imposition, an obstacle to economic development, but rather as a tool for enhancing the territory and increasing the competitiveness of the production system and businesses. A shared advantage must be pursued in the principle of common environmental management, for businesses, authorities and local populations. The business world evolves, territories equip themselves with policies and instruments aimed at strengthening them. Productive areas can also accompany these changes, responding closely to the needs of businesses and citizens, qualifying themselves to become one of the implementation tools of a policy aimed at increasing the competitiveness of the territory, in an economic, social and environmental sense.

## 5. Some conclusive remarks

The traditional approach of Territorial/Urban Planning, which laboriously pursued needs with additive interventions, has given way to Environmental Planning, part of a more articulated and complex planning process, attentive to the effects of anthropization and to the system-environment/territory interaction. In this perspective, the Planning activity becomes important insofar as it can promote development by

avoiding the consumption of non-renewable resources and respecting the reproducibility times of inexhaustible ones, moving from Urban Planning to Territorial/Urban Planning/Environmental Planning. EIP-APEA adopts the principles developed by industrial ecology, a science that investigates material and energy flows, with the aim of significantly reducing resource use and pollution. It suggests applying to industrial systems and their transformation-production cycles, the rules and principles that determine the functioning of biotic and abiotic systems that are characterized by symbiotic relationships and the absence of the notion of waste: all waste is, in fact, reintroduced into circulation to produce energy or as raw material, to start another process essential to maintaining global balance. However, absolute closure of the cycle cannot be achieved at the eco-district level, nor would it make much sense to achieve this (at least the end products, or goods, must come out). To hermetically close certain cycles could also, at times, burden them with costs more than the economic benefits (although in reality, the environmental, ecological and social benefits deriving from the implementation of such practices should also be included in the calculation of the latter, that is to say, the quantification first of the environmental damage [14] and then of its reduction. It is evident, on the other hand, that the neoclassical economy is programmed in a sectorial way to achieve high rates of production (high-efficiency system), while ecosystems from this point of view are not always so exemplary; furthermore, in order to close the cycles one must reckon with the ineluctable laws of thermodynamics: if the first principle states that it is not possible to create and/or destroy matter and energy, the second maintains that matter/energy subjected to a transformation process undergoes an increase in entropy. Therefore, the goal of closing cycles is to be understood as an aspiration of the green economy and not in the strict sense. The goal, therefore, to which one should strive, consists of a limited use of inputs (resources and raw materials), a limited production of waste and, above all, a collaborative behavioral pattern between the various components of the industrial ecosystem implemented through the exchange of materials and energy. This goes beyond the principle of product responsibility, as it also considers the process and its waste, which can no longer be outsourced. This presupposes a systemic approach and a co-operative relationship between companies, in a horizontal sense; moreover, it is evident that, to achieve such goals, the industrial system must possess high-tech systems, a preventive attitude towards pollution and operate a sensitive recycling of waste. There are two possible approaches to planning and implementing an Eco-Productive area: The definition of symbiotic production processes, in relation to material flows (energy, heat, water, waste, emissions, people, goods). From this perspective, cooperation between companies is intended to generate new possibilities for maximizing efficiency and effectiveness in the use of matter and energy; The sustainable configuration (planning/design) of production parks, in relation to the design of services and infrastructures useful for the establishment of companies, with a view to sustainability and the closing of natural cycles. The realization of an Eco-productive settlement-neighborhood should be the result of both paths, an eco-oriented planning/design that involves from the settlement to the single local units of the enterprises and again to the organization of the production process and the product life cycle in the awareness that it will always be the balanced synthesis of all the competing elements to generate an efficient Eco-productive settlement-neighborhood. It follows that the achievement of the status of Eco-Productive Settlement-District requires both a specific planning process, both on an urban and building scale, and the organization of the individual enterprise, also in terms of the time and economic cycle of activity.

**Attributions**

Within this contribution, which is the result of a joint elaboration by the authors, personal contributions can be identified as specified below: *The Green Economy - Eco Industrial Park - EIP* (Claudia de Biase), *Industrial Ecology - Eco-Equipped Production Areas - APEA: the Italian way of EIP* (Salvatore Losco), *Abstract* and *Some conclusive remarks* (joint elaboration).

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[14] Article 300 of Legislative Decree No. 152/2006 et seq. (Consolidated Environmental Act), in dictating the notion of environmental damage, taking up the indications contained in Directive 2004/35/EC, describes as *environmental damage any significant and measurable deterioration, direct or indirect, of a natural resource or of the utility ensured by the latter.*

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# The Rewilding Approach in Urban Design. The Case Study of Budolfi Plads in the Historic Centre of Aalborg (DK).

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## Abstract
Dwelling on Earth responsibly means guaranteeing global environmental well-being, within which the habitable environment for human beings must find a new homeostasis. At the turn of the second and third millennium, tackling environmental degradation and halting the continued loss of biodiversity became a global policy goal.
In this context, new approaches to biodiversity conservation and ecosystem restoration are emerging, such as rewilding, an approach that aims to strengthen the adaptive capacity of ecosystems by restoring natural processes and minimizing human management.
The article analyses urban rewilding as a design approach aimed at restoring natural processes and reintroducing nature on an urban scale, evaluating its advantages and positive effects in terms of improving health, supporting biodiversity and contributing to the fight against climate change. The aim of the research is to explore how urban design can use urban rewilding methods and techniques for the regeneration of cities.
The article describes the transformation project of Budolfi Plads, the central square of the historic centre of Aalborg (DK), as an example of urban design adopting the rewilding approach. The project involved the transformation of a dreary parking area into a central place with mixed urban functions. By attributing a predominant role to greenery, the project represents an innovative turning point for urban design in a historic urban context.

**Keywords:** Rewilding; Urban Regeneration; Green Transition; Aalborg; Budolfi Plads

## 1. Rewilding as a strategy to face the environmental crisis
Tackling environmental degradation and halting the growing loss of biodiversity are among the most urgent imperatives at the turn of the third millennium, recently indicated as political objectives by the United Nations Decade on Ecosystem Restoration 2021-2030 [1], by the EU Biodiversity Strategy for 2030 [2] and by the Global Biodiversity Framework Post-2020 issued by COP 15 [3] as implementation of the CBD (Convention on Biological Diversity).
In response to the global environmental crisis, different approaches to nature conservation, biodiversity protection and ecosystem restoration are emerging. Among these, rewilding is conquering large fields of experimentation, an approach that aims to strengthen the adaptive capacity of ecosystems by restoring natural processes and minimizing human intervention or management [4–6].
The concept of rewilding emerged in North America in the 1980s [4], when it was originally called "wildness recovery" [7], and has become increasingly popular around the world [8]. Originally, rewilding was concerned with the conservation and restoration of native biodiversity [9], while reducing human pressures and control [4, 10], through interconnected networks of large-scale reserves established primarily to protect major interacting species and their trophic relationships [11].
The goal was to make regenerated ecosystems, where possible, self-sustaining by providing for the conservation of large core reserves, wildlife connectivity corridors and the protection of keystone species [12].

## 2. Urban Rewilding

While rewilding was originally associated with rural projects, it is also experiencing growing interest in the field of urban regeneration as a design approach that can deliver quality built environments through the use of natural resources and the incorporation of native plants and animals into urban infrastructure [13]. Urban rewilding seeks to restore natural processes and reintroduce nature on an urban scale by balancing the needs of humans and wild environments to create better urban landscapes for all [14].

Goal 11 "Sustainable cities and communities" of the United Nations 2030 Agenda for Sustainable Development states that cities and human settlements must be "open, safe, resilient and ecologically sustainable". A sustainable city must offer long-term well-being to its citizens without compromising the functions of the urban ecosystem. Consequently, a sustainable city concept integrates green practices, green spaces and assistive technologies into the urban environment to reduce air pollution and carbon emissions, improve air quality and protect natural resources. These practices result in a healthier environment for the inhabitants and a lower carbon footprint for the city.

Sustainable cities are becoming increasingly important in reversing global climate change. Urban rewilding can help mitigate the effects of climate change by making cities more resilient and delivering a number of benefits, including:

- Promote biodiversity by providing food and habitat for wildlife and forming green corridors to connect fragments of nature together;
- Reconnecting city dwellers with nature, enabling people to receive physical and psychological benefits, develop stronger connections with nature, and appreciate ecosystem dynamics and the aesthetic values of wilderness;
- Help create or inspire ecological and cultural change in society;
- Reduce the management costs of urban green using native species able to survive and reproduce in an almost autonomous way and without expensive maintenance interventions (planting, pruning, cleaning, irrigation);
- Contribute to local rainwater management, enabling the collection, storage and purification of rainwater and its subsequent reuse;
- Contribute to the reduction of urban pollution through the sequestration of carbon in the atmosphere;
- Help reduce the heat island effect in cities.

In urban rewilding, nature cannot be left completely free to conquer its spaces; it requires careful planning and is configured as a transdisciplinary practice involving the disciplines of urban design, landscape architecture, botany, environmental engineering and hydraulic engineering.

Urban regeneration projects have been initiated around the world as a response to biodiversity loss and the climate crisis [4] with reference to the science-based restoration of self-regulating ecosystems and the transformation of human-nature relationships [15].

Among the best known examples: the Promenade Plantée (1988-1993, project by landscape architect Jacques Vergely and architect Philippe Mathieux); the pedestrian sections of the Petite Ceinture railway in Paris; the High Line in New York (2006-2009, architects Diller Scofidio+Renfro and landscape architect James Corner Field); the Garden by the Bay in Singapore with its 18 Supertrees; Nottingham's Broadmarsh Shopping Centre transformed into an urban wetland oasis; the Qunli National Urban Wetland in Haerdin (China), an urban park that provides ecosystem services and restores natural wetland habitats; the All-Ireland Pollination Scheme, which bans lawn mowers and pesticides in parks, roadsides and green areas to encourage the growth of plants and wild flowers essential to bees; the Stadte Wagen Wildnis Project in Hanover, Frankfurt and Dessau which reserves abandoned industrial areas for wild nature for the creation of new habitats for animal and plant species; Queens Plaza in New York (project by landscape architect Margie Ruddick) conceived as an island of wild herbs.

The wild urban garden as a device for safeguarding and increasing biodiversity is at the centre of the research of landscape architects such as, among the most innovative, Gilles Clément [16–18], designer of the Parc André Citroën, the gardens of La Défence, the garden of the Musée du quai Branly in Paris, etc., and Nigel Dunnet [19, 20], designer of the Olympic Park in London, the Barbican Centre in London, the suspended forest of Porta Romana Park in Milan, etc.

Numerous scholars have dedicated themselves to the theme of rewilding [21, 22] who outline a new positive environmentalism by restoring and regenerating damaged ecosystems. Among them, Massenberg notes that, particularly in Europe, characterized by densely populated areas and a long history of landscape cultivation, rewilding also affects socio-economic and socio-cultural dimensions. He suggests a holistic approach to rewilding, addressing the complex interplay between ecology, society, economy and culture [5]. He also notes that positive perceptions of rewilding by local residents are crucial to the successful implementation of the practice. Humans tend to appreciate the kind of nature and landscapes they have known since their youth [23]. Therefore, the loss of diverse and traditional cultural landscapes associated with historical and cultural heritage, a sense of place and a certain landscape aesthetics can represent a serious social brake on rewilding [24–26]. To overcome

the dualistic misunderstanding of man-nature relations in which humanity is outside nature, a social construction of the landscape through participatory approaches is needed.

## 3. Case study: the rewilding of Budolfi Plads

The contribution presents the redevelopment project of the Aalborg cathedral square, which began in March 2017 and was completed in November 2019. The project is inspired by the practice of rewilding and addresses the delicate issue of introducing wild nature into the historic centre of the city.
In this case, the theme of the transformation of historical contexts had to deal with both the dichotomy between conservation and innovation, and with a radical change in the historicised image of places. All this required a long and intense public debate, supported by the Municipality of Aalborg, which was attended by citizens and experts in landscape architecture and environmental engineering.

### 3.1. Context history

Budolfi Plads (Budolfi Square) is located in the heart of Aalborg, a city located in the northern part of Denmark. The city of Aalborg is the third largest city in Denmark, with a population of 221,082 (2021 data).
The city of Aalborg developed in the Middle Ages around a main east-west road, Algade. Around the year 1000, a church dedicated to Saint Budolfi was built in the centre of the main axis [27]. The Church, which became a cathedral in 1554, has always represented an important point of reference in the city of Aalborg [28]. Over time it has undergone numerous expansions and renovations that have combined the Gothic and Baroque styles.
The neighbourhood where the church stands, called Skolegadekvarteret due to the presence of a school, is one of the oldest. In the mid-fifteenth century, numerous manufacturing activities settled in this district which gave it an industrial character, as well as pubs, brothels and gambling halls which connoted it as the entertainment district of Aalborg [27]. As the city grew, the neighbourhood became very busy and featured many narrow, winding streets.
In the 1930s, when new, wider and more regular streets were built in Aalborg to accommodate vehicular traffic, Skolegadekvarteret became a slum district and was considered an unsanitary, infectious and morally depraved place. Between 1936 and 1939, the Municipality of Aalborg decided to rehabilitate the neighbourhood by demolishing 43 buildings and acquiring ownership of the freed land [27]. The streets were widened to accommodate cars and Skolegade changed its name to Vingårdsgade, hoping to remove the bad reputation as well. A square used for markets and events was built around the church.
After the Second World War, urban culture placed great value on modernizing historic urban areas with the introduction of parking lots and supermarkets. Thus, in the early 1960s, the Municipality rented the area of the square to private entrepreneurs for the construction of a car park, offices, shops, a petrol station and a public shelter. The contract covered an area of approximately 4,800 m2 and had a duration of 52 years (expiring on 1 January 2012). Upon expiry of the contract, both the land and the structures built will return to the property of the Municipality.
Following the design lines of the time, it was decided to create a dense settlement around the Budolfi church, in order to enclose the churchyard in a more measured space as was characteristic of medieval settlements. Even the functions of the new buildings had to respond to the new needs of modern life: thus, a supermarket was born, the first Kvickly in Denmark; the Budolfihus office building in a functionalist/modernist style; two office buildings, Algade 53 by Danske Bank and Vingårdshus. The car park was built on two levels, taking advantage of the irregularities in the terrain, and was equipped with a petrol station (Fig. 1).


Fig. 1: Budolfi Plads before the transformation. The white outline indicates the area under transformation. Source: Aalborg Kommune, 2017.

### 3.2. Urban regeneration and public debate

By the end of the 20th century the square had taken on a dilapidated appearance. In this period Aalborg had started a process of urban regeneration to guide the transition from an industrial city to a city of culture and knowledge [29]. The 2004 Comprehensive Plan for Aalborg Midtby envisaged the redevelopment of the areas surrounding the Budolfi Church: the indications of the plan envisaged the creation of a garden at the eastern end of the church and the arrangement of the existing parking lot, to give the character a worthy forecourt [27].

In view of the expiry of the lease (2012), in 2010 the Municipality started a public debate to discuss the potential of the site. In 2013, the area was the subject of a public tender. The sale, however, was not completed as the offers received were too low or did not comply with the tender requirements [30].

In 2015 there was a second debate; this time the debate was based on a draft proposal that the Municipality of Aalborg had developed in collaboration with the landscape architecture studio SLA and the real estate entrepreneurs Sadolin & Albæk [31].

To create a co-base for comparison between the various sub-surveys, all the proposals and comments have been grouped into four general themes: Urban space and urban life, Construction and use, Traffic and parking, Temporary use and furniture.

Some widely shared proposals emerged from the debate, including: the area should take on a green and inviting appearance; the history of the place had to be valued; the market function had to be re-proposed in more modern and functional terms; commercial activities and meeting places such as shops, cafés and restaurants were to be envisaged. The general vision was to create an oasis of peace and tranquillity in the centre of Aalborg, a green recreation area equipped for playing, meeting and socializing (Fig. 2) [31].

Fig. 2: Location of Budolfi Square in the historic centre of Aalborg. In black: connections with the central points of the historical centre. In green: urban spaces with green areas. Source: Aalborg Kommune, 2017.

### 3.3. The regeneration project

The proposal for the square project obtained largely positive approval, for which a new tender for the executive design was published. The tender was won by the consortium composed of NCC Construction Danmark A/S, Udviklingsselskabet Viben A/S and Rema Butiksudvikling A/S (consultants: Kjaer & Richter A/S, byMUNCH, urban and landscape design and Balslev Consulting Engineers A/S ) [32].

The most important problem was to reconnect the square to the cathedral. The Budolfihus building clearly separated the church from the square and the latter was essentially perceived as a desolate parking lot built in a back space rather than a central place in the city (Fig. 3).

Budolfihus was built in 1962 in a functionalist/modernist style (designed by architects Torben Stokholm and Christian Pedersen); the building had a cantilevered curtain wall above the base, curved walls with thin profiles in aluminium and polarized glass, a double-height central hall.

The National Association for Building and Landscape Culture believed that Budolfihus represented an era in the city's development of significant architectural and cultural-historical value. Although the National Association had recommended Aalborg City Council to protect the Budolfihus in order to preserve the entire post-war architectural heritage, the opinion prevailed to demolish the building in order to obtain a direct correlation between the Church of St. Budolfi and the square [30].

Fig. 3: Budolfi Plads before the transformation. The Budolfihus building separated the church from the square. The square was entirely occupied by a parking lot. Source: Aalborg Kommune, 2016.

Fig. 4: Budolfi Plads after the transformation. An artificial hill covers the underground car park. The pedestrian area is richly planted with native plant species. Ph. A. Badami, 2022.

The project envisaged the following transformations (Figs. 5-6): the walking surface was raised so as to leave the surface entirely pedestrian and cover the car parks; the buildings surrounding the square have a common architectural language and are built in red bricks to recall the traditional building materials used for the construction of the houses in the historic centre; all the rooms that open onto the square level host public functions (restaurants, cafes, art galleries, shops) and, through open (transparent) and active (openable) facades, interact with the public space by supporting a good synergy between the urban space and the function of buildings; the upper floors are intended for residential functions with homes equipped with balconies or terraces to host private outdoor living spaces; green roofs and green facades support local stormwater management solutions; most of the square is intended for greenery.

Fig. 5: Transformation project of Budolfi Plads. Planimetry. Source: Aalborg Kommune, 2017.

Fig. 6: Transformation project of Budolfi Plads. North-South section and East-West section. Source: Aalborg Kommune, 2017.

## 4. Rethink greenery in the city

The Budofli Plads regeneration project provides an innovative contribution to urban planning in historical contexts for the original conception of urban green.

The innovative value of the project consists in enhancing the ecosystem balances of nature, regardless of the principles of aesthetic-formal evaluation of urban green intended as mere decoration. For the selection of plant species, the principle of collaboration was adopted, i.e., all species were selected by virtue of their ability to adapt, live, reproduce and support each other in local climatic conditions and within an urbanized environment.

The local transformation plan of Budolfi Plads [32] contains the list (Table 1) of tree plants, shrub species, tall and perennial grasses, flower bulbs and ground cover plants. The plants must be planted according to precise associations (Fig. 7): to obtain a luxuriant and varied planting of the urban space – both in terms of species, character, size and function – the trees must be made up of different species of hardwoods, conifers and flower that can vary over the seasons in terms of flowering, leaf colour, bark and growth forms. Grasses, perennial herbs and flower bulbs must be combined with a great diversity of species, taking into account different growing conditions and in such a way that a dense planting is created. Low plant density varieties are combined with high plant density varieties to obtain a high plant density degree.

| PLANT SPECIES | |
|---|---|
| Trees | Robina Pseudoacacia, Gleditsia Triacanthos, Metasequoia Glyptostroboides, Prunus Maackii, Prunus Avium “Plena”, Prunus Padus, Pinus Sylvestris, Cedrus Deodara, Prunus subhirtella ”Autumnalis”, Quercus Palustris, Quercus Robur, Alnus Cordata, Acer Rubrum, Acer Campestre |
| Grasses | Stipa Pennata, Stipa Calamagrotis, Deschampsia Cespitosa Tardiflora, Carex pendula, Miscanthus sinensis "Ferner Osten" |
| Perennials | Echinacea 'Baby white swan', Salvia nemorosa 'Ostfriedland’, Persicaria amplexicaule 'Album', Sedum 'Matrona', Hosta Sieboldiana, Echinops exaltatus, Persicaria amplexicaulis, Hosta Halycon, Salvia nemorosa |
| Flower bulbs | Narcissus 'Mount Hood', Allium Christophil, Allium 'White Glant', Nectascodum silicium, Allium Sphaerocephalon |
| Ground cover plants | Brunnera macrophylla 'Jack Frost', Hosta Sieboldiana, Stachys Byzantina, Dryopteris filix-mas, Parchysandra terminalis |
| Pteridophytes | Foot fren Cotula Dioica Reptans |

Table 1. Plant species foreseen for the street furniture of Budolfi Pads. Source: Aalborg Kommune, 2017.

Fig. 7: Tree species selected for Budolfi Plads. Examples of intercropping between species. Source: Aalborg Kommune, 2017.

The design of the square is conceived starting from the greenery. The general image appears as a slight hill full of vegetation inside which the paths leading to the top are inserted. The mix of conifers, deciduous trees, grasses, ground cover and flowers restores the experience of a forest, importing a piece of Danish natural landscape into the historic city centre.
On the south and north sides of the square there are two large stairways intersected by ramps that blend into the vegetation, like paths in the woods. The large square above is paved with large white cement tiles interspersed with flowerbeds, like natural ground on which paving stones are laid for circulation. The tiles are marked by sinuous grooves that recall the traces that microorganisms leave in the plaster deposits, also acting as an anti-slip (Fig. 8). The excess rainwater that runs off the pavement is collected and diverted to an underground tank so that it can be used to irrigate the area during dry periods.
The flooring recalls both the colour of the church of San Budolfi and the white Portland cement which is one of the most important industrial productions of Aalborg, a symbol of the city known and exported all over the world.

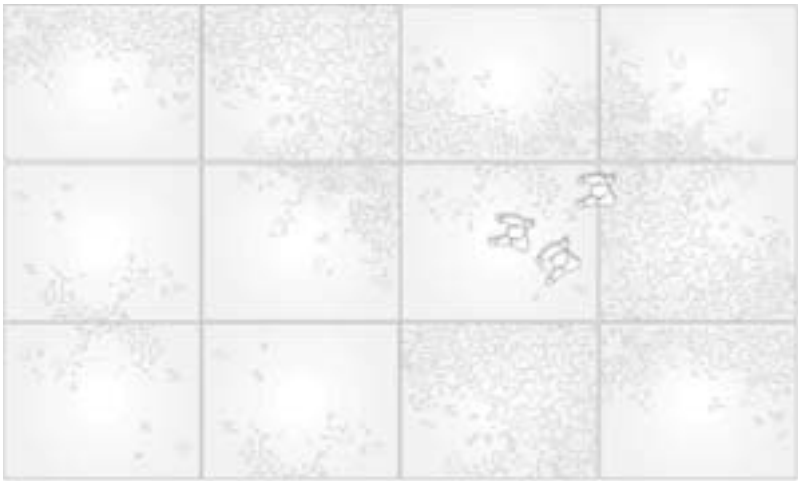

Fig. 8: Principle for engraving grooves in cement tiles. Source: Aalborg Kommune, 2017.

The furnishings of the square are designed to offer various and changing opportunities for rest and relaxation: chaise longues (Fig. 9), benches, terraces of bars and restaurants are distributed in such a way as to enjoy the most evocative views of the cathedral and the historic buildings that open around the square.

Fig. 9: Urban furniture in Budolfi Plads. Chaise longue in concrete and wood. Ph A. Badami, 2022.

Fig. 10: Render of the transformation project of Budolfi Plads. Source: Aalborg Kommune, 2017.

## 5. Considerations about the innovative value of the project

The project was awarded the Aalborg Municipality Architecture Award in 2020 for the harmonious combination of wilderness and architecture in the historic city centre. The Building Awards Committee wrote in its assessment that the heart of the city has been revitalized by removing traffic, inserting underground parking, increasing planting and biodiversity, and beautifully integrating the architecture, use and materials of the buildings into the historic area.

The project represents a breakthrough in traditional urban design. The open space was designed following the principles of natural ecosystems, reconstructing a piece of the Danish forest landscape. Covered surfaces and buildings adapt and integrate into this space, and not vice versa, reaffirming the priority role of greenery.

The urban policies implemented for the realization of the project involved citizens, specialists, investors and stakeholders in a process of cooperation. Dialogue and collective participation preceded the design phase and were the basis of the design choices. This ensured the appreciation of a project that transformed the appearance of the central square of the historic centre of the city to the maximum; moreover, the multifunctionality of the square has made it possible to respond to the various questions and expectations expressed by the different users.

The project has made a significant contribution to the environment and biodiversity. The vegetation is varied, lush and verdant, appealing to the senses and ensuring different experiences as the seasons change. The species planted have been chosen to increase biodiversity, to create variety in terms of spatiality and to insert a new green volume in a dense part of the city. Large trees have been planted to create lush greenery in a short amount of time, while a mix of hardwoods and softwoods allows for an evergreen expression to be maintained during the winter months.

The large biomass that the project has introduced into the area through the green roofs, flower beds and trees has multiple effects on the microclimate of the area: the vegetation absorbs CO2, absorbs polluting particles from the air and reduces the acoustic resonance between buildings; provides shade in the summer months reducing the urban heat island effect; helps reduce rainwater runoff and increases evaporation.

With the transformation of Budolfi Plads, a new green identity has been created in the heart of Aalborg offering accessible meeting places for people of all ages, thus strengthening social cohesion. Today the square is buzzing with life and has become one of the busiest and most loved central points in the city.

Fig. 11: Budolfi Plads. View of the elevated square from the east side. Ph. A. Badami, 2022.

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# Territorial governance and climate adaptation. Towards an environmental perspective of urban regeneration [1]

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## Abstract
The literature, the scientific and disciplinary debate and the growing awareness on the part of national and international bodies of the impact of climate change on the territory (European Green Deal, 2019, Horizon Europe 2021-2027) have highlighted, in recent years, the need for climate-proof policies, strategies, tools and actions as a goal to be achieved through the updating and innovation of spatial government tools, according to an integrated and inter-scalar approach for the construction of urban regeneration strategies in coherence with the objectives of the European Strategy on adaptation to climate change (EU, 2021) and the addresses of the 17 Sustainable Development Goals of the 2030 Agenda for Sustainable Development (UN, 2015) and the Climate Conference (COP26, 2021).
This scenario is reflected in the most recent EU programming and policies and is, moreover, a transversal objective of the PNRR (Mission 5 Inclusion and Cohesion (Urban Regeneration and Social Housing), as well as of the PNR 2021/2027 (AT 2 Humanistic Culture, Creativity, Social Transformation, Inclusive Society in close correlation with AT 5 Climate and AT 6 Environment).
In this context, the contribution presents some of the results of the research activities carried out by the authors that highlight, starting from the analysis of national and international planning experiences and best practices, the urgency of defining new perspectives and new theoretical-methodological and operational references for an innovative planning system, as a tool for a sustainable and resilient regeneration of contemporary cities and territories, at the supra-municipal, municipal and local scale, with significant impacts on mitigation and adaptation to the effects of climate change.

**Keywords:** urban regeneration, adaptation, climate-change, local plan

## 1. Urban regeneration and governance of the contemporary city. The framework of European and national policies and programming
In the contemporary city, the many contradictions induced by the effects of globalisation, physical degradation, social, economic and cultural marginality [2], environmental fragility, extreme climatic changes and seismic events, and the pressure of migratory flows, the new instances resulting from the changing system of values and behavioural patterns of the population, overlap with the 'genetic anomalies' that have characterised the development of Italian cities since the early 20th century, highlighting the emergence of a new, pressing '*urban question*' [3].
An issue that implies the various marginalities mentioned above and that underlines, also concerning the recent global health emergency, the urgency of activating policies, strategies and tools that provide integrated responses to the instances of environmental regeneration, social revitalisation, cultural and economic enhancement of the city, according to principles of sustainability, combining quality of life and quality of the environment, and prioritising the implementation of new *urban welfare* to guarantee local communities the right to health, education, public mobility, housing, and the city [4, 5].

The realisation of this new *welfare* recalls, therefore, the need for and constitutes the priority objective of an integrated and inter-scalar strategy of public governance aimed at urban regeneration and territorial rebalancing [6], which finds a punctual contextualisation in the EU policies [7], in the *European Urban Agenda* [8], in the policies for the promotion of sustainability and efficiency of cities from a *Smart* perspective [9, 10], as well as in strategies aimed at ensuring the protection, restoration and enhancement of ecological-environmental components through the construction of *Green and Blue Infrastructure* [11].

Energy efficiency and ecological transition, climate change adaptation, *smart grids* and mobility have also constituted the growth-supportive thematic objectives for 2020-2027 within the European Cohesion *Policies* (ERDF, ESF+, Cohesion Fund and EMFF), aimed at a smarter Europe, through innovative economic transformations; greener and low-carbon; more connected, through mobility and regional connectivity; more social, through the implementation of the European Pillar of Social Rights; and closer to citizens, through sustainable and integrated development of urban, rural and coastal areas through local initiatives.

In this, fully grasping the sense of the guidelines sanctioned by the United Nations with the identification of the 17 "*Sustainable Development Goals"* (SDGs), within the "*2030 Agenda for Sustainable Development"*, adopted by the Member States in 2015, and in particular the need to "*make cities and human settlements inclusive, safe, resilient and sustainable*" (SDG no. 11), through the experimentation of forms of innovation for the improvement of the living conditions of citizens and for the cultural, economic and social growth of communities, consistent with the goal of "*protecting, restoring and promoting the sustainable use of terrestrial ecosystems, sustainably managing forests, combating desertification, halting land wastage and halting biodiversity loss*" (SDG No. 15), including through the adoption of "*urgent measures to combat climate change and its impacts*" (SDG No. 13).

More recently, urban regeneration and related issues have found further operational references and specific funding channels in the *European Green New Deal* [12], the EU's main growth strategy aimed at the transition to a sustainable economic model that will make Europe the first climate-neutral continent by 2050, in the *Just Transition Fund* [13], aimed at providing support to territories facing serious socio-economic challenges resulting from the transition to climate neutrality, and in the new EU programming *2021/2027 Horizon Europe* [14], which introduces, as a core principle, the need for change in the EU economy and society to reduce environmental degradation and risk, halt and reverse the decline of biodiversity and sustainably manage key resources while respecting the EU's climate objectives.

In particular, the *Food, Bioeconomy, Natural Resources, Agriculture and Environment Cluster aims* to ensure a balance between environmental, social and economic objectives through actions aimed at: "*restoring ecosystems and biodiversity, sustainably managing natural resources to ensure food security and a clean and healthy environment; make Europe the first circular, climate-neutral and sustainable economy through the transformation of mobility, energy, construction and production systems; create a more resilient, inclusive and democratic European society, prepared and responsive to threats and disasters, addressing inequalities and providing high-quality health care, empowering all citizens to undertake green and digital transitions*". Objectives shared with the *Climate, Energy and Mobility Cluster*, which supports the implementation of the *Paris Agreement* [15] and the *2030 Agenda for Sustainable Development*, within the framework of the European Commission's long-term strategic vision '*A Clean planet for all'* [16] for '*a prosperous, modern, competitive and climate-neutral economy*', emphasising the interdependence between the transition to a neutral economy and the energy and mobility sectors.

At the national level, this integrated vision between territorial government policies and environmental, economic and social policies is operationally reflected in the *National Recovery and Resilience Plan* [17], launched in 2021 in implementation of the European *Next Generation EU* (NGEU) programme. The PNRR is fully consistent with the six pillars of the NGEU and "*amply meets the parameters set by the European regulations on the quotas for 'green' and digital projects", in line with the 'do no significant harm' (*DNSH) *principle* that inspires the NGEU. Moreover, as tangible evidence of the attention paid to the issue of territorial rebalancing, the NRP allocates about 40 per cent of the territorial able resources to the South and contributes operationally to the pursuit of all seven *flagship* projects of the EU's *annual Sustainable Growth Strategy* (*European flagship*).

In particular, the Mission "Green *Revolution and Ecological Transition*" is aimed at achieving "*the green and ecological transition of society and the economy to make the system sustainable and ensure its competitiveness. It includes actions for sustainable agriculture and to improve waste management capacity; investment and research programmes for renewable energy sources; investments for the development of the main industrial sectors of the ecological transition and sustainable mobility. It also envisages actions to improve the efficiency of public and private real estate, and initiatives to combat hydrogeological instability, safeguard and promote territorial biodiversity, and ensure the security of supply and the sustainable management of water resources*.

In this context of reference, as is already the case in the major European capitals, the integrated and inter-scalar strategy of public governance aimed at urban regeneration and territorial rebalancing must

become, therefore, also in Italy, the central axis of a National Urban Agenda and which, for these purposes, must invest all the policies about the government of the territory, from the development policies of the settlement and infrastructure system to those of protection and enhancement of the environmental system and its ecological, landscape, historical, cultural, social and economic values; from local 'territories' policies to national and supranational ones [4].
A strategy, therefore, not only of town planning, referring mainly to the physical part of the city, but of social inclusion and local economic development, which, for these purposes, takes the public city, the set of public components or public use relating to open spaces, green areas, services, mobility, and social housing, as the reference structure [18].
The public city must, therefore, be constituted as the framework of the coherence of the structuring choices of an overall and compensatory process of regeneration of contemporary cities and territories, aimed at the realisation of new urban *welfare* constituted by a tangible and intangible, interactive and integrated 'network of networks' that guarantee capillary territorial protection and endowment [19].

## 2. Urban regeneration and governance of the contemporary city. The ecological-environmental perspective

In the context of European and national policies and programming, the construction of new *urban welfare* requires, therefore, the deployment of a new conception, which, through an experimental approach, characterised by high levels of interdisciplinarity, inter-scalarity, iterativity and integration, acknowledges the new instances of the contemporary city, responding both to the need for an overall vision, capable of interpreting the outcomes and regeneration potential after the urban explosion phase, and to the need for a renewed relationship with planning and design processes.
Integration from which to derive, operationally, a convergence of paradigms, legislative and regulatory apparatuses; programmes; new forms and new contents of instruments; implementation mechanisms; *performance* parameters and indicators; prototyping; levels of governance; to substantiate the notion of urban regeneration, build the public city and realise the new *welfare*, implementing a concrete policy of planning and production of services.
On this objective converge research and experiences conducted at national and international levels that, through concrete experimentation in plans, programmes and projects, have produced new points of view, and practised new approaches, in any case, characterised by the tendency to overcome the logical devices linked to the concepts of *separation* and *opposition* [4].
In this framework, therefore, the elaboration of new perspectives and new theoretical-methodological and operational references appears necessary, which use the physical-territorial dimension as a structural reference, of integration and interaction, grasping *"the direct link between the country's productive and social transformations and the repercussions on the cities and the territory"* [20] and which recover significant relations between understanding and proposal.
Among these, in particular, the contribution emphasises several planning experiences, at the level of vast areas and the local level, conceptually ascribable to an ecological-environmental perspective of urban regeneration, examined in the context of research conducted in various capacities by the authors [21].
These experiences, which show the search for a transcalar continuity of objectives and actions, in the dual strategic and regulatory form of plans *"* [22], take on an operationally decline crucial issues at the heart of EU policies for sustainable development and *climate change*, for the improvement of territorial connectivity and the harmonisation of ecological, landscape and cultural values *"* [23], the promotion of the efficiency of cities from a *smart and green* perspective, concretely pursuing an integration between urban planning and ecology.
With these aims in mind, the plans' forecasts direct urban transformations towards redevelopment and modernisation of the existing city, triggering virtuous processes of environmental regeneration, based on the concepts of *compensation* and *ecological-environmental potential*, linking each intervention to actions to improve the fundamental resources air, water and soil; highlighting the role of environmental components to provide integrated responses to instances of anthropic development and preservation of natural capital, combining morphological, cultural and social redevelopment interventions with actions of an ecological and landscape nature [18].
The interventions are, therefore, aimed at the implementation of new strategies for adaptation and mitigation of the effects of climate change and settlement pressures, which take the form of integrated actions for the reconfiguration of environmental components; the reduction of soil consumption, environmental regeneration, soil renaturalization to the protection and enhancement of biodiversity, through the creation of green infrastructures, hierarchical ecological networks, *green ways*, as real 'regeneration matrices', united by indicators/requirements/standards, including ecosystem services, soil permeability, water management, social inclusion, tree and shrub densities, and the promotion of new environmental values to hydraulic invariance through sustainable stormwater management, water saving and sustainable urban drainage; to the reduction of sealing levels, energy saving and the safety of existing buildings, favouring the formation of an urban environment with high climate adaptation

performance the mitigation of the 'heat island' effect through the reduction of energy used in cooling and heating buildings; the reconversion, adaptation and implementation of sustainable and non-polluting collective mobility systems; the remediation of contaminated soils in brownfield sites; the regeneration of the existing building stock [24].
Starting from these experiences, it is, therefore, possible to outline new theoretical-methodological and operational references for an innovative planning system, able to support urban regeneration strategies according to the specificities of territorial contexts and to pursue, through urban planning instrumentation, actions that have significant effects on mitigation and adaptation to the effects of climate change.
New references that, in a perspective of reform of the national urban planning legislation, allow for integration of the contents and the form of the instruments, responding to that need, already present in the reformist plans of the nineties, of a wide and organic "dilatation" of the field of competence of urban and territorial planning, which comes to involve the ecological-environmental contents, developing a model of urban sustainability centred on the ecological regeneration of the city, hence on the set of actions for the qualitative improvement of environmental resources activated directly by the plan, in the awareness that *"modern urban planning discipline was born rigidly linked to the layout of the city, but progressively it has involved (also by laws) the territory and then the landscape, the environment and today it involves the entire ecosystem*" [25].
Therefore, new references to innovate operationally, paradigms, legislative and regulatory apparatuses; programmes; forms and contents of the instruments; implementation mechanisms, parameters and *performance* indicators; prototypes; levels of governance, as well as practices of the urban plan as a tool for a sustainable and resilient regeneration of contemporary cities and territories, at the supra-municipal, municipal and local scale, to substantiate the notion of urban regeneration, build the public city and realise the new *welfare*, implementing a concrete policy of planning and production of services [26].

## 3. Experimentation and innovation of plans between strategic and regulatory dimensions

In recent years, an increasing number of guidelines and toolkits have been developed to support local governments in assessing the impacts of climate change and identifying effective policies, strategies and tools to respond to risk phenomena [27]. However, despite the undoubtedly significant role of urban planning in the processes of spatial adaptation to climate change [28], concrete experiences incorporating these contents, in some national contexts, are still quite limited. There is, therefore, a large literature concerning the guidelines for climate change adaptation policies, but there is a gap concerning the literature on the outcomes, in operational terms and terms of the transposition of these policies into spatial government instruments.
The dual strategic and regulatory form of the plans, already recalled in paragraph 2, refers, respectively, to the supra-municipal planning level (metropolitan or regional area), which identifies the main strategies for cities adaptive and resilient to climate change, and to the local planning level, which highlights a gradual process of integration of the plan contents, both in terms of implementation of the cognitive framework of territorial vulnerability, with the preparation of management documents that give the consistency of the areas affected by the risk phenomenon, differentiated by level of hazard and in relation to any time horizons analysed (heat islands, floods, flooding phenomena, subsidence, etc.), and in terms of identifying possible mitigation and adaptation project actions on target areas identified by the Plan, from which quantitative and qualitative indicators/requirements/standards can be identified, referring to the measures adopted [29, 30].
Concerning the Italian national context, the *Euro-Mediterranean Centre on Climate Change* Foundation in its 2021 report [31] has drawn up an integrated analysis of the risk related to rising temperatures, heat waves, and urban flooding, aimed at highlighting the expected scenarios for six of the ten Italian metropolitan cities (Bologna, Milan, Naples, Rome, Turin, Venice) through four filters comparing the different territorial realities:

1. *Climate past and future,* in which an analysis is proposed on how the climate of cities might change in the coming decades, also based on the phenomena recorded over the last 30 years in each city;
2. *Climate impacts,* in which changes in the frequency and intensity of temperature and precipitation are analysed about the effects of climate change on the territory;
3. *Risk assessment,* in which a detailed analysis of how each city deals with the assessment of risk from climate change affecting its territory is proposed;
4. *Adaptation Tools,* which offers a summary of the main tools deployed by each city to cope with climate risks.

Starting from the results of this Report, and with particular reference to the contents of the fourth filter "*Adaptation Tools*", the contribution proposes, through the preliminary identification of several criteria, an assessment of the level of effectiveness of policies and planning tools concerning adaptation to climate change in the case study of the city of Bologna. The assessment concerned three levels of

government (Region, Metropolitan City and Municipality) and the respective planning levels and tools (regional, supra-municipal and local) (Tab. 1).
The activity of analysis and critical investigation of the case study was based on the study of the plan tools drawn up by the respective levels of government, the dossiers and reports produced by public administrations and published on institutional websites, and the study of scientific articles and *proceedings* produced on the subject.

| | **The regional level** | | **The supra-municipal level** | **The local level** | |
|---|---|---|---|---|---|
| **Cities** | **Regional Urban Planning Law (LUR)** | **Regional climate change adaptation strategy** | **Supra-municipal level planning** | **Climate Change Adaptation Plan** | **The local level of planning** |
| Bologna | LUR No. 24/2017 | Climate Change Mitigation and Adaptation Strategy (2018) | PTM - Metropolitan Territorial Plan (2021) | Adaptation Plan Municipality of Bologna (2015) | PUG - General Urban Plan (2021) |

**Tab. 1** Planning levels and tools in the Bologna case study

The assessment criteria identified for the regional level relate to the presence or absence of climate change adaptation content within the Regional Urban *Regulatory Framework (Regional Urban Planning Law)* and the possible approval of the Regional Adaptation Strategy (in coherence with the *National Climate Change Adaptation Plan* [32], as a framework for the definition of adaptation goals and actions at the supra-municipal and local level.
The assessment criteria identified for the supra-municipal level, which is the responsibility of the metropolitan city governing body, concern the *consistency of adaptation objectives* contained in planning instruments, understood as objectives of an explicit nature (defined specifically as a response to climate change) or implicit nature (not specifically defined as a response to climate change, but also useful for adaptation).
The assessment criteria identified for the local level, which is the responsibility of the local government body, concern the possible approval of the Adaptation Plan (in coherence with the 2018 *National Climate Change Adaptation Plan*); the *consistency of the adaptation measures* contained in the planning tools(implicit or explicit) the measurability of the expected impacts about the adaptation measures through parameters/indicators/standards for the measurement of the expected impacts about the implementation of the objectives and actions; the *updating of the* Plan's *Territorial Knowledge Framework* about the climate analysis and the identification of territories potentially at risk.
A further criterion for the overall assessment of the effectiveness of adaptation policies and tools concerns the *level of consistency* (full/partial/zero) between the contents of supra-municipal and local-level plans and the regional urban regulatory framework.
The authors believe that the criteria identified for the evaluation of the effectiveness and consistency of planning tools can represent a reference grid for the subjects in charge of the territorial government to assess the strengths and weaknesses of their urban planning tools and, more generally, the level of response to climate change of the governed territories, for a possible process of updating and innovation of the same.

## 4. The case of Bologna

### 4.1 The Regional Level

*The Regional Town Planning Law*
The LUR of the Emilia-Romagna Region no. 24/2017 "*Regional regulation on the protection and use of the territory*" contains explicit references (art. 1 and 21) to the need to combat land consumption and enhance the territory in its environmental and landscape characteristics through ecological and environmental endowments that translate into the reduction of climate-altering emissions responsible for global warming; in the remediation of air and water quality; in the proper management of the water cycle; in the reduction of noise and electromagnetic pollution; in soil permeability; in the ecological rebalancing of the urban environment; in the mitigation of the effects of global warming; in the reduction of seismic, hydrogeological, hydraulic and flooding risks [33].
Article 34 '*Strategy for urban and ecological-environmental quality*' sanctions the need for '[...] *adaptation to climate change, the defence or relocation of built-up areas and infrastructures at risk and the improvement of the healthiness of the urban environment, also thanks to the implementation of environmental and territorial compensation and rebalancing measures and the realisation and enhancement of ecological and environmental endowments* [...]'.
Concerning the '*cognitive framework*' the importance of updating is declared (art. 22) as a constitutive element of the territorial and urban planning tools for an organic representation and evaluation of the state of the territory and of the evolutionary processes that characterise it, with particular attention to

the effects linked to climate change, and as a necessary reference for the definition of the objectives and contents of the plan.

*The Regional* Climate *Change Mitigation and Adaptation Strategy*
The *Climate Change Mitigation and Adaptation Strategy* (D.C.R. 187 of 20.12.2018) identifies fifteen reference sectors, which correspond to the main regional areas of competence and intervention, divided between the physical-biological and the socio-economic sectors, and divides the regional territory into five homogeneous territorial areas concerning which it highlights the risk analysis according to value classes.
The strategy formulates proposals and "suggested actions to complement/adapt existing programming (where possible) or to be introduced in the definition of future sectoral Plan and Programme documents", divided between those "useful for standardisation/planning/incentivisation", "useful for improving emergency management" and "necessary for research and development" [34].

**4.2 The supra-municipal level**
The Metropolitan *Territorial Plan of the Metropolitan City of Bologna* (PTM), approved by DCM no. 16 of 12/05/2021, outlines 5 main strategies that it calls 'challenges' articulated in 10 strategic policy objectives:
Challenge 1: Protect the soil;
Challenge 2: Ensure security (about the effects of the climate crisis and urban metabolism)
Challenge 3: Ensure inclusiveness and liveability (through regeneration processes of the urbanised territory);
Challenge 4: Attract sustainable investment;
Challenge 5: Apennines, Via Emilia and the plains: a single territory
Implicit structural objectives of climate change mitigation and adaptation can be found in some of the Challenges. In particular, Challenge 1 identifies the fight against settlement dispersion through the preservation and protection of natural ecosystems and the reduction of land consumption by a maximum of 3% of the current urbanised land, and Challenge 4 the promotion of attractiveness and accessibility by strengthening and qualifying metropolitan networks and nodes sustainably.
Explicit objectives are instead identified in Challenge 2 and refer to the recovery of usable space for cycling and pedestrian mobility, as well as permeable and vegetated surfaces, reducing (where necessary and possible) the size of the road section; to the transformation of parking areas with re-permeable and vegetated interventions to avoid flooding and reduce 'heat island' phenomena; the creation of 'green and blue infrastructures' including protected areas, wetlands, forests, wooded areas and parks, with an overall review of ecological corridors including uncultivated land and areas that can be reclaimed and renaturalised (the NMCP adopts the objective of increasing the average urban green area per inhabitant by 50% to 45 square metres); the recovery of 'space for the environment', to reduce the number of people living in the city to a minimum of 1,000.); the recovery of the 'space for water', with landscape solutions alternative to the emergency solutions of the lamination basins; the 'territorialisation' of a strategy of local production of energy from renewable sources; the identification of areas subject to different forms of 'risk' (hydrogeological, seismic, due to climate change, pollution from dust, infiltrating substances, noise) to exclude them from possible new urbanisations; incentives for all types of intervention to counter the 'heat island' phenomenon and to favour the absorption of rainwater [35].

**4.3 The Local Level**
*Adaptation Plan Municipality of Bologna*
The plan was created in 2015 thanks to the LIFE+ BLUEAP (*Bologna local urban adaptation plan for a resilient city*) project and analyses vulnerabilities related to three areas:

1. combating heat waves in urban areas;
2. extreme events and hydrogeological risk;
3. combating droughts and water shortages.

In an attempt to limit the rise in temperatures in the urban area during the summer season, an increase in green areas is planned, from large peri-urban parks and street trees to smaller interstitial spaces in more structured urban areas. The Adaptation Plan aims to act and implement green infrastructures that retain water, rather than accelerate its runoff, and enhance the role of natural ecosystems. One of the measures is to make pavements permeable and to encourage rainwater storage through green roofs or the creation of storage volumes and to encourage the reduction of sealing. The Plan's measures aim to reduce water withdrawals, both by further limiting losses from the distribution network and by reducing consumption, particularly civil and agricultural, and by using alternative water resources and recovering rainwater for non-drinking uses.
The Plan was drawn up through a participatory process involving public and private bodies, businesses and citizens and includes several challenges, for each of which objectives and actions are identified to

increase the safety and resilience of the territory, which are fully effective when integrated into municipal planning tools [36,37, 38].

*The General Urban Plan*

The General Urban Plan, approved by DCC No. 342648 of 2021, synthesises the 5 challenges into 3 prevailing 'urban strategies' that constitute the vision of the Plan itself: Resilience and Environment (Fig. 1); Habitability and Inclusion; Attractiveness and Employment.

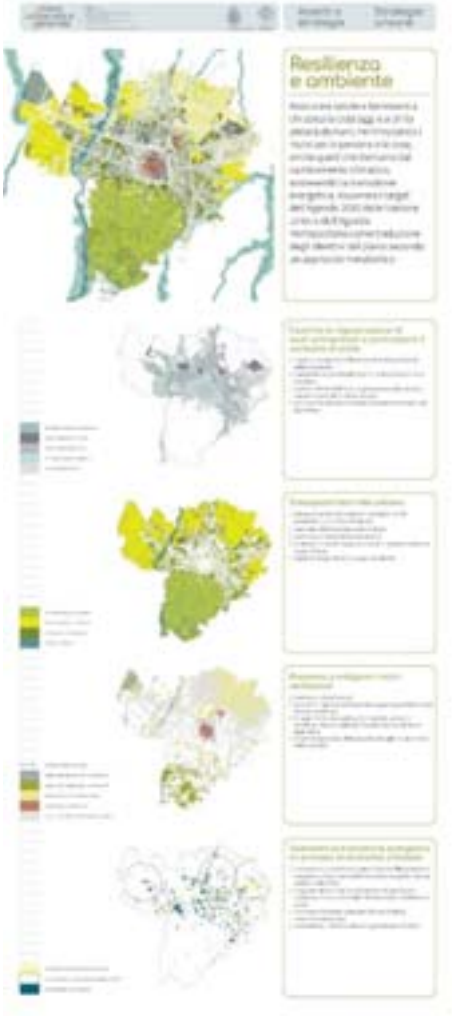


**Fig. 1** Bologna General Urban Plan (2021). Structure and strategies. Urban strategies

In particular, in strategy no. 1, the Plan identifies, in coherence with the contents of the MTCP, implicit and explicit structural objectives and actions to counter territorial fragilities connected to climate change, such as the recovery and efficiency of the existing building stock; interventions for the reuse and urban regeneration of built-up areas and anthropised soils; interventions for the de-sealing and de-paving of soils to recover hydraulic functionality and the function of the ecological corridor; urban blue infrastructure and improvement of the urban tree balance through urban forestation measures at different scales, urban greening; regular water flow in the mouths of canals and ditches and the network for the adduction, distribution and accumulation of rainwater for compatible uses inside or outside buildings; mitigation of the heat island effect in urban areas and the introduction of measures aimed at climate adaptation in buildings.

The urban strategies are then broken down into 24 'Local Strategies' using sheets containing the individual local actions to achieve the strategy (Fig. 2). The local strategies, referring to individual parts of the territory, identify the opportunities and criticalities of the site related to natural and anthropogenic risks and the possibilities for project transformation.

Concerning the territorial cognitive framework, the Plan has elaborated a microclimate map, which identifies a series of microclimate fragilities, based on climate scenarios for the Bologna area elaborated by ARPAE - Emilia-Romagna Climate Observatory, in collaboration with the University of Bologna, Department of Civil, Environmental, Chemical and Materials Engineering (DICAM).

The Plan also identifies significant indicators about the objectives and strategies and their association with a target value to evaluate the Plan's implementation actions and monitor the effects, through annual

updating of the set of indicators that make up the environmental framework, such as the permeable, semi-permeable and impermeable surface area (sq m) indicator; the private and public green surface area (sq m) indicator; the tree balance indicator (number of trees); the surface water quality indicator [39].

**Fig. 2** Bologna General Urban Plan (2021). Draft Local Strategies

The case of Bologna is certainly one of the most interesting in the national panorama, both from the point of view of the explication of 'explicit' climate change adaptation objectives and actions within the supra-municipal and local level instrumentation and in terms of coherence between policies, strategies and planning instruments. The case study highlights the presence of an updated Regional Regulatory Urban Framework concerning climate change adaptation contents and the approval of both the Regional Strategy and the Local Climate Change Adaptation Plan. Moreover, concerning the regulatory dimension, the Local Plan identifies indicators for the measurability and monitoring of the effects of adaptation actions regarding the objectives and strategies and presents the update of the Territorial Knowledge Framework about the vulnerability of territories.
In this sense, it is possible to assess a full consistency between the contents of the regional regulatory apparatus, the contents of the Regional Strategy and Adaptation Plan, the strategic objectives of the supra-municipal planning level and the regulatory guidelines of the Local Plan, adapted and modulated from the regional/supra-municipal to the local scale.

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# Urban vineyards as example of city regeneration

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## Urban vineyards as example of city regeneration

The urban vineyards are an example of city regeneration both in terms of tourism and of the quality of life for citizens, a model which in some Italian and European cities is an integral part of the urban fabric and has always seen in nature the strength to survive. We could dare to define it as a sort of model of urban life that is increasingly sought after and updated, not only in a common vision of well-being, but also as a distinctive feature and tourist driving force. As in the past, the territories of urban agriculture show this desire for a new rurality. The union of a series of small agricultural areas becomes the strategic key for real environmental effects on general quality. In particular, urban vineyards become places of regeneration to be inserted into a complex system with osmotic criteria. Among the many examples, and the new urban vineyards that are spreading throughout Italy, perhaps very few people know that the territory of the Municipality of Naples is in second place in Europe, after Vienna, in terms of the number of hectares devoted to vineyards: Agnano, the Camaldoli, Posillipo, the Vomero, are the areas of the cities that host most of them. The agricultural culture therefore becomes a change of life, towards a different social conception, and a widespread well-being.

**Keywords:** urban vineyards, city regeneration; social conception

## 1. The idea of Urban vineyards[1]

Today the life of more than half of global population is concentrated in urban areas and over the next few years the urbanization process is supposed to expand. In this perspective designers' attention should be focused on avoiding urban life collapse at a certain moment. A new vision is essential with the goal of pursuing adequate urban adaptation processes, in view of sustainable biological and physical natural strategies to be introduced and monitored into built environments.
While urban life changes, communities express the desire to find better places for enjoying everyday moments of profound wellness. The goal is consequently searching for spaces with the appearance of being in a certain sense separated from the town, as this desire is a twofold one: we would like to live in a country and at the same time we want to remain connected to the built environment.
Urban agricultural places could help us in this perspective for their connection to local biodiversity, with a variety of species to be protected and enhanced. Even when urban agriculture territories are confined and small, they express the desire for a new rurality as the union of a series of small agricultural areas becomes the strategic key for real good environmental effects on general quality.
Urban vineyards, particularly, where they remain, are places in which is evident the ancient practice of previous generations and can become places of regeneration to be introduced into a complex system with osmotic criteria. Here, the ancient practice of previous generations is evident connecting them again to the food chain, the environment regeneration, heritage and culture.

[1] Francesca MUZZILLO

The maintenance of urban vineyards is so a topical challenge, as they can help to repair and protect towns, becoming curative elements, as well as a source of refreshment and calmness, promoting the sense of respect for the places where we live.
With this objective, the reference to Pompei is essential, as the orchards and the gardens were there based on an alternation of open spaces, closed volumes and urban connections, with well-done criteria into spatial structure considering also the opportunity of having again into the town processes of natural vegetation life.
Returning to the Roman tradition of compounding rural and urban spaces, we can pursue the dream of creating new set-ups of places based on a real natural ecological balance. The fundamental basis to be considered is an appropriate design, which can give environmental conscious responses not only concerned with technical approaches, but also based on the organization of human societies. It is again a question of culture in a unique stratification of history, architecture, vegetation, in the safeguard of a compounded identity.
Rural strategies and nature-based solutions to be inserted into town governance are at the same time very antique and innovative in order to support decisions in view of a measurable monitorable and efficient design of the living space for the well-being and comfort of users and communities.

## 2. Napoli city as a urban vineyards case study [2]

In our country wine is synonymous of culture, history, tradition, but also of the future; we stay in a world that has endured many changes in recent years - accelerated by the pandemic and an increasingly necessary search for sustainable and innovative solutions - and facing the challenge of climate change, today is fundamental that living in ever greener and more sustainable cities cannot and must not remain a utopia.
More and more realities have challenged themselves to create this synergistic relationship between urban space and nature, not only through the cultivation of vertical gardens and urban vegetable gardens, but often also through the creation of real metropolitan vineyards.
In this context, even if it may seem singular, from a certain point of view the city of Naples was avant-garde, as much as it ranked second in Europe after Vienna, for the number of hectares of vineyards. This splendid Neapolitan reality has always maintained throughout its evolutionary history an unusual connection between city and countryside.
If we review the Tavola Strozzi (Fig. 1), by the painter Francesco Rosselli, dating back to 1470, the Vomero hill catches the eye, immortalized together with the entire city; it is an area that saw its first urbanization only towards the second half of the 1600s. In fact, as is evident from the painting, these were places that had always been entirely dedicated to grazing and cultivation. Precisely because of this agricultural vocation, the Neapolitans for centuries called the Vomerese area 'a hill of broccoli' (‘a collina de’ broccoli).

**Fig. 1: Tavola Strozzi by the painter Francesco Rosselli**

The rustic landscape and the tranquility of the countryside struck the nobles to such an extent that they decided to establish their summer residences in Vomero. This habit then expanded in the eighteenth century, when the construction of Via Salvator Rosa allowed mobility between the center and Vomero.
It follows the confirmation, in settlement terms, of a strongly system characterized by the close dialectic that is established between center and structure within a unitary logic motivated by predominantly productive purposes; that is, between the discontinuity of the rural and urban nucleuses dispersed throughout the territory – some of which are of considerable size and endowed with wide margins of autonomy – and the order of the agricultural land which constituted their main economic resource and source of livelihood. Furthermore, in this phase, some internal

[2] Fosca TORTORELLI

demarcation lines between sub-regions of the plains consolidate which, despite the substantial homogeneity of their characteristics, showed, by location, formation and history. different vocations of belonging.
Starting from the 17th century, orchards, vineyards and the trade in these products and their derivatives constituted an economic asset that was often used to improve fields, or to embellish and enlarge residences. The growth of the place was regulated by the production cycles of the land and the production was unlikely to exceed the needs of the villagers.
The awareness of how close the commitment was between agriculture and the characteristics of the soil was a great conquest for Neapolitan agriculture, which reorganized itself according to its environmental vocations. In fact, it was only in the 19th century that tree cultivation spread to Naples, becoming the cornerstones of Neapolitan agriculture, thus making the most of dry lands, unsuitable for vegetables which were instead grown in more fertile and humid areas. Thus, it was that the tree crops began to characterize the hilly area, and the suburban perimeter, modifying the original appearance of the city, while to the east, on the irrigated land, the vegetable gardens extended. The new Neapolitan agriculture changed the methods of production and the products.
The countryside, which has now become an expanse of open fields, was used for cultivation, even if in a fragmented way and with very modest productivity indexes. This happened because the populations, having abandoned the plains for the safer hilly areas, cannot devote themselves to crops that require constant care and a continuous presence on site. The only cultivation that was not abandoned was that of the vine, the regular succession of vineyards must have been one of the rare constant elements in the life of the agricultural landscape in the early Middle Ages.
Agnano, Camaldoli, Posillipo, Vomero, are the areas of the cities that host most of the vineyards in the Neapolitan city. In this case, agricultural culture assumes an important role, as a factor of change that sees a different social conception and widespread well-being. These are heroic producers who with passion not only keep intact an ancient tradition that is not without difficulties, but at the same time become guardians of the environment. Carrying out a metropolitan production presents many difficulties, and yet, it is thanks to their determination that even today we can rediscover its vineyards in one of the most fascinating and evocative cities in the world as treasures to be guarded and protected on a par with the artistic and archaeological ones of which the city is rich.
An example of this is the Vigna Camaldoli (Fig. 2), also known as the Colonel's vineyard, located on the southern slope of the Camaldoli hill, and entirely contained in the municipality of Naples. The vineyard is mainly made up of Piedirosso grapes arranged on several terraces and extends for about 5 hectares, with an altitude between 200 m and 290 m a.s.l., a site that has a tuffaceous matrix (Neapolitan yellow tuff 15,000 - 10,000 years ago).

**Fig. 2: Da sinistra: La vigna urbana dei Camaldoli di Cantina Astroni e la vigna dell' azienda Agnanum**

That luxuriant greenery on the Vomero hill has remained virtually unchanged over the past six centuries, capable of withstanding the brutal aggressions of a overbuilding that nothing would spare.
The same goes for the San Martino vineyard, with its 7 hectares of nature located in the heart of the city, which have been torn away from the neglect of time. Or finally, the Agnano area, where the constant care and manual restoration of the sandy and volcanic soils guarantees a hydrogeological seal. These producers have invested in supporting these precious hidden treasures; places where the visitor manages to re-establish a connection with a very distant past and to understand in a concrete way how important it is to preserve it in order to give the city an opportunity, an experience that should increase the tension for the defense of the environment.
The protection of the unique wine heritage of its kind is not negligible, which especially in the Phlegrean area preserves the type of ungrafted cultivation. without the use of the American vine as a rootstock.
Therefore, the high historical, traditional, cultural and moral value of an element remains, the vineyard, which in theory has always accompanied exclusively peasant realities, but which in the city of Naples seems to be intertwined with the humanity that has crossed it the centuries.

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# Results of Study of Atmosphere Air Pollutions Caused by Automoblie Transport in Urban Conditions on the Example of Togliatti City of Russia

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## Abstract

Automobile transport is one of the main sources of atmosphere air pollutions in conditions of urban territories. The constant increasing of impact of different pollutants from automobile transport to the air quality is presently a serious problem causing serious negative effects for the public health and for environmental state.
New results of study of atmosphere air pollutions in urban conditions are presented on the example of the territory of city district Togliatti. For measurements of atmosphere air pollutions caused by automobile transport the points of transport network with maximal intensity of transport movement were selected. Results of measurements of atmosphere air pollution of urban territory on the basis of average daily concentrations and maximum single concentrations of typical pollutants of automobile transport (carbon monoxide, nitrogen monoxide and dioxide, hydrocarbons, sulfur dioxide etc.) were analyzed. In all points of measurements exceeding values of carbon monoxide were determined.
Methods and approaches of reduction of negative impact of atmosphere air pollutions caused by automobile transport were suggested, including administrative-organizing, technical, urban development etc.

**Keywords:** Automobile transport, atmosphere air, pollution, emissions, estimation

## 1. Introduction

Pollution of atmosphere air presently became one of the most serious problems causing significant negative impact in conditions of urban territories. Automobile transport is one of the main sources of atmosphere air pollutions in conditions of urban territories. The constant increasing of impact of different pollutants from automobile transport to the air quality is presently a serious problem causing serious negative effects for the public health and for environmental state [1-8].
Methods of estimation of atmosphere air pollutants of urban territories are different in different countries and not completely efficient [1, 2, 4, 7].The lack of information about the level of air pollution in towns is making difficult development of efficient measures of pollution reduction. Especially urgent is the problem of the study air quality emissions from motor vehicles [1-8].
In this paper new results of study of atmosphere air pollutions in urban conditions are presented on the example of the territory of city district Togliatti.

## 2. Results of experimental study of atmosphere air pollutions caused by automobile transport in conditions of urban territories

For measurements of atmosphere air pollutions caused by automobile transport the points of transport network of Togliatti city of Russia with maximal intensity of transport movement were selected (table 1).

Table 1 - The results of measurements of average daily concentrations of air pollutants in the urban territory of the city of Togliatti

| The points of transport network of Togliatti city of Russia with maximal intensity of transport movement | | |
|---|---|---|
| № of the part of city territory | Name of the part of city territory in which point of measurements is situated | Coordinates of the measurement point |
| **Avtozavodsky district** | | |
| 12 | Stepan Razin Avenue (Dzerzhinsky street – Primorsky boulevard) | 53°31′17″N (53.52135) 49°17′43″E (49.295294) |
| 22 | Sverdlov Street (Stepan Razin Avenue – Voroshilov street) | 53°31′35″N (53.526521) 49°18′40″E (49.311185) |
| 25 | Avtosrtoiteley Street (Dzerzhinsky street - Sverdlov Street) | 53°32′0″N (53.533415) 49°19′43″E (49.328684) |
| **Central district** | | |
| 45 | Karl Marx street (Molodezhiy boulevard – Lesnaya street) | 53°30′58″N (53.516066) 49°24′30″E (49.40823) |
| 39 | Lenin street (50years of October boulevard – Gorky street) | 53°31′22″N (53.522806) 49°24′51″E (49.414267) |
| 59 | Banykin Street (Ushakov street – Komsomolskaya street) | 53°30′1″N (53.50029) 49°24′53″E (49.414653) |
| **Komsomolsky district** | | |
| 67 | Gromova street (Gromova street – Yaroslavskaya street) | 53°29′10″N (53.48603) 49°28′29″E (49.474804) |
| 71 | Yaroslavskaya street (Gromova street – Kommunisticheskaya street) | 53°28′38″N (53.477194) 49°29′10″E (49.48615) |
| 64 | Matrosova street (Gromova street – Kommunisticheskaya street) | 53°28′36″N (53.476572) 49°28′26″E (49.473987) |

Laboratory instrumental research of air quality based on the average daily concentrations of typical pollutants for motor vehicles (carbon monoxide, nitrogen dioxide, nitrogen oxides, hydrocarbons, sulfur dioxide) at the nodal points of the transport network Togliatti city with a maximum intensity of movement were carried out. The results of instrumental studies of air quality based on daily average concentrations ($C_{a.c.}$) of substances characteristic for motor vehicles (carbon monoxide, nitrogen dioxide, nitrogen oxides, hydrocarbons, sulfur dioxide) at the nodal points of the transport network of the Togliatti city with maximum traffic are presented in Table 2.

The measurements were carried out using a universal portable gas analyzer GANK-4. The feasibility of using the gas analyzer GANK-4 for the study of air environment parameters proves that this device provides automatic periodic or continuous monitoring of the concentration of certain harmful substances in the air with a relatively high degree of accuracy without special tools and pre-sample preparation.

Results of measurements of atmosphere air pollution of urban territory on the basis of average daily concentrations and maximum single concentrations of typical pollutants of automobile transport (carbon monoxide, nitrogen monoxide and dioxide, hydrocarbons, sulfur dioxide etc.) were analyzed. In all points of measurements exceeding values of carbon monoxide were determined.

It is possible to conclude that the air near the city district Togliatti highways with maximum traffic most is highly polluted by carbon monoxide contained in motor vehicle emissions.

Table 2 - The results of measurements of average daily concentrations of air pollutants in the urban territory of the city of Togliatti

| N of points of measurements | Characteristic of point of measurement | The estimated substance | Results of measurements of $C_{a.c.}$ |
|---|---|---|---|
| 1 | Stepan Razin Street | Nitrogen dioxide | 0,5MPC |
| | | Nitrogen oxide | 0,2MPC |

| | | | |
|---|---|---|---|
| | | Sulphur dioxide | 0,1MPC |
| | | Carbon monoxide | 2,9MPC |
| | | Saturated hydrocarbons $C_1$-$C_{10}$ | 13,4 mg/m$^3$ |
| 2 | Sverdlov Street | Nitrogen dioxide | 0,3MPC |
| | | Nitrogen oxide | 0,2MPC |
| | | Sulphur dioxide | 0,2MPC |
| | | Carbon monoxide | 1,9MPC |
| | | Saturated hydrocarbons $C_1$-$C_{10}$ | 10,4 mg/m$^3$ |
| 3 | Avtosrtoiteley Street | Nitrogen dioxide | 0,2MPC |
| | | Nitrogen oxide | 0,2MPC |
| | | Sulphur dioxide | 0,2MPC |
| | | Carbon monoxide | 1,7MPC |
| | | Saturated hydrocarbons $C_1$-$C_{10}$ | 10,1 mg/m$^3$ |
| 4 | Karl Marx Street | Nitrogen dioxide | 0,3MPC |
| | | Nitrogen oxide | 0,2MPC |
| | | Sulphur dioxide | 0,1MPC |
| | | Carbon monoxide | 2,2MPC |
| | | Saturated hydrocarbons $C_1$-$C_{10}$ | 12,8 mg/m$^3$ |
| 5 | Lenin Street | Nitrogen dioxide | 0,3MPC |
| | | Nitrogen oxide | 0,2MPC |
| | | Sulphur dioxide | 0,2MPC |
| | | Carbon monoxide | 1,9MPC |
| | | Saturated hydrocarbons $C_1$-$C_{10}$ | 13,6 mg/m$^3$ |
| 6 | Banykin Street | Nitrogen dioxide | <0,1MPC |
| | | Nitrogen oxide | 0,3MPC |
| | | Sulphur dioxide | <0,1MPC |
| | | Carbon monoxide | 2,0MPC |
| | | Saturated hydrocarbons $C_1$-$C_{10}$ | 14,5 мг/м$^3$ |
| 7 | Gromova Street | Nitrogen dioxide | 0,3MPC |
| | | Nitrogen oxide | 0,2MPC |
| | | Sulphur dioxide | 0,2MPC |
| | | Carbon monoxide | 1,9MPC |
| | | Saturated hydrocarbons $C_1$-$C_{10}$ | 12,1 мг/м$^3$ |
| 8 | Yaroslavskaya Street | Nitrogen dioxide | 0,3MPC |
| | | Nitrogen oxide | 0,3MPC |
| | | Sulphur dioxide | 0,2MPC |
| | | Carbon monoxide | 1,5MPC |
| | | Saturated hydrocarbons $C_1$-$C_{10}$ | 11,8 мг/м$^3$ |
| 9 | Matrosov Street | Nitrogen dioxide | 0,3MPC |
| | | Nitrogen oxide | 0,3MPC |
| | | Sulphur dioxide | 0,2MPC |
| | | Carbon monoxide | 1,6MPC |
| | | Saturated hydrocarbons $C_1$-$C_{10}$ | 10,6 mg/m$^3$ |

## 3. Integral estimation of air pollute on of urban territory of Togliatti city

Integral estimation of air pollution on of urban territory of Togliatti city was also carried out. The most significant impact to the index of danger of Togliatti city are imputing such components of air pollution as nitrogen dioxide, carbon monoxide, formaldehyde. The most dangerous sites in city are North part

of Avtozavodsky district connected with North Industrial unit and zone of the Central district near to the chemical enterprises.
In fig. 1 Integral estimation of air pollute on of urban territory of Togliatti city is shown. Five different kind of the territory were selected: I – Clear; II – Relatively clear («Norm»); III – Polluted («Alarm»); IV – Dirty «Danger»); V – Very dirty («Harmful»).


**Fig. 1**: Integral estimation of air pollute on of urban territory of Togliatti city

| | |
|---|---|
| | I – Clear |
| | II – Relatively clear («Norm») |
| | III – Polluted («Alarm») |
| | IV – Dirty «Danger») |
| | V – Very dirty («Harmful») |

## 4. Methods and approaches of reduction of negative impact of atmosphere air pollutions caused by automobile transport

Methods and approaches of reduction of negative impact of atmosphere air pollutions caused by automobile transport may be subdivided to administrative-organizing, technical, urban development, using road with impoved etc.
Recommendations for the improvement of air quality near to the main sources of air pollution were developed for the conditions of atmospheric air of Togliatti city of Russia.
The author have proposed a number of recommendations, the most important of them are:
- conducting long-line greenery near major highways (on the road sections with high rates of emissions of pollutants);
- creating the conditions to reduce the amount of transit traffic passing through Togliatti city (completion of construction of an interchange on the M5 and the construction of a bridge across the Volga "Togliatti - Klimovka" other construction of bypass roads);
- using of intelligent management system of road traffic flow by setting the video fixation systems, which will optimize traffic, traffic management by means of computer-controlled traffic lights, introduction of information technologies for traffic control which will to use the principle of "green wave" to reduce downtime;

- development of improved gas emissions reduction devices constrictions;
- improvement of monitoring system of air quality of Togliatti city;
- development and reconstruction of the road network of the city;
- systematic raids to control the toxicity of exhaust gases of cars on major highways in all areas of the city;
- speed control of automobile transport on the streets.

## 5. Conclusions

Results of measurements of air pollution in conditions of Togliatti city of Russia were described. For measurements of atmosphere air pollutions caused by automobile transport the points of transport network of Togliatti city of Russia with maximal intensity of transport movement were selected.
Results of measurements of atmosphere air pollution of urban territory on the basis of average daily concentrations and maximum single concentrations of typical pollutants of automobile transport (carbon monoxide, nitrogen monoxide and dioxide, hydrocarbons, sulfur dioxide etc.) were analyzed. In all points of measurements exceeding values of carbon monoxide were determined.
It is possible to conclude that the air near the city district Togliatti highways with maximum traffic most is highly polluted by carbon monoxide contained in motor vehicle emissions.
Recommendations for the improvement of air quality near to the main sources of air pollution caused by automobile transport in conditions of atmospheric air of Togliatti city of Russia were suggested.

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# Development of Classification and Approaches to Monitoring of Negative Impact of Oil Containing Wastes to Humans and to Biosphere

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## Abstract
Oil containing wastes may cause significant negative impact to the human's health and to biosphere especially due to the high toxicity.
Analysis of existing criteria and approaches to classification of oil containing wastes has been carried out. Classification of oil containing waste according to the different classification principles is suggested.
Peculiarities and stages of monitoring of negative impact of oil containing wastesto biosphere are considered. Method of estimation of degree of impact of oil containing wastes as toxicants to the humans and to biosphere is suggested. In comparison with existing methods using of this method is allowing us to carry out complex consideration of the main toxicological values of oil containing wastes as toxicants on the basis of it point-rating ranging.
Biological tests of samples of surface waters of the Kuibyshev reservoir at the place of wastewater discharge into the reservoir for acute and chronic toxicity were carried out.
The results of biological tests of surface water samples are not revealing acute or chronic toxicity, but the period of research was rather short.
Results of work are allowing to carry out more effective and high quality environmental control of toxicity of oil containing wastes and it negative impact to the humans and to biosphere in total.

**Keywords:** Oil-containing wastes, classification, impact, biosphere, monitoring, toxic pollution

## 1. Introduction
Negative impact of oil containing waste to the humans and to the biosphere in total is constantly growing [1, 3-9, 11, 13, 14]. Presently the problem of oil containing waste negative impact may be considered as one of the most important problems taking to account high degree of toxicity.
Oil containing waste may cause complex negative impact to the landscapes of territories, to biosphere and to the human health. Toxic waste of oil-gas industry may cause different negative impact to the humans leading to the damage of cardiovascular and respiratory systems, skin damage, toxicity poisoning and other negative sequences.
Kinds of negative impact of oil gas industry to the human's health and to environment may be subdivided as following.
1. Global changes, variation of conditions of existence of animals and plants.
- dysfunction of exchange in the system “atmosphere-ocean”;
- mutations apparition etc.
2. Pollution of water and grounds by toxic substances:
- chronic pollution by heavy metals (mercury, cadmium, lead, arsenic, zink etc.) presenting in drilling fluids and sludges;

- penetration into the water of oil and oil fractions, high toxins, mutagenic and cancerogenic polyaromatic hydrocarbons and organic acids;
- formation of radioactive sludges by radionuclides penetrating with formation waters.
3. Threat to life activity of living substances:
-death of species;
- the emergence of pathological signs and histological disturbances in organism;
- accumulation of oil hydrocarbons in organs and tissues of plants and animals;
- great loss in the quantity of fish catch;
- decreasing of life period.
4. Destruction of structure of ecosystems:
- total disappearance of some species;
- change of dominating and sub-dominating species;
- degradation of production-destruction processes in ecosystem.
- soil damage during impat of oil contaning waste;
- death of fish etc.
Constant growth of volumes of oil containing waste in result of development of oil and gas fields and increasing of industrial activity of oil production enterprises causes necessity of search of new approaches to classification anf monitoring of negative impact of waste.

## 2. Approaches to classification of oil containing waste

Consideration of existing classifications of waste of enterprises of chemical, oil-chemical and oil extracting industry is allowing to conclude about the efficiency of only such approaches to classification wchich are coherent with technologies of utilization of waste and a rest of extraction and processing of natural raw. In such cases main classification feature (or features) is suitability of waste to processing using certain technology. Usually the boundaries of such suitability are determined by combination of physical, chemical or other properties of waste.
Waste of oil and secondary products of oil processing, as a rule are different complex multycomponent mixtures of substancies having different chemicasl, component, phase structure, physical-mechanical and physical-chemical properties [2, 10, 12, 15]. It explanes the difficulty of development of classification of such kind of waste.
Composition of oil sludges is presented by wide list of ratio of components. Analysis of literature sources about previous investigations of oil containing waste of different regions of Russia is showing that waste materials are chracterised by wide range of composition but are having general tendency of physical-chemical characteristic of layerwise components of storages of oil containing waste.
Oil containing wastes may be subdivided to the following main groups.
1. Wastes of non-reagent treatment of ail containing waste water (e.g. sludge from sludge storages of oil treatment plants);
2. Wastes in result of reagent treatment of ail containing waste water (e.g. sediments generated during treatment of waste water with using of chemical substances);
3. Mixed wastes of difficult separated oil containing materials and fractions;
4. Wastes containing few combustible components;
5. High concentrated wastes of oil products requiring special methods of utilization.
Classsification of oil containing waste according to the different classification features developed by author is given in table 1.

Table 1 - Classification of oil contaning waste according to the different classification features

| **1. According to conditions of formation** |
|---|
| - discharges during cleaning of oil reservoirs;<br>- accidental spills during oil extraction and transportation;<br>- barn oils;<br>- ground oil slugdes;<br>- bottom oil sludges;<br>- oil sludges of reservoir type;<br>- waste from repair;<br>- oil ground;<br>- waste of reagentless processing of oil containing waste water;<br>- waste are generated in result of reagent treatment of oil containing waste waters;<br>- mixed waste of difficult separated oil containing materials (synthetic surfactants, the flotation concentrates etc.);<br>- used lubricants, products of oil tanks cleaning;<br>- bottom waste which are forming on the bottom of different water reservoirs after spill oil;<br>- waste after well drilling; |

| |
|---|
| - waste formed in the process of oil extraction in the processs of cleansing oil;<br>- waste forming during oil storage and transporting in tanks etc. |
| **2. According to aggregate state** |
| - liquid oil contaning waste;<br>- solid and high-viscosity oil containing waste;<br>- ground waste as a product of junctuion of soil and spilled oil;<br>- surplus activated sludge etc. |
| **3. According to physical-chemical prorerties** |
| - physical properties;<br>- chemical composition;<br>- presence of mechanical additives etc. |
| **4. According to the degree of ecological danger** |
| - class of danger of waste;<br>- degree of toxicity of waste;<br>- field of potential ecological impact (soil, water reservoirs, ground waters, spacially protected natural territories etc.). |
| **5. According to the type of technological process of oil sludge formation** |
| - oil sludges are generated during repair of well and accidents with oil pipelines;<br>- oil sludges of oil treatment industry;<br>- oil sludges are generated in the process of washing of pipes in pipe storage etc. |
| **6. According to the methods of processing** |
| **Thermal methods**<br>- Incineration in open storehouses;<br>- burning in ovens of diffrent types and constructions;<br>- thermal drying;<br>- pyrolyse etc.<br>**Physical methods**<br>- gravitational sedimentation;<br>- separation in centrifugal field;<br>- filtering etc.<br>**Physical-chemical methods**<br>- solidification by dispersion with hydrophobic reagents;<br>- neutralization;<br>- oxidation;<br>- electrophysical methods;<br>- flotation;<br>- coagulation;<br>- sorption;<br>- extraction etc.<br>**Biological methods**<br>- treatment by active sludge;<br>- anaerobic fermentation;<br>- biothermal composting;<br>- phytocide etc. |
| **7. According to the possibility of using** |
| - waste to be subject of secondary using;<br>- waste to be subject of disposal;<br>- waste to be subject of destruction (burning etc.). |
| **8. According to the field of application** |
| - obtainment of hydrocarbons;<br>- lubrication of mechanisms of chains;<br>- obtainment of forms during manufacturing of concrete slabs in house-building factories etc.;<br>- using as prophylactic agents for prevention of freezing together of coal and for prevention from wind erosion during it transportation;<br>- burning as oven fuel;<br>- using in production of bricks;<br>- using in production of keramzit;<br>- obtainment of bitumen;<br>- obtainment of sulphur dioxide, ammonium sulphate and high-sulphur coke;<br>- obtainment of paraffin etc. |

## 3. Methods and Results of Estimation and Environmental Monitoring of Toxicity of Oil Containing Waste on the Example of Samara Region

Environmental control of toxicity of oil containing waste is a complex procedure including estimation of sources of toxicity, determination of the most potentially dangerous zones of toxicity of urban territories, selecting of methods of estimation of toxicity, analysis of results of estimation of toxicity, conclusions about the degree of toxicity, and, finally, development and implementation of methods of reduction of negative impact of toxicants.

Toxicity can be measured by its effects on the certain target (e.g. organism, organ, tissue or cell). Because individuals typically have different levels of response to the same dose of a toxin, a population-level measure of toxicity is often used which relates the probabilities of an outcome for a given individual in a population [1, 9, 15]. When such data does not exist, estimates are made by comparison to known similar toxic things, or to similar exposures in similar organisms.

Assessing all aspects of the toxicity of cancer-causing agents oil containing waste involves additional issues since it is not certain if there is a minimal effective dose for carcinogens, or whether the risk is just too small to see. In addition, it is possible that a single cell transformed into a cancer cell is all it takes to develop the full effect.

Biological monitoring is the kind of environmental monitoring allowing to estimate efficiently the degree of the toxicity of different sources. Presently many scientists have carried out research devoted to using biological indicators as test-objects. For example, it is well known that for estimation of quality of water it is using Woodiviss index. For estimation of degree of the toxicity of water medium green protococcus algae Chlorella (*Chlorella vulgaris* Beijer) and craw fishes *Daphnia magna* Straus are often used as test-objects.

Method of estimation of degree of impact of oil containing waste as toxicants to the humans and to biosphere is suggested. In comparison with existing methods using of this method is allowing us to carry out complex consideration of the main toxicological values of oil containing wastes as toxicants on the basis of it point-rating ranging.

The following toxicological characteristics have been taken into consideration:

- poisoning of human body;
- skin-resorptive effect on humans;
- sensitizing effect on humans;
- toxic impact of oil containing waste to the biocenoses and to the components of ecosystems;
- toxic impact of oil containing waste to the agrochemical characteristic of soil;
- the degree of toxicity of substances in oil containing waste (for estimation the substance corresponding to the most high class of danger is selected);
- class of danger of oil containing waste (for determination of class of danger geological testing methods may be used).

In table 2 the scheme of distribution of points (balls) during estimation of degree of impact of oil containing waste as toxicants to the humans and to biosphere is presented.

Table 2 - Distribution of balls during estimation of degree of impact of oil containing waste as toxicants to the humans and to biosphere

| Name of indicator of estimation | Parameter of estimation | Points |
|---|---|---|
| **Poisoning of the human body** | Do not cause of impact | 0 points |
| | Chronic poisoning | 1 point |
| | Acute poisoning | 2 points |
| **Skin-resorptive effect on humans** | Do not cause of impact | 0 points |
| | Causes weak impact | 1 point |
| | Causes irritating impact | 2 points |
| **Sensitizing effect on humans** | Do not cause of impact | 0 points |
| | Causes weak impact | 1 point |
| | Causes irritating impact | 2 points |
| **Toxic impact of oil containing waste to the biocenoses and to the components of ecosystems** | Do not cause of impact | 0 points |
| | Causes weak impact | 1 point |
| | Causes irritating impact | 2 points |
| **Toxic impact of oil containing waste to the agrochemical characteristic of soil** | Do not cause of impact | 0 points |
| | Causes weak impact | 1 point |
| | Causes irritating impact | 2 points |
| **Toxic impact of oil containing waste to the hydrosphere** | Do not cause of impact | 0 points |
| | Causes weak impact | 1 point |
| | Causes irritating impact | 2 points |

| Name of indicator of estimation | Parameter of estimation | Points |
|---|---|---|
| **The degree of toxicity of substances in oil containing waste** | High toxicity | 3 points |
| | Medium toxicity | 2 points |
| | Low toxicity | 1 points |
| | Toxic impact is not determined | 0 point |
| **Class of danger of oil containing waste** (for determination of class of danger geological testing methods may be used) | I class of danger | 4 points |
| | II class of danger | 3 points |
| | III class of danger | 2 points |
| | IV class of danger | 1 point |

Points gradation is distributes as follow: classes of toxicity of substances of oil containing wastes are estimated using 4-point scale, and toxic characteristic of impact to humans – using 2-point scale.
Total rating point is determined by summing up of components of points of estimation. Total rating point has 5 gradations, illustrating the degree of negative influence of oil containing wastes to the humans and to biosphere.

**Fig. 1**: Research ship “Biologist”

Experimental researches were carried out according to the requirements of accredited methods of determination of acute toxicity of probes of surface fresh, ground, drinkable, sewage waters, water

extractions from soil, sewage sediments and wastes in laboratory conditions by variation of optic density of test-culture green protococcus algae Chlorella (*Chlorella vulgaris* Beijer) according to methodic PND F 14.1:2:3:4:10-04 16:1:2:3:3.7-04 and by determination of mortality of craw fishes Daphnia (*Daphnia magna* Straus) according to methodic PND F T 14.1:2:4.12-06, 16.1:2:3:3.9-06.
Biological tests of samples of surface waters of the Kuibyshev reservoir at the place of wastewater discharge into the reservoir for acute and chronic toxicity were carried out. In fig. 1 research ship "Biologist" is shown. As experimental samples 1 $dm^3$ probes of wastes of the water of the Kuibyshev reservoir of the Volga River were investigated.
The results of biological tests of surface water samples are not revealing acute or chronic toxicity, but the period of research was rather short.

## 4. Conclusions

Classification of oil containing waste according to the different classification principles is suggested. Further researches of classification of waste of oil gas industry should involve development and using of new normative-technical base of kinds of oil containing waste and approaches of it estimation, including special gededic surveys and inspections, determination of negative factors, estimation and forecast, prevention and elimination of negative processes during impact to man anf to biosphere. It is necessary to develop in more details a number of necessary parameters and criteria during estimation of negative impact of oil containing waste. For monitoring of land pollution by oily waste it is necessary to use more widely modern methods and technical means of monitoring (including satellite geodesy systems, methods of remote probes, surface express-methods, methods of bioindication, biotesting etc.).
Peculiarity of suggested approach to environmental control of toxicity in comparison with existing methods is complex consideration of the main toxicological values of toxicants (e.g. oily waste) on the basis of it point-rating ranging.
The results of biological tests of surface water samples are not revealing acute or chronic toxicity. Monitoring studies of water bodies, including territories with other anthropogenic sources of pollution, including areas of oil and gas production, should be continued.
Results of work are allowing to carry out more effective and high quality environmental control of toxicity of oil containing waste and it negative impact to the humans and to biosphere in total.

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# ScanToBIM and Digital Twin of architectural heritage: case study on Badia of San Lorenzo, Casamassima in Italy

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Abstract
The current digital survey tools and the implementation of new virtualization methodologies of architectural spaces allow to the discipline of drawing towards new operational paradigms, allowing new semantic approaches and leading to an ever greater federated integration of the model with all the other disciplines involved in the AEC sector. Starting from the analysis of the state of the art of the integrated digital survey techniques available today, in this research a Scan-to-BIM workflow has been tested applied to a historic building, the Badia di San Lorenzo located in Casamassima (BA) in Italy. After analyzing the critical issues that the parametric approach brings with it in virtualization operations, we proceeded with an aerial photogrammetric survey and a terrestrial LIDAR survey, subsequently aligned through the use of targets. This survey was used as a reference for the subsequent BIM semantic modeling phase, identifying a basic LOD for each element, suitable for the representative purposes. Through the use of application plugins, the geometric accuracy of the model account was verified through an analysis of the variance of the 3D surfaces with respect to the surveyed points. Throughout the modeling phase, particular attention was paid to the semantic coherence of the elements, avoiding as much as possible the use of generic components which, by their nature, do not allow for a correct stratigraphic description. This approach is also motivated by the desire to allow maximum recognition of these elements during the eventual conversion to the IFC interchange format, as desired by international Best Practices. Finally, to allow effective use of the digital survey, an interactive, web-based platform has been created, from which to view and query the integrated survey remotely.

**Keywords:** BIM, survey, heritage

Fig. 1: Photographic survey

## 1. From traditional survey to ScanToBIM methodology (R. Parente)

The development and availability of digital surveying technologies, such as LIDAR or terrestrial and aerial photogrammetry, have made possible increasingly accurate surveys of even highly formally complex architectural spaces, freeing the designer from demanding traditional metric analyses that he or she was forced to deal with in the application of direct surveying during the campaign phase, in order to trace irregular forms back to known measurements. (Docci and Maestri, 2008)(Gambardella C. (ed.), 2019). Current LIDAR technologies, used in LaserScanner instruments, are based on the use of instruments capable of emitting laser pulses and calculating the distances to the objects ahead by measuring the return time or return phase of the pulse itself. This measurement, together with the angle of inclination at which the pulse is emitted, constitutes polar coordinates of the individual point detected, traceable to a local Cartesian representation, going to constitute, with the other points, what is called a "point cloud." This technology applied progressively to the interior and exterior of a building makes it possible to create a coherent digital reproduction that follows the morphological trend of the entire object of analysis. Another advantage in using the LaserScanner is the speed with which it can measure several thousand points in a few seconds, even assigning a chromatic value to each of them, thus recreating real "virtual" environments that can be explored, understood and measured easily by the designer. Such drawings, thanks to the integration of different survey sources (e.g. aerial or terrestrial aero-photogrammetric) can lead to a total survey of the artifact, preserving high accuracy and sharpness. (Bolognesi and Garagnani, 2018), (Flood, 2004; Whitehead and Hugenholtz, 2015) To enable a proper and functional integration of laser and photogrammetric technologies, it is essential to design a survey campaign that recognizes and resolves any criticalities inherent to these technologies (e.g., the presence of large glazing, mirrors, impervious atmospheric conditions, etc.). In order to obtain a point cloud that is increasingly functional for the intended purposes, to date, Machine Learning algorithms are also being experimented with that allow for a semi-automatic optimization of the point cloud in functional terms (Marais et al., 2019). In the process of studying a building, the digital survey is followed by the modeling, geometric synthesis phase, which the designer must carry out through 3D authoring and information management tools that also allow the attribution and linking of information parameters of various natures (e.g., geometric, textural, economic, historical, etc.) directly to the solids created, thus forming a semantic link with the individual three-dimensional components that form the model, orienting these forms to their meaning or functionality (Verdoscia et al, 2019) (Gambardella C. (ed.), 2019) This new digital construction process, which goes by the name of BIM (Building Information Modeling) methodology, although designed to manage the entire design life cycle of a building, is also widely used in the analysis and preservation of architectural heritage through the so-called as-build reproduction of existing buildings, applying reverse engineering methods that lead from the digital survey to the modeling of a real "digital twin," in a process that goes by the name of ScanToBIM (Corso Sarmiento et al., 2019b). In the scientific literature, the term HBIM has been adopted to consider the application of BIM methodology to historic buildings, marked by strong stylistic and architectural connotations, with the aim of safeguarding or managing these assets, taking advantage of the semantic and parametric content offered by the BIM approach. (Rocha et al., 2020) . In such a method, as mentioned above, the survey phase conducted with digital instrumentation and methodology, produces huge amounts of spatial information recorded mostly uncritically, through a process that leads to a kind of automatic point decomposition. (Attenni, 2019). Although this leads the planner to less effort in the campaign phase, it leads him or her to have to discern, in the massive survey, the points attributable to the shapes essential for the description of the object of study, through decimation, optimization and discretization activities. These operations must be guided by the objective of identifying the geometric generators and directrices essential, in the subsequent phase within BIM Authoring software, for the consistent creation of three-dimensional solids.

Fig. 2: Point’s cloud of Badia of San Lorenzo

### 1.2 Accuracy, criticality and testing of the HBIM model (R. Tavolare)

Fig. 3: Photographic survey. Detail of the bell gable on the main elevation

The advantage that the digital survey produces, contrasts with the interpretative issues in the development of 3D BIM, imposing considerable effort to the designer in understanding the geometric and functional characteristics of forms, always limited to the generative possibilities of BIM authoring software. (Volk, Stengel and Schultmann, 2014b).
To go over these limitations, some nodal programming functionalities provided in 3D development environments such as Dynamo or Grasshopper can be used, which allow the creation of customised compositional 'rules' that can enable the definition of complex parametric objects. (Capone and Lanzara, 2019).
The geometrization of solids into BIM Authoring environments involves the splitting of shapes into oriented three-dimensional elements, each with its own formal, functional and informational characteristics. The choice of how to break down these geometric entities in a 'hierarchical' way, while preserving their recognisability and meaning, has been addressed by various studies with different methods and approaches.
It becomes clear, therefore, that the 3D modelling process is strongly linked to the realisation specifications of the digital survey it refers to, which must therefore meet resolution and accuracy requirements that are in agreement with the level of geometry-information requirements of modelling, and sufficient to guarantee the recognisability of shapes, significant and informative details according to the required objectives.
This aspect begins to be covered in the international standards that are working on the standardisation of building processes. In these documents, there are various references to the issues of three-dimensional/informative reliability of modelled objects. In UNI-EN-ISO 19650, this parameter is defined as LOIN, while in UNI 11337, it is called LOD (development level). (Fabris, 2019).

Fig. 4: Planimetry points station LIDAR

## 2. The case study: the Badia of San Lorenzo (R. Tavolare)

The Badia of San Lorenzo, located close to the Lama San Giorgio near the SS172 a few kilometres from the town of Casamassima, represents, with the Church of Santa Maria di Monticella and Santa Maria del Soccorso, one of the oldest examples of rural sacred architecture in Casamassima. (Campanella, 2016). Presumably built in the 10th century, today it stands on the oldest nave of the mono-apse building and it is in a good state of preservation. The origin of the building is deduced from some documents stored in the Basilica of St. Nicholas in Bari, in that they quote the year 1078 for the foundation of the Ognissanti di Cuti Abbey, in the territory of Valenzano, also mentioning a small monastery in the Casamassima area, presumably referring to the Badia under study.

As confirmation of this, we find among the stored documents, acts of some donations made by some monks residing in this small monastery in December 1108.

In the 16th century, some work was carried out that altered the church's internal roof, with a barrel vault grafting onto side walls that were specially enlarged in the same period to ensure static purposes.

During the recovery works, the interior of the Badia of San Lorenzo had numerous mural paintings located mainly in the apsidal area and on the adjacent side walls, hidden by layers of whitewash and masonry transformations that had affected the church spaces during the past years. The demolition of the masonry carried out to restore the apse revealed three overlapping pictorial cycles in the apse area and a single cycle on the side walls.

The outermost layer of the fresco depicts the martyrdom of San Lorenzo, with San Sisto Papa, surrounded by flying angels and the Immaculate Virgin, dating from around the 17th century. The study of the building involved an first analysis phase through a preventive photographic campaign and the definition of digital eidotypes that allowed a better formal awareness of the building body and a subsequent more effective design of the indirect survey campaign through the identification of critical issues and morphological characteristics of the context subject of the study. This was performed using an SLR camera with a 15-250mm lens in combination with a 50mm fixed lens, with a stabilised tripod. During the photographic survey campaign, particular attention was given to the documentation of the architectural elements and details that distinguish the object of study in order to provide documentary and geometric support for the subsequent study and processing phases. As can be seen from the

pictures, the church is in a good state of preservation, with some minor environmental degradation, which, however, has left unaltered the Badia's original conformation. The wall face is mainly composed of stone material plastered with white lime. The main prospect, in addition to housing the entrance portal with an annexed prothyrum, has a small bell gable surmounted by a pediment housing a bell with mechanical rope movement. The roof has a double-pitched structure with regular roof tiles. This configuration clearly appears to be the result of a recent reconstruction that replaced an earlier, and hypothetical truss structure during works dating back to around the 16th century. (Campanella, 2016). The interior floor level is slightly below ground level with the presence of two steps giving immediate access to the central nave with its barrel-vaulted roof. The side walls host niches carved into the load-bearing masonry and an opening towards the south side.

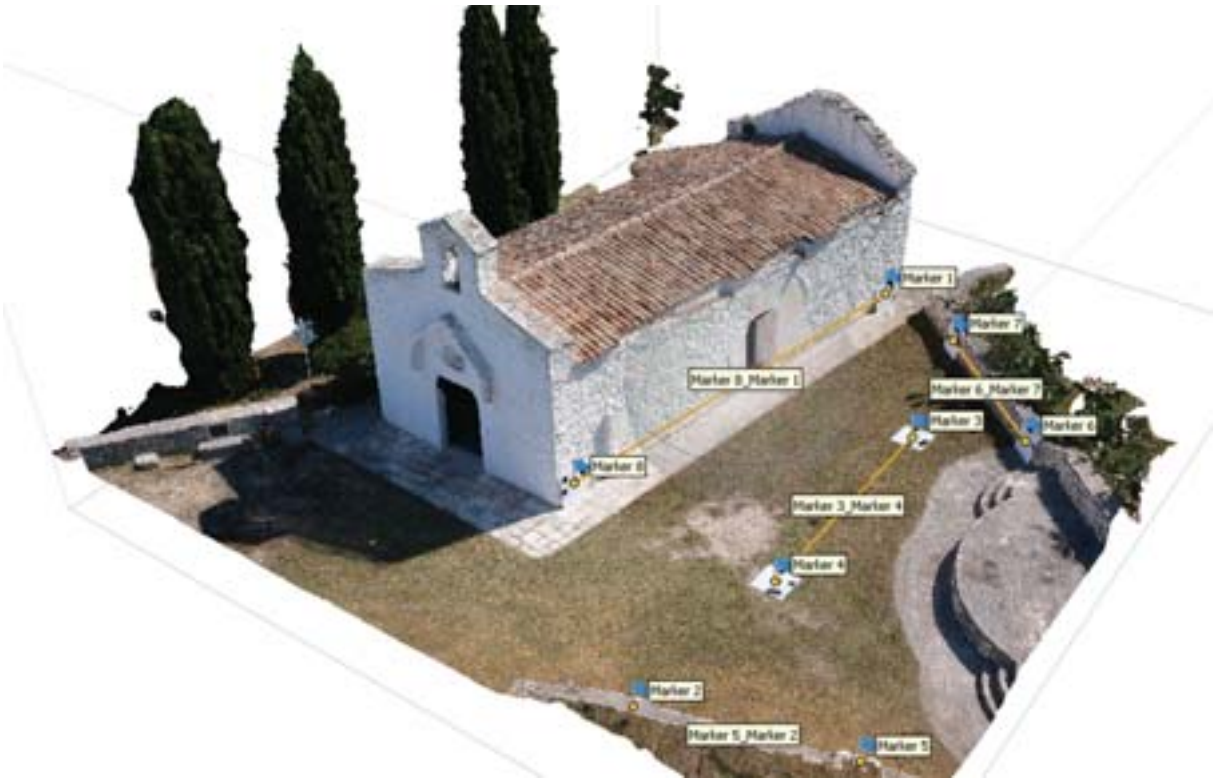


Fig. 5 Cloud of points by fotogrammetry survey

### 2.1 Digital terrestrial and aerial survey campaign (R. Tavolare)

The study of the morphological location of the interior and exterior spaces of the building considered, allowed the design of an integrated survey campaign, using terrestrial LaserScanner instrumentation and aerial photogrammetric methodology. A FARO FOCUS 3D 120 instrument with a tripod was used for the laser survey. The instrument fits into the category of phase-controlled laser scanners and is based on the emission of a laser beam that affects neighbouring obstacles by reflecting towards the instrument. The correct configuration of the digital survey campaign and the related instrumental configuration become fundamental moments for a coherent three-dimensional restitution. For this purpose, it was decided to plan the instrumental stations in advance by studying the environmental occlusions and morphological characteristics contextual to the object of study. Considering the environmental and volumetric configurations of the space under study, configurations were chosen based on the external or internal positioning of the instrument. For the outdoor area, a resolution of approximately 44Mpts was set with a NOHD (axial/radial) of 12.50/4.20 m that allowed a 10m equivalent accuracy of approximately 6 mm. For the internal survey, instead, a resolution ranging from 11 to 28 Mpts was chosen, preferring a redundant overlapping of the surveyed points in order to increase their relative resolution and allow a better formal definition of the small alterations present inside the Badia. In order to allow an accurate merging of the two surveying methodologies, suitably printed 80x80 cm targets were positioned at a known distance, and arranged to allow them to be recorded from both the terrestrial and aerial campaigns. These targets, in the subsequent processing phase, will allow a coherent and accurate alignment and scaling of the two survey campaigns, thus forming a single integrated point cloud. At the same time of the terrestrial survey, an aerial photogrammetric survey was

carried out, using a drone (DJI Spark model with relief kit) through a flight plan consisting of two flyovers: one zenithal, with a regular grid mesh in which 48 photographs were recorded at a resolution of 3968x2976 px and another circular perimeter, at flight altitudes of 7 m and 11 m, with a 45° inclined shot, in which 91 photographs were recorded at a resolution of 3968x2976 px.

Fig. 6 Workflow methodology

### 3. Processing of digital terrestrial survey and aerial photogrammetric survey (R. Parente)

Following the survey phase, the recorded data were processed. The terrestrial laser survey was implemented through the use of Autodesk Recap Pro software, with the loading of the stations carried out and the processing of the alignment phase, which is essential for the union of the individual scans into a single point cloud, by means of the mixed automatic/manual method of homologous points, verifying that the values of overspace, equilibration and points <6mm were within the limits of accuracy and geometric reliability. The processing thus obtained made it possible to constitute an initial point cloud that was perimetered through the deletion of scattered points that were not functional for the representation of the case study. The images recorded with the Drone were processed using Agisoft Metashape software. These uploaded files, in high-quality JPEG format, were implemented by safeguarding the GPS references of the XREF metadata recorded during the flight, which are essential for consistent and more accurate photogrammetric processing. After loading all files, the scattered cloud was processed, assigning a point limit value of 50,000 and the maximum accuracy. These settings, allowed the operations of matching and searching for homologous points among the photographic shots without performing any scaling of the images, thus preserving their graphical quality. During the aerial survey, no occlusive moving objects were recorded and therefore, it was chosen not to apply any masking algorithm to the images. This processing, allowed the spatial resolution of the camera in 3D space by reconstructing the basic alignment of the photogrammetric survey which was consistent with the flight plan planning. Next, markers placed via targets in the spaces in front of the Badia were identified and metric distances measured during the campaign phase were assigned. This operation, allowed geometric scaling of the point cloud for later better integration with the terrestrial laser survey. Next, we moved on to the processing of the so-called dense cloud, setting up a high quality calculation phase and applying a moderate postproduction filter for the detection and elimination of any orphan points with respect to the dense concentration. In order to verify the correct planar coverage of all surfaces constituting the building envelope of the Badia, the three-dimensional mesh was processed by triangulation of the dense cloud with a minimum interpolation setting. The result obtained met the coverage requirements by reporting no geometric anomalies or geometric voids. The cloud thus created was decimated with a step size of 0.5 cm, cleaned up by perimeter deletion of areas not required for completion of the terrestrial survey, and imported within Autodesk Recap Pro software to be merged with the processed cloud from digital terrestrial survey.

This operation was facilitated by the use of the Targets placed during the two survey campaigns and used as fiducial points (markers) for the alignment of the homologous points and thus of the entire clouds. Using Autodesk Recap Pro software, sections were made of the entire point cloud thus processed with the highlighting of points coplanar to the section plane, so as to highlight any planar inconsistencies and the presence of any orphan points. After the two point clouds were merged, a final overall decimation was performed with a 0.5-cm grid and further optimization with elimination and cleanup of elements outside the perimeter, moving elements and instrumental noise.

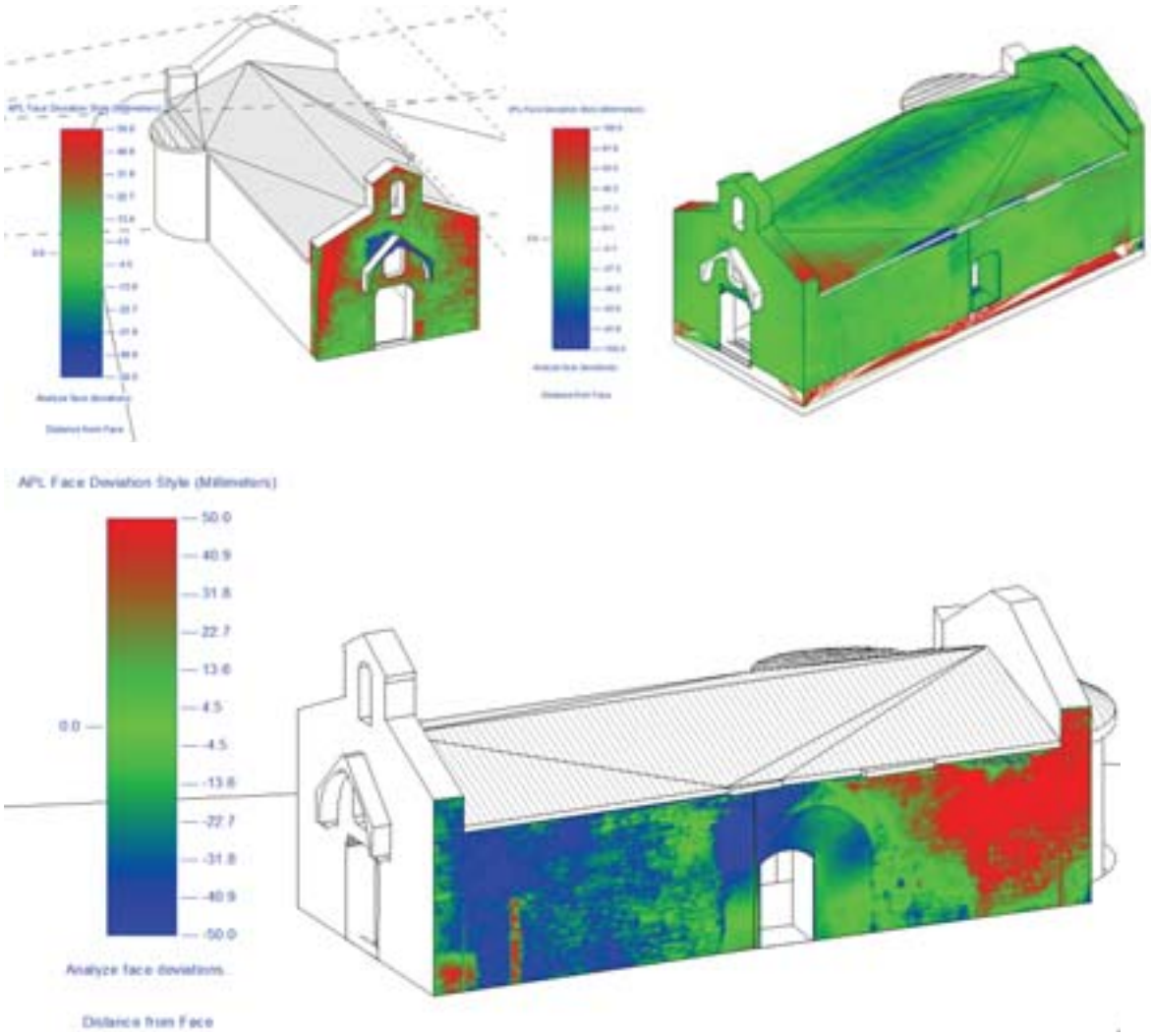


Fig. 7 Deviation analysis

## 4. Processing of digital terrestrial survey campaign and aerial photogrammetric survey (R. Tavolare)

For the HBIM design phase, the Autodesk Revit authoring software was adopted. This development environment, in addition to offering architecture-oriented implementation tools and methodologies, offers full compatibility with digital survey projects in Recap. After customising the template file by customising the metric specifications and the project location, we proceeded with the point cloud import processed in the previous steps. The imported cloud was placed in the project origin and external perspective views orthogonal to the building fronts and a section view on axis with the nave were created. These views allowed the definition of the elevation reference levels of the project to which the respective design views used for the formal definition of the 3D solids refer. To this purpose, it was chosen to define the quota 0.00 at the threshold of the entrance to the Badia. Next, the plan view properties were set to allow a planar section at an elevation of 1.20 metres above level with projection of the points below a range of 10 cm, customising the visibility of the point cloud in monochrome mode to make it easier to read and understand. In order to allow a consistent implementation of the 3D objects, grids and reference planes coinciding with the surveyed wall surfaces were created. These planes will subsequently host the families of objects created. Considering the descriptive and informative purpose of the object of study and the non-regular nature of the structure of the vertical elements, it was decided to adopt modelling with local families customised by means of integrated 3D generators. This choice, although tendentially inadvisable in BIM authoring contexts, if appropriately configured, allows for a coherent three-dimensional genesis of the forms constituting the Badia while offering the possibility of appropriately parameterising the modelled elements by orienting them towards information. For this reason, in this case study, an approach oriented towards the preservation of form, as the stylistic language identifying the work was chosen, linking through appropriate design parameters these forms

to real digital twins made up of three-dimensional meshes processed directly from the surveyed point clouds. In this way, the designer as well as the user of the BIM model will be able to select the visualisation mode of the modelled components by alternating parametric geometries with three-dimensional meshes. Having then identified the generatrices of the volumes, constituting the perimeter walls of the Badia through the use of model lines (choice made in order to make these references reusable later for the processing of the other components), the wall elements were generated as local wall category families. The EAST and WEST elevations are characterised by a wall apparatus elevated above the ridge point of the pitched roof with irregular gables. This imposed a separate modelling using subtraction solids. In particular, with regard to the masonry to the EAST, adjacent to the central apse, the graft of the barrel vault in the nave below also had to be considered in the subtraction. For the central roof and apse generation, it was decided to use the roof system family, integrated into Revit. This choice, in addition to guaranteeing a design semantic homogeneity, will allow a better integration with the information reports generated in the authoring software, allowing possible analyses and metric and/or material calculations useful, among other things, for the building management. The modelling of this element was carried out with the aid of secondary points, measured according to the reference of the point cloud acquired, which allowed an effective point-by-point simulation of the irregular plano-altimetric course of the roof structure. The configuration of the entrance staircase has 3 risers with an average height of 0.14 m and 3 treads with an average depth of 0.33 m; in particular, the first tread is wider than the remaining part of the ramp, obliging the use of the SCALE DRAWING command by identifying the contour and tread polygons that make up the small ramp. For an easier reading of the plan, it was decided to configure a view that dissected the point cloud at a height of 1 m above the interior floor level. Visualisation of the point cloud in normal mode allowed for better planimetric identification of the treads. The elaboration of the building's internal volumes forced a careful geometric analysis in order to identify the most effective directrices and generators for the reproduction of the barrel vault and the niches present. As one can easily imagine, the choice of generative syntax for such geometries must aim to best respond to the representational and informational needs intended to accommodate information. With the help of appropriate section views, the altimetric and planar references were drawn in order to define the relevant overall dimensions. Subsequently, with the help of integrated 3D generation tools, the various local components were modelled. At this stage, it was essential to study the intersections and thus the unions of these geometries with the components already present, in order to standardise these joints and allow a coherent stratigraphic 'fusion'. With regard to the external decorative apparatus, the most appropriate reference planes were identified for the NURBS generation of these geometries, trying to maintain the stylistic recognisability of these elements.

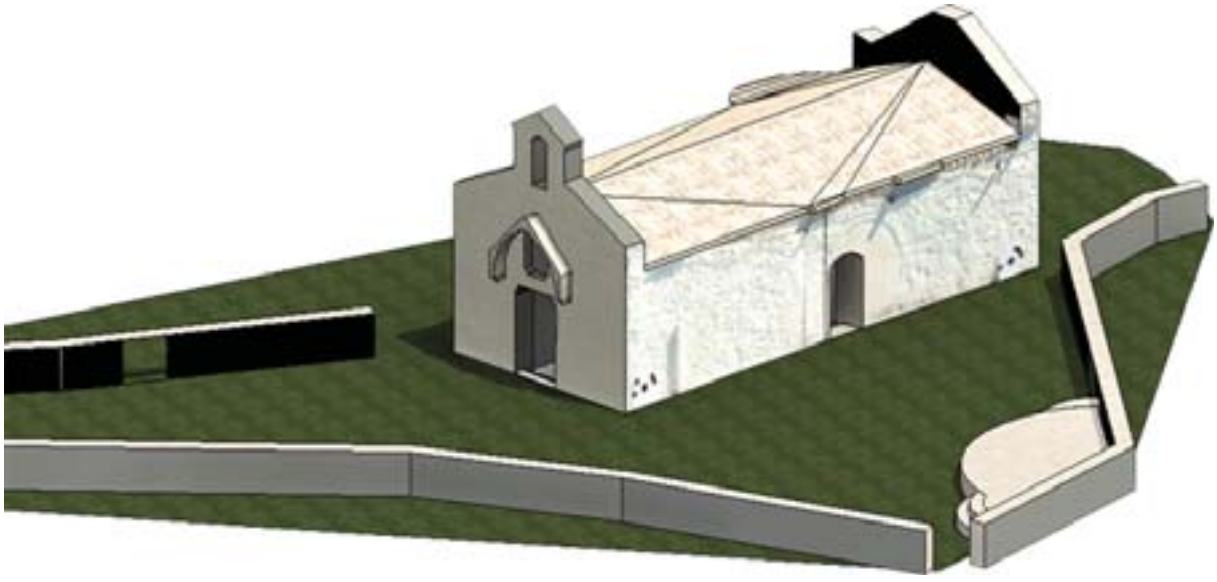

Fig. 8 Building Information Model

## 5. The choice of LOD and the aid of Digital-Twin (R. Parente)

In the Research proposed here, a degree of formal and informational approximation was considered such that it meets the documentary and conservation purposes related to the buildings of our local architectural heritage. As we have seen, in BIM design it is of fundamental importance to refer with the term LOD to the degree of development to which the model to be created must refer (Corso Sarmiento et al., 2019b) (Bloomberg, Burney and Resnick, 2012). The application difficulty that this approach brings concerns the geometric and informational abstraction required to achieve any standards encoded

by various reference standards. By separating the geometric part (LOG) from the informational part (LOI), an object modeled in BIM can in fact be conceptualized specifically according to its intended purpose. In the case study, we chose to adopt a LOG that allows a generic abstraction of elements (cf. LOD B - Standard UNI11337) oriented to the shape, subdividing the three-dimensional elements according to the semantic category they belong to, in order to respect the ontology consistency that can be referred to with any future integrations. Such a form-oriented approach also responds to the common need, especially in HBIM, to encode a model in such a way that it can be interrogated in geometric terms by CAD drawings automatically extrapolated from the BIM environment, or to associate instrumental information with it to support any future rehabilitation and preservation work on the building. The limitation to which this approach may lead is attributable to the specific generative potential related to the software environment used. For example, in this case study, working in the Autodesk Revit authoring environment, it was necessary to approximate the masonry conformation to extrusion nurbs generators, effectively forcing the use of directrices orthogonal to the identified generators, accepting small deviations with respect to construction irregularities or structural degradation phenomena (spalls, out-of-plumb, etc.). Any needs for documentation of such phenomena, however, can also be fulfilled later through information integration associated with the individual modeled elements, using a higher LOI level. An example of such an approach sees the use of graphic texturing support as a visual integration tool, used to represent and document the model in the As-is conformation or fulfill any documentation needs on the state of deterioration present in the structure under consideration.

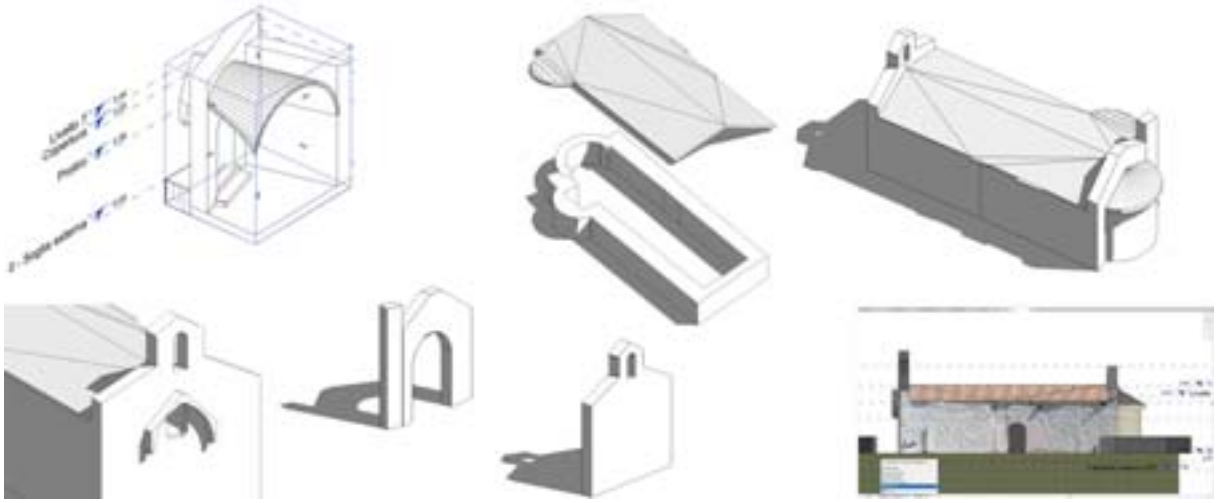

Fig. 9 BIM model implementation steps

### 5.1 The graphic medium in the service of visual documentation (R. Parente)

In the case study, we chose to experiment with such integration by processing and extrapolating orthophotos generated within the Agisoft Metashape photogrammetry software, based on the aero-photogrammetric point cloud generated during the aerial survey phase. After defining the photoplane by identifying markers placed on the side wall of the church, we generated a planar orthomosaic by setting a vertical axis passing through markers point 5 - marker 4 with a resolution per pixel of about 5 mm and exported it in JPEG compressed format. In order to optimize the color configuration of the image, the contrast and RGB contour lines of the image were optimized using photo editing software, while verifying the absence of optical distortion in the image with the help of a support grid to check for falling lines.

The image processed in this way was integrated within Autodesk Revit authoring software, associating it with the graphic properties of the material defined as side masonry painting. Through the geometric measurement of the texture thus processed, the relevant texture parameters were configured, thus matching the UV mapping of the texture to the selected masonry component. The result of such application becomes an effective representative tool that succeeds in simulating the perceptual appearance of the element, offering possibilities for analysis directly within the BIM design environment. In this way, the designer can easily choose the desired representational level arriving at a textural simulation of the masonry face that allows a partial overcoming of the geometric limitations that such environments impose during generation.

### 5.2 Digital-twin in support of fruition (R. Tavolare)

In the event that the level of development requires a higher accuracy than that offered by the modelling tools integrated in the BIM Authoring software, connection parameters to external data sources can be

implemented. In particular, in this case study, it was decided to simulate this need by programming a web-based user platform that would allow the navigation and metric interrogation of the digital survey as an integrative support in the use of the BIM model. For the creation of the utilisation web platform, it was decided to use the open-source environment based on WebGL graphics acceleration called Potree (www.potree.org), which allows the parametric rendering of a point cloud by web, offering measurement tools and interactive sections. If one considers the information dimension that an integrated survey can bring to its processing, it is easy to imagine the difficulties that IT has to face in order to enable interactive use by web. Usually, the interactive representation of a point cloud brings with it difficulties. Some software adopts different implementation strategies, mostly based on a fragmentation of the point cloud based on classifiable voxels, to which a geometric element of simple rendering (such as a circle, a square or a cube) is associated, managing the analysis density dynamically. In these software packages, the resolution and representation mode of the points can be changed by means of appropriate configuration parameters. In the case study, it was decided to include a design parameter linked to the wall elements that leads, by link, to a web connection to the interactive metric consultation environment. Obviously, this approach can be segmented into the respective and appropriate semantic categories required for design purposes, so that individual elements can be parameterised by linking them to extracts of point clouds that can be interrogated and viewed remotely. The use of parameters as a reference to external information resources meets the need required in the BIM environment for open interoperability between model design and use environments. In particular, with respect to the use of open formats such as IFC, these resources will be available to BIM model users, regardless of the authoring environment used.

Fig. 10 Aerial photographic survey

### 5.3 Model verification in the Scan-To-BIM process: application to case study (R. Tavolare)

As already mentioned, the modelling operation leads the operator to a kind of geometric abstraction aimed at reproducing a real environment. In addition to the creation and synthesis operations that the operator is called upon to perform when using BIM methodology, it is essential to introduce geometric verification methods that validate the synthesis operation by analytically reporting the variance from the digital survey. This should be part of the operational paradigms of each expert called upon to apply scan-to-BIM methods, so as to certify the veracity and accuracy of the modelling, based on the LOD/LOG chosen or commissioned. Efforts have long been made to standardise this validation operation by hoping for a method that could describe the degree of accuracy of a model with respect to a survey. (Bonduel *et al.*, 2017; Brumana *et al.*, 2019) The U.S. Institute of Building Documentation has drawn up documentation and certification for model validation assessment in the BIM field, seeking to achieve a shared standardisation called LOA (Level of Accuracy). Although this approach is dependent on the quality of the surveying and point cloud creation phase, it is certainly an excellent basis for the geometric testing of a BIM model, applied both in MACRO (on entire buildings) and MICRO (on individual objects). In fact, it should not be forgotten that the comparison operation performed by the validation software is based on the spatial analysis of the points constituting the digital survey with respect to the surfaces of the modelled solids. Both parts, therefore, are related to the technical instrumental characteristics, the settings and configuration of the survey campaign, and the choices made in the genesis of the three-dimensional forms. This comparison operation can easily reveal the presence of errors or geometric approximations with the help of a colour representation. These elaborations must however be carefully scrutinised by the operators to verify that these highlights are not due to the presence of occlusions within the point cloud or three-dimensional exceptions in the design (consider, for example, that such geometric deficiencies could be attributed to LOD design choices). In this case study, it was decided to use an integrated tool inside the Autodesk Revit authoring environment, in order to retain maximum informational and geometric integrity to the created model. In

particular, the Autodesk Point Layout software in version 2020 was used. As can be seen in the following images, the variance checking operation was performed on some building surfaces by setting an analysis range of ± 20 cm. The processing shows on a chromatic basis the spatial deviation from the modelling surface of the masonry, highlighting the inevitable differences caused by the presence of decay, occlusions and out-of-plumbness of the surveyed masonry. In addition, the images also show the presence of courses marking the wall morphology, which, in BIM modelling, are lost due to the flatness with which the 3D wall component is generated. In order to verify the accuracy of the created three-dimensional model, a variance range of ±10 cm was chosen by monitoring the external vertical infill surfaces and the pitched roof, as shown in the figures. To support this analysis, it is essential to use photographic or other support in which it is possible to study the areas highlighted in the graphs above.

## 6. Conclusions (R. Parente, R. Tavolare)

The research made possible the testing of the peculiarities of the Scan-to-BIM approach in the HBIM environment, following an operational workflow based on an integrated survey (LIDAR and aerial photogrammetry) and highlighting the potential and criticalities that this method brings. The use of this approach allows the designer called upon to virtualise the architectural environment, a valid metric and visual support, indispensable in the three-dimensional creation phase as a reference for the creation of 3D elements. In the HBIM method, the modelling phase must necessarily be based on an understanding of the architectural elements present in order to generate models with a correct semantic configuration, integrated in a digital space congruent with the intended purposeThe use of integrated texturing techniques and information parameterisation, which can also be linked to external or online resources, can solve the operational limits of BIM authoring software, expanding the descriptive potential of a digital architectural model, even in support of disciplines such as the recovery, design or conservation of cultural heritage. In this way, the information federated in the various models and disciplines supports the design team, which can integrate it within its own workflows, guaranteeing an accurate aid for a better understanding of spaces and the state of places.

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# UNRESOLVED PERFECTION

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## Abstract
What is the center in 2023?
I am not afraid, like Hans Sedlmayr of losing the center propelled by the "strong current directed toward the unconscious, the primitive, the primordial, toward darkness and fog, toward what lies beneath us.
Le Corbusier spoke of the total image of the world perceived and understood as a sacred place and source of inspiration; with his work Mundanuem (1929), i.e., World Museum, he represents man undergoing the laws of the city, living in the state and continent through temporary and permanent manifestations of continents, states and cities.
The project Unresolved Perfection aims to represent, through the design of a museum installation, the multitude of facets of society by generating a unidirectional path where the visitor is obliged to walk through all the spaces.
The irregular shape of the floor plan represents the chaos of today's society that is enclosed within a perfect form with the intention of representing irrationality within perfection in such a way as to perform the miracle of the unspeakable space, a true world that is revealed to those in whose right.
The next step is the leap in scale, an urban evolution of the installation, a hallucinogenic and formal civilization capable of transforming the earth into its unconscious satellite. An act of civilization, which is an act of human overpowering nature, is an act against nature, a Hippodamean installation that regulates and manages the space, causing the architectures formed within it, all with functions imagined, dreamed of by those living in today's society, to have a regular layout but with a "chaotic" cover represented by the planimetric layout of the installation lying on the buildings, a chaos dominating over the rigid Greek rule.
The design approach does not want to focus on paths, the important thing is that the user of the space finds himself since the moment this happens the birth of a man is finally realized, and "how beautiful a man when he is a man," said Menander.

**Keywords:** World, Irrationality, Center

### 1 What is the centre?

It is new scenery, all around there are new, brand new and very old centres at the same time. They are the centres of all time of humans. It is nothing but a new humanism, man at the centre of everything, at the centre of all things; at the centre even of that technology that seems so distant from him, from us, man is the greatest technology that has ever existed, he is the one that forever and forever will be.
SAVE HIM!
It is a simple exhortation, an exhortation to save and respect the centre by freeing the soul in the world; this would already be a great revolution, to go back to respecting the world and listening to its voice that has always spoken to us and for so long, perhaps too long, we have not listened to it. I am not afraid, like Hans Sedlmayr of losing the centre pushed by the "strong current directed towards the unconscious, the primitive, the pri- mordial, towards darkness and fog, towards what lies beneath us"[1]. And, therefore, every time we put pen to paper, we wanted to start from scratch, as the search for beauty alone is not enough. Le Corbusier spoke of the total image of the world perceived and understood as a

sacred place and source of inspiration; with his work Mundanuem (1929), i.e. World Museum, he represents man undergoing the laws of the city, living in the state and continent through temporary and permanent manifestations of continents, states and cities.

### 1.2 What is Mundaneum?

What made it possible was the work and vision of the Belgian bibliographer and entrepreneur Paul Otlet, founder of the Mundaneum, a kind of 'universal palace of knowledge'. Otlet's name is unknown to most people today, but at the time it was common to see it next to the names of heads of state and Nobel Prize winners, and who scholars and insiders now consider to be a pioneer of the information age and a forerunner of the contemporary web. "The idea of the world wide web germinated in the mind of Paul Otlet," wrote computer scientist Robert Cailliau, who developed the world wide web. The Mundaneum officially opened its doors in 1920, in the Palais du Cinquantenaire in Brussels. The idea of a 'universal palace of knowledge' was closely linked to the political ideas and internationalist commitment of Otlet and La Fontaine, the latter of whom received, among other things, the Nobel Peace Prize in 1913. The Mundaneum was to be at the centre of a larger 'world city' project in which Brussels was to host the headquarters of the League of Nations. Another Mundaneum headquarters, designed by Le Corbusier, was planned in Geneva. The city, in the intentions of its creators, was to be able to accommodate one million inhabitants. A city of knowledge opened by a gateway marked by two giants. A knowledge centre, an art centre and an Olympic centre were to be built in what was to be called the Avenue des Nations.

**Fig. 1:** Universal Knowledge, Collage by author

### 1.3 Interrogation

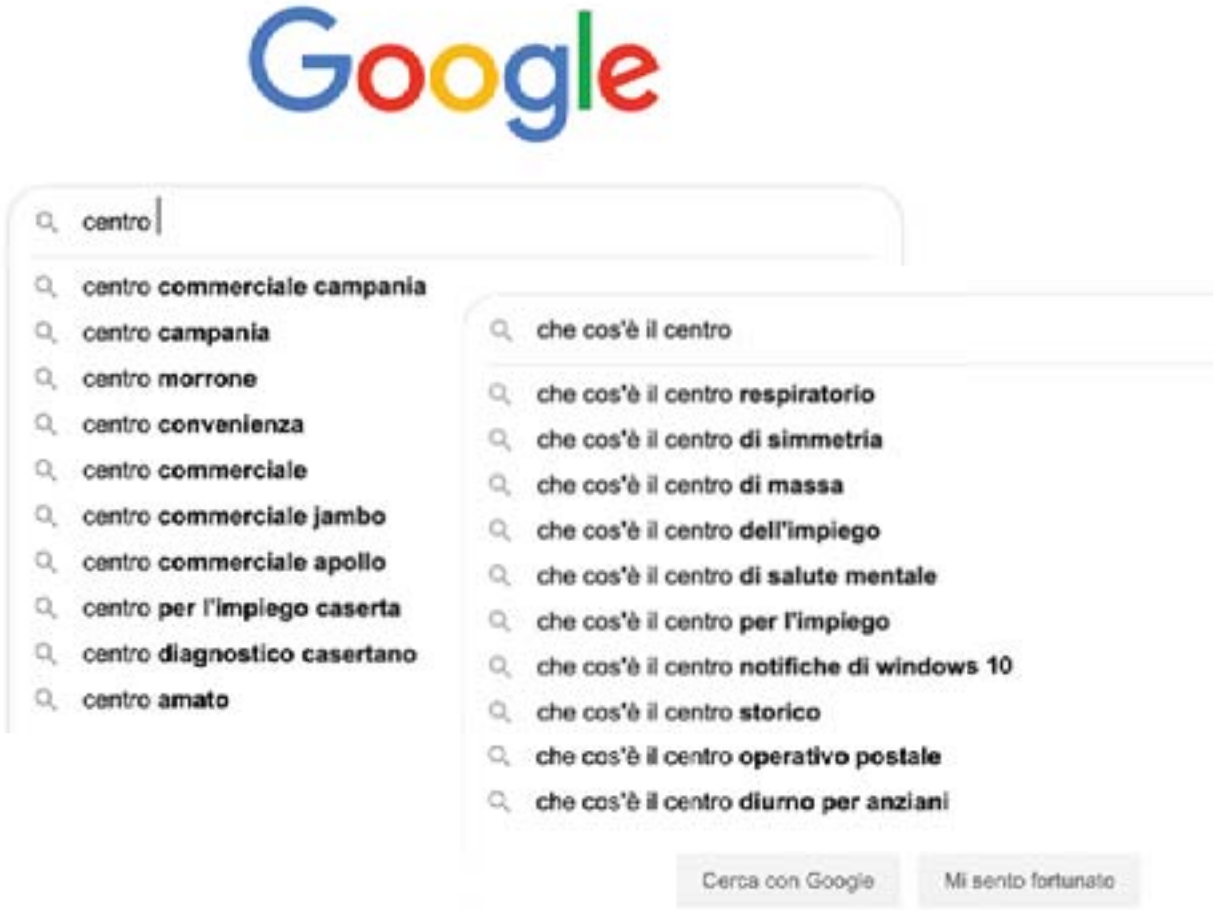


**Fig. 2:** Research Google, collage by author

After having asked Google what the centre was, I thought I would ask people in order to receive more stimuli and a better insight into the concept of the centre, given the lack of relevant answers on the subject. A questionnaire was submitted to 25 male and female people in the 18-52 age group. The test is structured through 'open questions' where people are asked to associate terms, colours and shapes with the concept of the centre. Grids were submitted (such as squares, circles, hexagons and rectangles) where people had the freedom to interpret the theme. This work was then organised into infographics representing the multitude of different opinions with the aim of emphasising the different view of the centre depending on one's point of view.

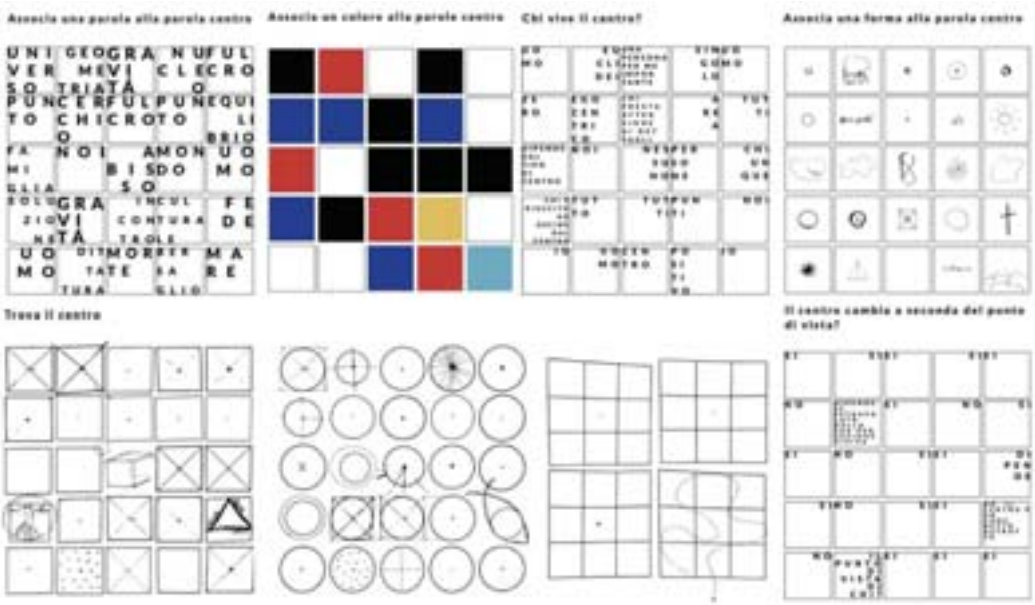

**Fig. 3:** The test, collage by author

## 2 Form builder

Here the idea of origin is then confronted with that of beginning. This word comes from the verb in-ire, thus indicating what moves from within this type of simplicity in the origin itself, expressing itself in a path that possesses its own process value. However, tectonic essentiality is not simply reduced to the expression of the static device but transcends this itself into a conceptualisation of it that transforms it into a three-dimensional diagram. For the more benevolent, this is a formal experiment. Absolutely new forms are always very rare; most of them arise from the evolution of older forms. Such forms are considered pure oddities. Craziness. It is not necessarily the case that an absurd idea is meaningless. As seen in the previous chapter, some have wondered about the representation of the world in an architecture. This process of constructing the form starts with the question:

Who lives in the centre? The people. Where do people live? In cities. Where do cities live? In the world.

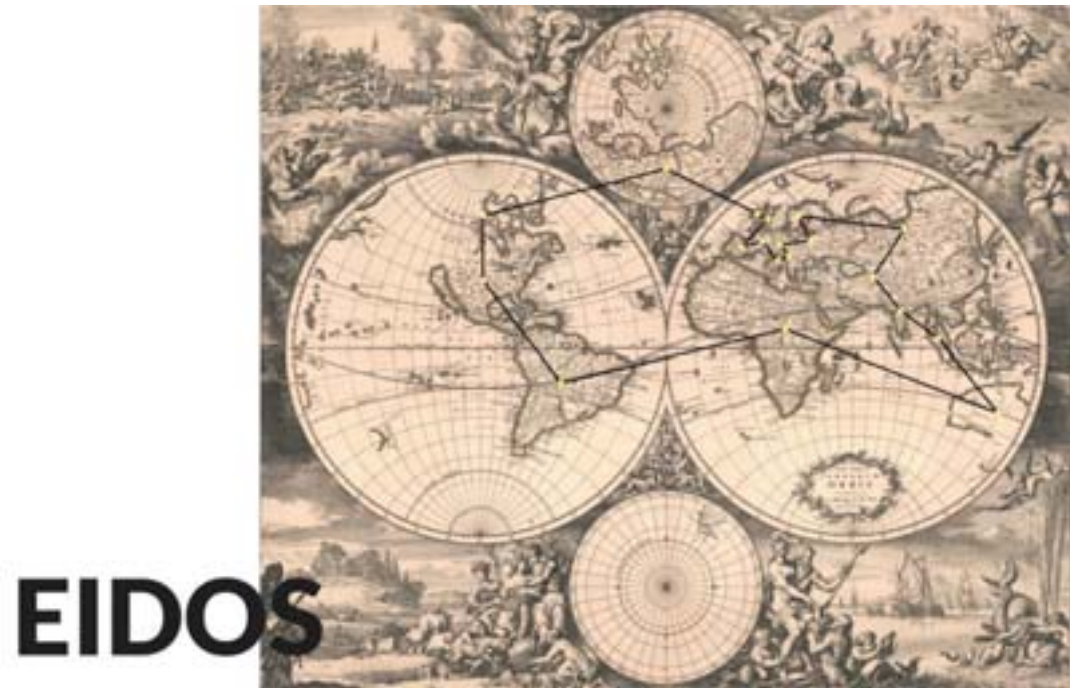


**Fig. 3:** Eidos concept, collage by author

The idea of the project was to locate the centres of the European nations and continents and join them together in order to construct a 'global' form where the multitude of present facets of society generate a unidirectional path, where the visitor is obliged to walk through all the spaces. The chaos of today's society is represented through the irregular shape of the floor plan, enclosed within a shape as perfect as infinity. The intention is to represent the irrationality of society within perfection in such a way as to generate "a true world that is revealed to those who are entitled to it". By delimiting and enclosing the facility with this perfect form while presenting openings to the outside, it defines a system of orientation based on the inside/outside and earth/heaven relationship. This happens because the place needs a boundary. The origin of the place is linked to the archetype of the fence which, in establishing a separation, identifies an inside and an outside that is given the task of rationalising the irrational. Quoting G. Di Domenico (1988) "To make architecture is esseentially to make enclosures. Perhaps the essential meaning of architecture lies in its being an enclosure, in constructing a sphere of controlled space, separating an inside from an outside by means of a wall" [...] "Architecture is to make enclosures; and, by separating the part from the Whole, to recreate the Whole, to make architecture a World."[2] Belonging to the inside is the recognition of identity, while its organisation establishes the modes of orientation through the typological relations of inside-outside, above-below, front-back.

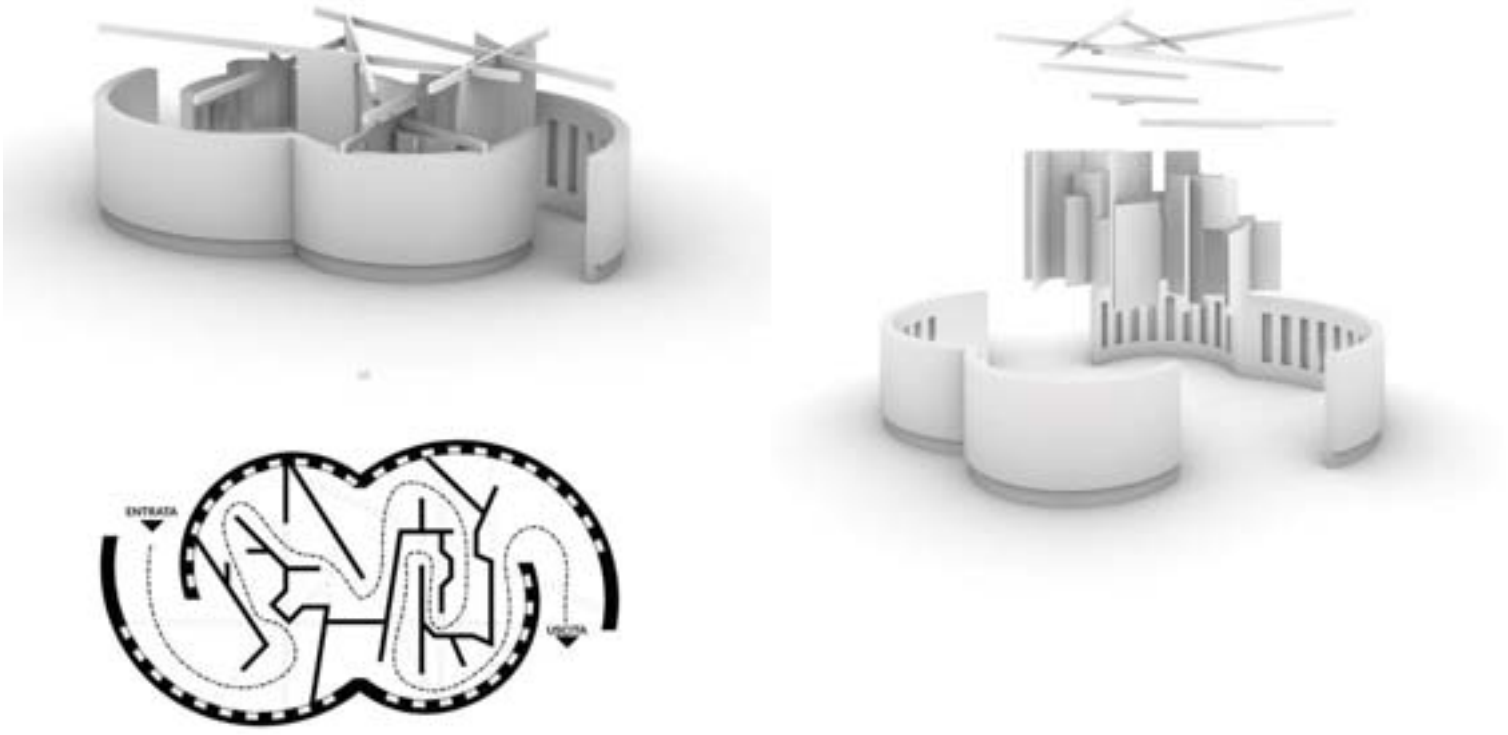


**Fig. 4:** Design, collage by author

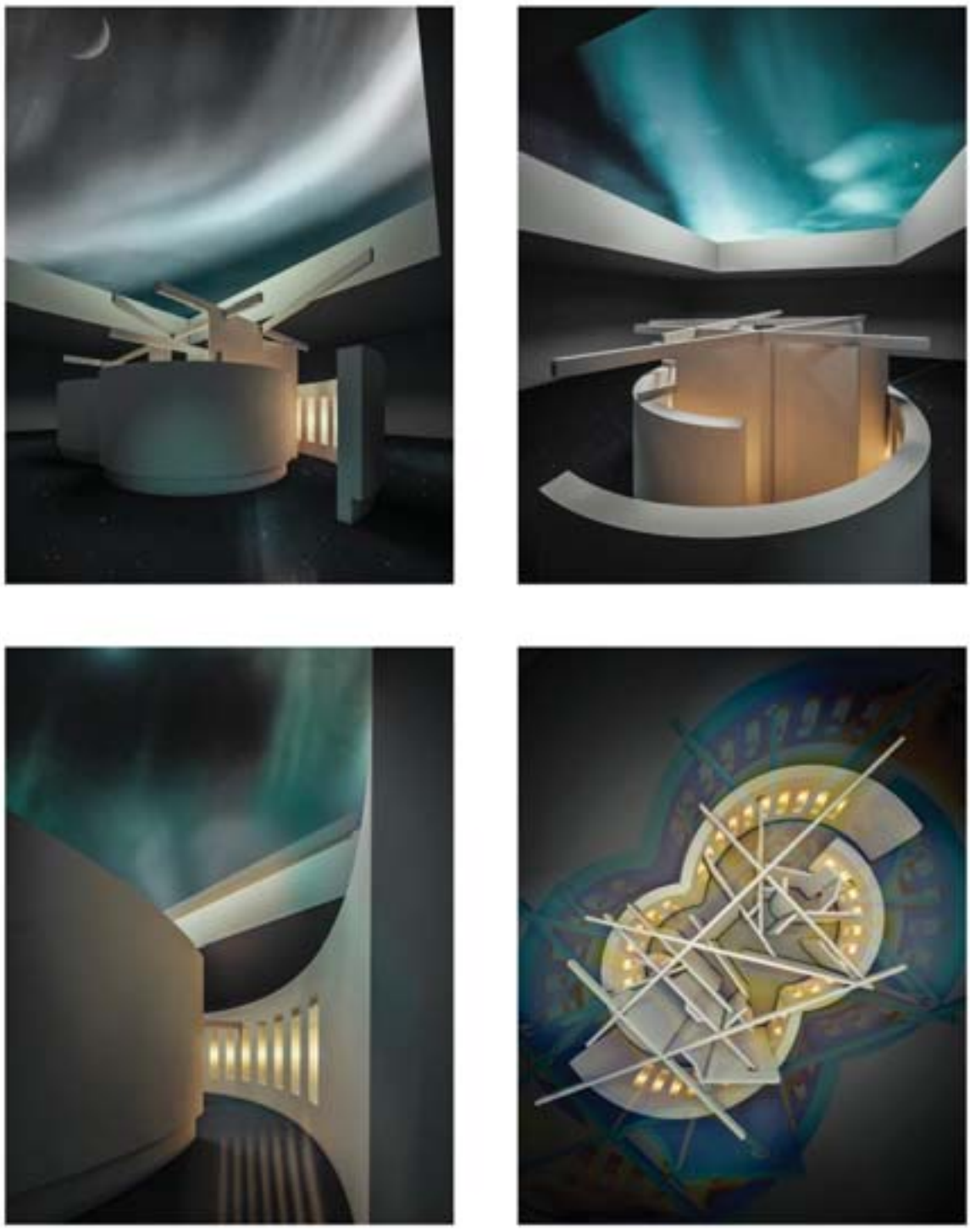

**Fig. 5:** Design Render, image by author

### 3 Figurative psychopharmacopoeia

It is another here, this, everything happens here. It is the place of the possible of the desire of the real. The universe in relation to our gestures, a small movement corresponds to a macroscopic transformation of the entire galaxy.

You, at the centre of this universe.

A city built by people's ideas, a place that demands to be interpreted. A place that does not simply trace the building by automatically re-proposing it in its form but, in a way, redesigns it, reconstructing it not

only in its main elements and characters but introducing a series of inevitable and unexpected changes into them. The functions of the buildings in this city are: a building with workshop spaces, dwellings, a brothel, a church and a prison; these are derived from the answers to the test mentioned earlier. A leap in scale, an urban evolution of the installation, a hallucinogenic and formal civilisation capable of transforming the earth into its unconscious satellite. An act of civilisation, which is an act of human overpowering nature, an act against nature, a Hippodamean installation that regulates and manages space, ensuring that the architectures formed within it, all with imagined functions, dreamed up by those who live in today's society, are controlled and dominated over the rigid Greek rule. The focus is not on paths but rather on the importance of looking within.
If you can find yourself and realise yourself, a man is finally born, and 'how beautiful a man is when he is a man' said Menander.

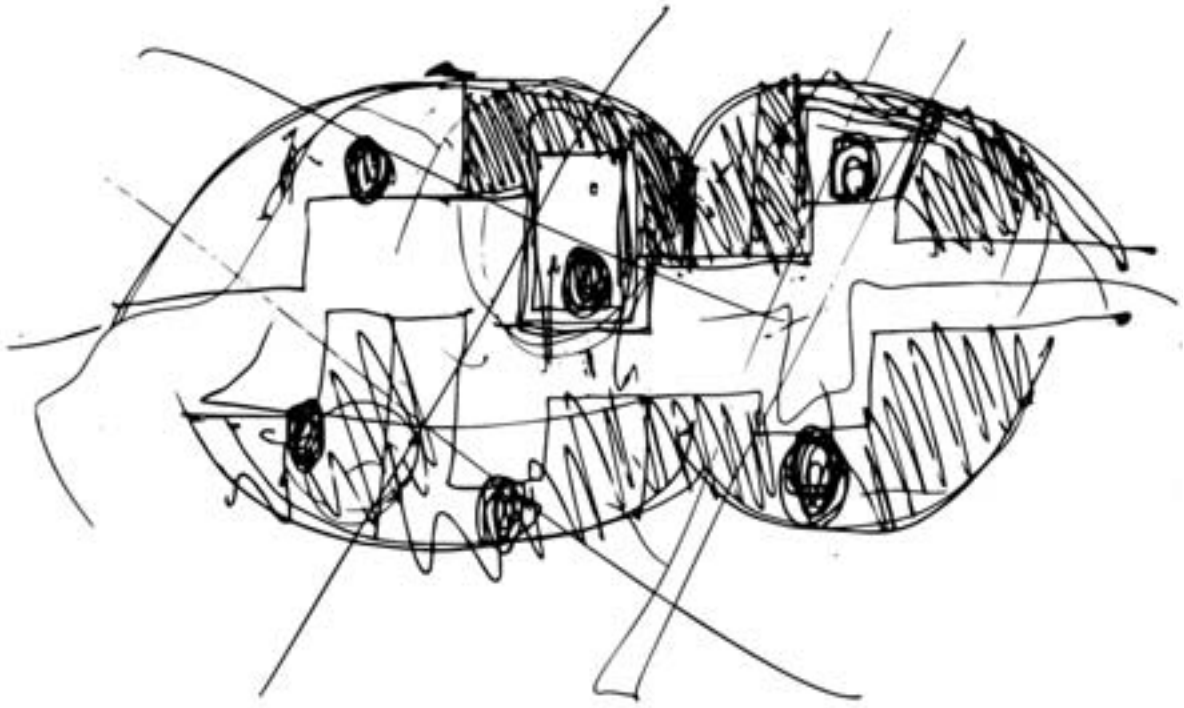

**Fig. 6:** Design Sketch, image by author

## 4 The last dance

The last act is the beauty of the awareness of something that has come to an end. There is a different flavour in the last act if one lives it in the knowledge that it can be as infinite as the first. A utopian experience aimed at representing a critique of a society's subjection to cultural legacies. The desire to lose oneself and not always to find oneself is the filrouge of this architectural odyssey, to be tossed around in a world that now only has the forms of rationalist architecture as regular.
Have we found the centre? Certainly not.
The incredible and at times paradoxical thing is that everyone is obsessed by that centre, by that rewriting of the fundamentals, they are hypnotised in an ambition that is at times incomprehensible because it is substantially devoid of results and unnecessarily burdensome for architecture, cities and landscapes. The demand for architecture always starts at the margins and therefore one must act using images that are understood in the world of an unregulated present, of a present that adapts and transfigures the forms of the past and the contemporary, expressing the maximum energy that can be imagined. I have tried to give you my vision of centre because we could have chosen different conjunctions, different centres, considered the stars and much more. These two experiences want to tell you that architecture is the vision of a theme, and sometimes not necessarily for didactic purposes, but seen as an exercise that stimulates one to find oneself and move others to search for themselves. For the designer must ask himself what it means to make cities and landscapes where one feels good, and above all reveal the secret (almost always unsolicited by anyone) of what is necessary for others to follow his directions in designing a perfect world.

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# NATURE FOR UNDERSTAND THE RESILIENCE'S ARCHITECTURE

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## Abstract

From Mother Nature the lesson of adapting to change, a practice essential to the survival of the species. A vision of the upside down of unused or unusual spaces, examples of imaginary architecture from Italo Calvino and his imaginative cities to the visionary Le Corbusier who anticipated the time of bio-welfare. How Frobel's concept towards educational modes is essential in the spaces of education experienced from an early age and how important it is to raise awareness from an early age to the issue of climate change. The Covid-19 pandemic has taught us to think outside our walls, valuing the small domestic context to the large urban scale that surrounds us. Nature succeeds in adapting to adversity, so man succeeds in living as he would in a dense, expansive mangrove forest, able to change his way of life by crossing different limits, thresholds and conditions just as homo sapiens is destined to survive according to the Darwinian theory of evolution.

**Keywords:** Resilience, Climate Change, Architecture

## 1. The invisible city

There is a glorious city but with a troubled history, it's name is Clarice: the invisible city born from the pen of Italo Calvino. Over the centuries, decay and rebirth of the city, emptied by the force of a cynical mother nature, among the various tests faced even the plague, among other things, Clarice has suffered extensive damage to the architecture, a symbol of a historical past, abandoned to its nefarious future for neglect and lack of a culture of urban maintenance. This city, in its best splendor, was envied by any overseas population, now, the signs of it's best period survive, transformed into new needs, find new life. No one knows how much time has passed since the Corinthian capitals were placed above their columns, now they find a new life as a support for the baskets of chicken coops or the marble urns of funerary origin, they find instead use for planting basil plants.
"A certain number of objects move about in a certain space, now submerged by a quantity of new objects, now wearing out without replacement; the rule is to mix them each time and try again to put them together."[1]
The visionary and writer Italo Calvino, thus conceived one of the many imaginative cities that populated his imagination, not far from our reality, as for Clarice a city with inhabitants capable of adapting to new needs. Here then is the need to address the concept of resilience, as the ability of a system to adapt to change, that is many endogenous elements, even biological, which contribute to the restoration of lost parts. The metaphor of the scar: when we accidentally cut a part of our skin, during the healing of the wound a series of factors take place that make that part of the body more resistant, restoring the lost or damaged cells. Calvino's visionary city does the same, adapting to the needs of life by exploiting what can be salvaged from a city falling apart: the healed wounds of urban survival.

**Fig. 1:** NOVEMBRE Fabio, upside down, design for Illulian, reinterpretation by the author

### 1.2 Covid teaches

Worldwide, it is estimated that the immense mangrove forests in tropical countries cover 150,000km2. Their extraordinary peculiarity allows them to be able to bear and use brackish water of coastal lagoons or survive with sea salt water; an extreme condition difficult to study because their habitat is characterized by the particular cohesion between two apparently conflicting conditions. This contrast, as experienced by mangroves, is often common in our cities that need to have an interface between conditions that are often different between rural and urban, where the excessive anthropization of parts of the city suddenly turns into rural or where services and functions of daily life start to lack without half measures; moreover, in cities the quality of life often relates to population density, which often has a strong impact in a few square kilometers, it is precisely for this reason that we must functionalize every square meter available starting from our four walls.
Thick and wide woody forest constituted from a complex architecture of branches and roots that emerge from the water, particularity that makes of these botanical species aerial and at the same time underwater plants, for these peculiarities they resist to the high tides and to the floods more dangerous for the man so also for the tsunamis, these forest plants are resistant like the seel they adapt to all the conditions of difficulty that the tropical habitat submits them. The mangrove teaches us that the human species of homo sapiens must be able to cross limits, thresholds and different conditions, adapt to survive according to the Darwinian theory of evolution.

The Covid-19 pandemic has taught us so much and among many things to delimit the spaces we have around us. We have perceived the poverty of an exclusively domestic dimension, while it was shelter and how much we have lived of the urban poverty that at the same time had desertified in the city and social proximities, streets, squares, museums, bars desolately empty that ante Covid, we would have seen swarming of people. It would therefore be necessary to improve the condition and the principle of use of the term City, making them more flexible and able to cross different conditions, just like the mangroves teach us, where a museum is also a square or where a library is also a co-working area or why not, where a school is also a public park.
"neighbourhoods that combine advanced technological solutions for the production of energy from renewable sources with a creative redesign of residential spaces and public space, that adopt building typologies and morphologies that allow them to generate more than they consume, to put back together residence and work, to welcome human and biological diversity as a value."[2]

**Fig. 2:** Photo by the author, typical mangrove plantation in sea salt water, Puerto Rico, USA

### 1.2 Biowellness in the Upside Down

From mother nature the teaching of adapting to change, a practice essential to the survival of the species. A vision of the upside down of unused or unusual spaces, one of the many examples of architecture that anticipated the time of biowellness is by the visionary Le Corbusier, who approached the qualification of spaces and functions according to their nature, architecting the cohesion between different sectors but at the same time systematic with each other. The roof-garden or the roof-terrace requires a logical use for living purposes. In general, for a city, roof-gardens mean the redemption of all built-up areas, giving homes an added value in terms of aesthetics and quality of life.

The architect Martha Shwartz, founder in 1990 of the Martha Schwartz Partners studio with offices in Cambridge, Massachusetts and London, United Kingdom, is a visionary woman with a Calvinian sense of lightness. Among her various projects, she is the creator of the Spice Garden on the ninth floor of the Whitehead institute building, a micro-biological research center, albeit in a Pop scenographic key, where the faux vegetation and idealized Zen garden-style design represents a new analysis of Le Corbusier's famous De Bistègui attic. A striking example of an innovative vision of the use of space that the visionary Le Corbusier had anticipated in 1930, in which he instituted in the second point of the five principles of architecture the roof-garden or roof-terrace,
"gives back to man the green, which is not only under the building but also and above all above it." [3]

**Fig. 3:** SCHWARTZ Martha, Whitehead Institute "Splice Garden" 1997, Massachusetts, USA

### 1.2 The Teacher Gardeners

For these principles, it is important that the new generations are properly educated in this field, so that they are empowered from an early age. Children growing up in certain highly anthropized contexts should be taught the concept of inclusiveness where nothing and no one is marginalized, where the idea of space is centered on very open environments, where the border or constraints disappear and where they themselves must discover them as part of the natural environment.
"Kindergarten, the gardens of childhood. The so-called school-garden is the place where childhood, likened to a plant, can grow freely looked after by teacher-gardeners." [4]

Frobel's thinking towards educational methods aimed at producing serenity and functionality in spaces that are experienced as children, such as schools. Garden-schools are places of childhood, where educators had the task of completing the formation in a harmonious way from the physical to the moral and intellectual faculty of the child in close contact with nature. A pivotal and anticipatory principle for the generations to come, because it will be the new generations that one day will have to mitigate the problems that man has created in the past.
"A reappropriation by humanity of the value of a biological continuity that is traceable in its own genetic complexity of being the custodian and bearer of the memory of the past and at the same time of belonging to those who inhabit the future by living in the present." [5]

**Fig. 4:** VO TRONG NGHIA Architects, Farming Kindergarten, Vietnam, 2013

## 2. Conclusions

The awareness of the point of no return! Just think of the clock with 15 digits and 20 meters wide that overlooks Union Square in Manhattan, a work of art installed on 19 September 2020 on the Metronome, between the windows of a skyscraper that has left dismay in the world, the Climate Clock marks a countdown of the time that remains before we enter the irreversible phase of the emergency climate of global warming, but the clock of consciousness also detects the percentage produced of renewable energy of the globe.
A warning, an alarm to wake up from inertia the human being still incredulous that the world may one day become uninhabitable, a countdown that warns of the imminent danger marked in years, days, hours, minutes and seconds.
"the growing awareness of the unsustainability of the city model in the developed world and the obvious socio-economic problems of some parts of the population in this part of the world, has given a strong impetus to urban agriculture movements and interventions in these contexts as well." [6]
In recent years, there has been a growing interest in the intensification of the reuse of spaces dedicated to greenery, such as urban gardens, roof-gardens or vertical gardens, a real re-appropriation of land taken away from nature.

This new way of doing architecture and urban planning makes cities more performant and adaptable over time, cities which, thanks to the concept of resilience and sustainability, make man's vision towards an infinite future and not towards a future marked by a timer indicating the end of it’s history.


**Fig. 6:** GOLAN Gan, BOYD Andrew, the climate clock, Union Square, Manhattan, USA, 2020

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# Byrsa Acropole Unesco heritage site. Reorganization of the Archeological site of Byrsa, Carthage in Tunisi and new wings of the Archeological Museum.

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## Abstract
This essay focus on Contemporary architecture as answer for critical urban and rural places contexts, with a particular effort and attentions of historical or recent ruins sites, and is inserted in *Contemporary Architectural and Urban design relationship with tradition and identity of Places* research carried out by the author. This objective is pursued working on architecture of museum typology, its variation over time, and with both theoretical and operative aspects.
Some of the Places that have been investigated (gathering prize for architectural design or been inserted in specifi exhibition on topics) by the research have as a common condition of post-war sites and some of them have been recognized and protected by UNESCO in the Near East including Aleppo, Baghdad, Bamyian, Kandahar and Mosul; some others have been investigated for the recovery of archeological sites with a special effort on romans' historical archeological site in the mediterran area including Cordoba, Penela and Pompeii.
This essay presents the project for the refurbishment and the complete reorganization of the archeolical site Byrsa Acropole in Tunis (Carthage), UNESCO site and ICOMOS attention site, promoted by an international competition started by Expertise France and Patrimoine3000 and promoted by UIA, during 2022. The process that drove the design team is the core of this essay. Research work have been carried out trying to establish a deep bond with this far away and high emotional Place recognized as cultural heritage context.
That part of the research has been focus on critical redraw of places and its main built architectures, in order to learn and understand natural and anthropic rules and traditions, to discover hidden metrical rules and space declinations, to unearth stratigraphy proportions and traces of landscape identity.

**Keywords:** Memory, Archeological site, Roman architecture, Carthage, Site Specific, Cultural Heritage, Unesco sites.

The requalification project of the UNESCO site of the Acropolis of Byrsa for the refurbishment and the complete reorganization of the archeolical site Byrsa Acropole in Tunis (Carthage), UNESCO site and ICOMOS attention site, promoted by an international competition started by Expertise France and Patrimoine3000 and promoted by UIA, during 2022.
The project here described has been developed by a research group at the University of Florence headed by Riccardo Renzi with Elena Ceccarelli, Gabriele Marinari, Silvia Maria Ripa and with the collaboration of Valentina Marras, Andrea Nicoletta Nicosia, Lucia Paggini, Maria Luisa Pilo and Dania Al Naimee. The proposal was accepted in second round of evaluation by an international jury headed by Alberto Veiga and it is going to be exposed with four panels during a dedicated exposition in Tunis starting from May 13th.
The proposal project starts from a careful reading of the stratification of the different textures existing on the site. For a complete reorganization of the site, demolition interventions are planned on all the valueless buildings present in the area in order to restore legibility to the valuable elements present.

The archaeological remains, the cathedral and the historical part of the seminary are preserved and integrated into new buildings which will accommodate all the new functions leading to a complete revitalization of the place destined to become one of the main cultural centers of the country.
The new buildings respect the existing layouts and alignments and do not interfere with the non-buildable areas of archaeological respect. The seminar building is complemented by a new L-shaped building that completes the layout while respecting the existing alignments and heights. Smaller bodies of a single floor above ground complete the re-functionalization of the space by providing it with the spaces necessary for the new functions. Access to the new cultural center is via UNESCO Square, the perimeter of which has also been redefined thanks to the project for the new monumental staircase and the Antiquarium building. Interventions are planned on the exterior paths to ensure that the materials and finishes harmonize with the landscape context in which they are inserted. The archaeological area is made accessible via a ramp that connects the different levels by integrating the existing paths. The set of open spaces acquires paramount importance thanks to the careful project that provides differentiated places for outdoor activities and a complete reorganization of flows and archaeological and exhibition routes.
The existing vegetation is preserved and integrated, guaranteeing shaded areas along the route. and the accessibility of open spaces also during the summer months. The project attempts to respond to the difficult relationship between contemporary architecture and cultural, historical and landscape heritage while respecting the fragile context in which it is inserted.

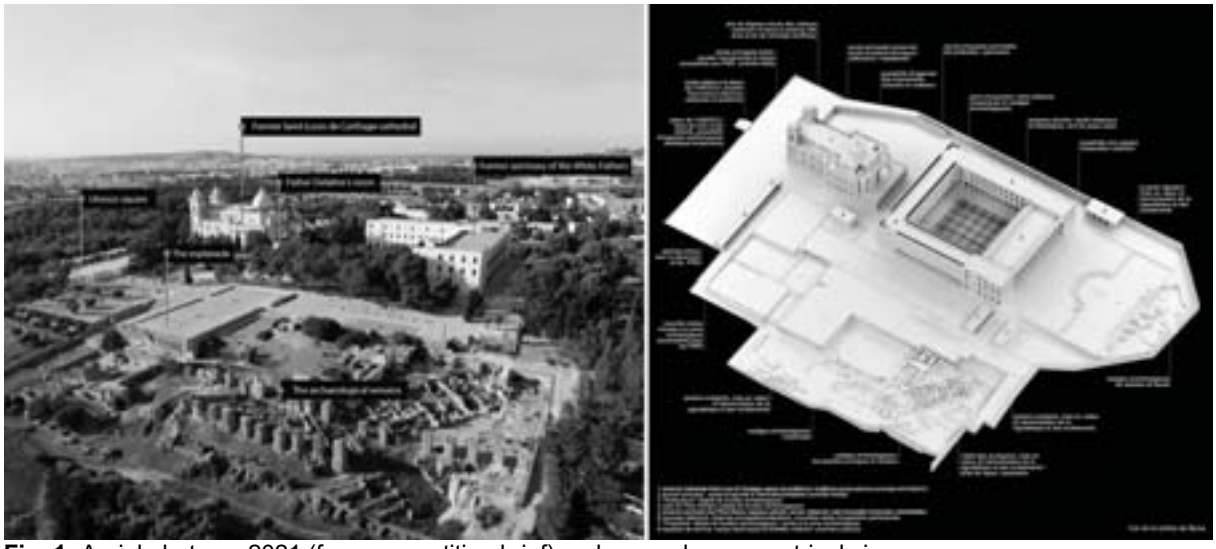

**Fig. 1:** Aerial photo as 2021 (from competition brief) and general axonometrical view

The architectural project provides for the demolition of all buildings without historical value and the construction of new volumes that integrate with the valuable elements present on the site. The cathedral, given the large spaces available, is intended to accommodate the activities of the conference room and the auditorium. The Antiquarium building and the two parallel bodies of the newly built Propylaea, defined by three blind sides and one fully glazed, located at the main access points to the archaeological area, protect and exhibit the most precious archaeological remains, informing visitors visitors on the content of the visit. An extension is planned for the building of the seminar by a building in the form of a bridge which completes the existing device and rests on the ground in only three points.
The section shows how the extension defines a continuous portico to the ground floor on two sides and how the two suspended levels receive natural light from the double band of attic and first floor dormers. The building houses reception areas, exhibition, cultural, conservation and administrative areas, and visitor services spread over 3 levels. The square courtyard is in close relationship with the landscape thanks to the continuous portico on two of the four sides and serves to display the archaeological finds under the glazed floor. The new buildings offer large spaces characterized by great flexibility and adaptability to different future uses. The project uses few materials in order to obtain overall homogeneity and integration into the site: all the facades of the new buildings are delimited by cement panels with local paste aggregates which adopt the colors of the place, while the exterior floors are provided with natural limestone of the place with a light color.

**Fig. 2:** View from UNESCO square and Carthage Cathedral

From the main public access, the Place de l'UNESCO, the visitors can access the former Saint-Louis de Carthage Cathedral, space dedicated to the auditorium and conferences, and by controlled access to the information point/ticket office of the archaeological park and museum. The new building is raised, allowing the passage and crossing of the new exhibition forecourt, and houses two side stairwells serving as service access to the conservation spaces on the first floor, and emergency exits from the storage spaces. 'exposure. The main entrances to the new courtyard are located in the historical building of the seminary, on one side are the entrances to the cultural/pedagogical spaces, the research center and the library, located on the ground floor; on the other, the main entrance to the museum with the visitor reception services.

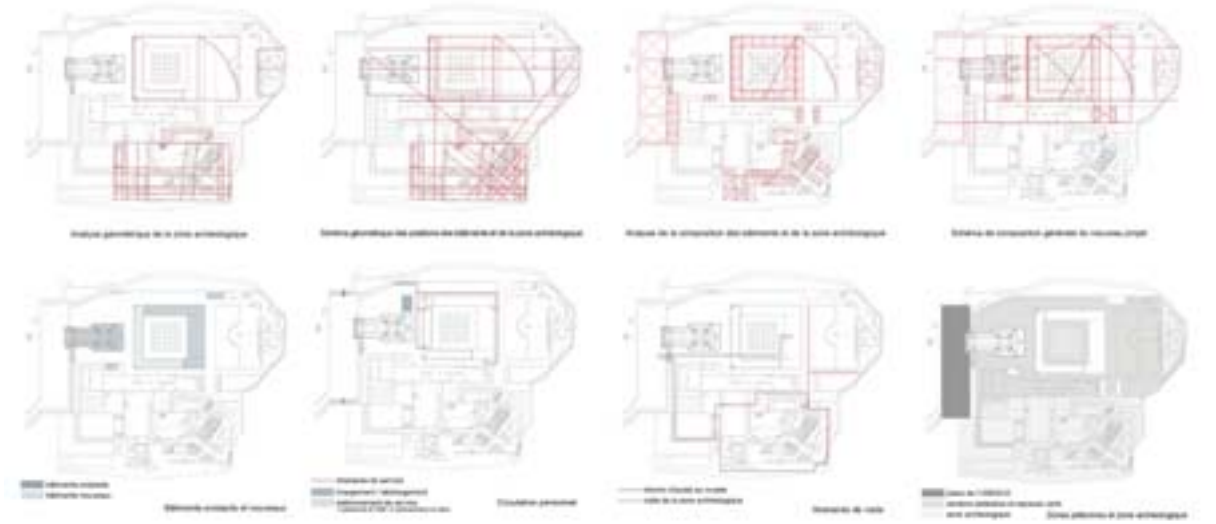

**Fig. 3:** Diagrams, schemes and geometrical rules of general design of the area

These spaces, including the restaurant/shop space, also overlook the archaeological area to the east, so that the restaurant can be independent of the museum space and usable by visitors to the archaeological areas. On the ground floor are the toilets and the stairwells/elevator located laterally, which lead to the first floor where the administrative and management offices are located, and the spaces intended for temporary exhibitions. The route of the permanent exhibition also begins on the first floor, continuing with a fluid route and occupying almost the entire second floor of the building. The new building has the roof accessible to enjoy the panorama of the archaeological area, the city and the coast. The deposit of archaeological excavations is made up of two new buildings called “Antiquarium”, next to the reception/ticket office, and “Propylées”. Both buildings conceptually and physically represent the entrance to the archaeological area. The Père Delattre room and the north building have been preserved and enhanced and house technical services and sanitary facilities/first aid for visitors.

By the cycle path to the northeast, two pedestrian accesses to the north and west (Decumanus Maximus staircase) and one for vehicles to the southwest, it is possible to access the UNESCO Square. Two small parking areas are planned, one for staff and persons with reduced mobility on the south side, and one on the north side where the bus/taxi stop for visitors and a bicycle rack and electric charging station are located. The place is thus free for the organization of temporary artistic events. The archaeological and museum area has two entrances, one service dedicated exclusively to staff and deliveries, located on the north side; and public access from the monumental staircase and ramp, accessible to people with reduced mobility, located next to the entrance to the cathedral. Here is the first reception point with the information point/ticket office (controlled access), from which the two museum routes branch off with the possibility of accessing the museum or the archaeological area. Going along the cathedral, we come to the new museum building which, rising, allows the circular flow of the new square, formed by the existing seminary building and the new building being expanded. To reach the main entrance to the museum and the entrances to the cultural spaces, located in the existing building, you have to cross the new glazed exhibition square.

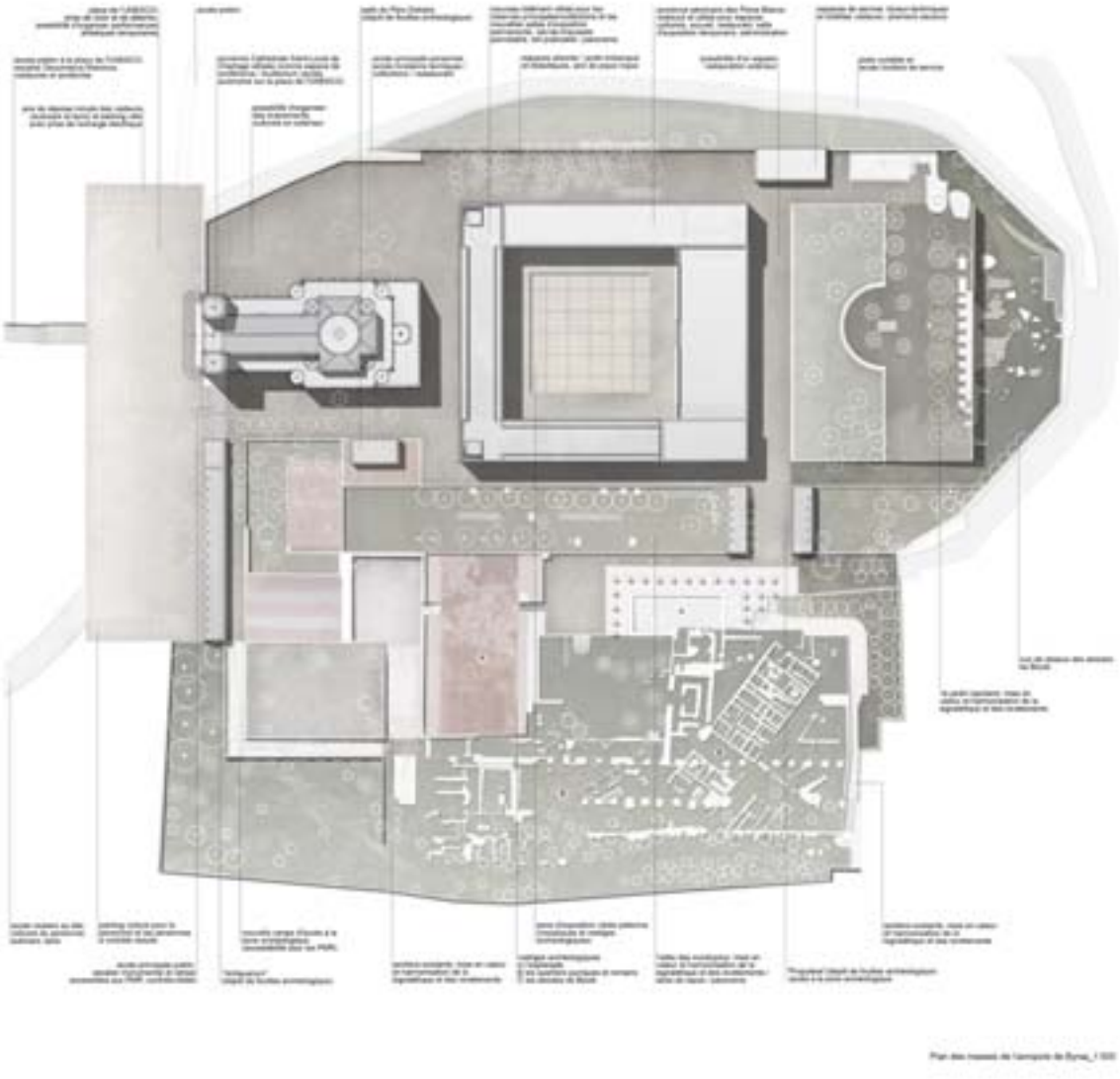

**Fig. 4:** General plan

Access to the archaeological area is on the upper southwest side of the area, after the ticket office and after walking along the “Antiquarium”: the new building that houses the archaeological finds illuminated and visible from the outside . It is possible to reach the archaeological zone B the Punic and Roman quarters to the south, via the new ramp that guarantees its accessibility. Via the existing developed paths, it is also possible to reach the archaeological areas A and C, the esplanade and the apses of Beulé. To the north, the existing building houses technical rooms and toilets that can be used by visitors to the archaeological area. From this side it is also possible to access the restaurant located in the existing building of the seminar, with the possibility of an outdoor area dedicated to catering.

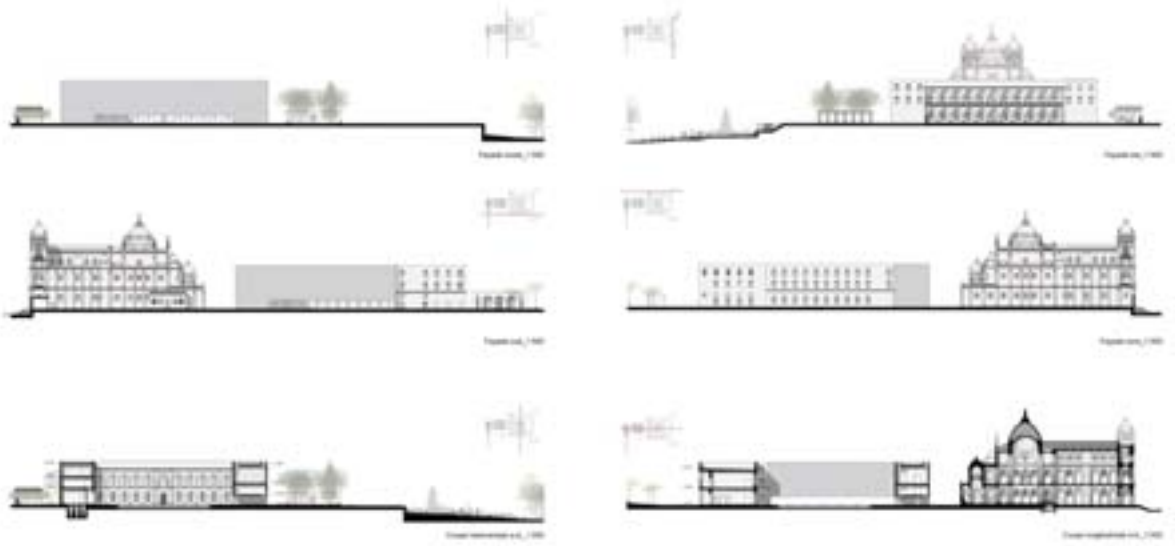

**Fig. 6:** Sections and facades

The structural concept that guides the project proposal starts from two main points. The first sees the consolidation of existing buildings, the second sees the development of new buildings. With regard to existing buildings, the criterion used provides for the reconstruction of new floors, consolidating both the foundations and the walls of the buildings, especially in the corners and in the masonry joints. The new floors of the existing buildings are planned in a lighter and more resistant material, with metal beams, corrugated sheet and reinforced concrete casting. For the consolidation of the foundations, injections of resins are planned and, in case of greater need, interventions with iron trellises, passage elements and concrete castings. As for the masonry, if necessary, cladding elements with reinforced fibers from natural materials are considered.
The new small buildings (reception/ticket office, Antiquarium and Propylaea) have a simple structure with a metal frame and filling with honeycomb blocks, built on a minimal foundation so as not to impact the ground.
The new building that houses the museum is designed as a large bridge structure, with two reinforced concrete blocks (stairwells) serving as supports; the other supports consist of reinforced concrete walls adjoining the existing buildings (workshop). The two suspended galleries of the museum are designed as large continuous metal bridge-beams, inside which are positioned the attics.
The facades of the building (as well as those of the small buildings) are designed in prefabricated blocks of light-coloured composite concrete to take up the facade of the existing seminary. Inside, the walls are still in white plaster and the floors, on the other hand, in a cement finish with a darker colored surface resin. The new flooring of the museum square is planned in light natural colored limestone, in contrast to the glass roof which houses a temporary part of the museum exhibition.

**Fig. 6:** View of new courtyard of Archaeological Museum

The environmental approach that guides the project of the new Archaeological Museum stems from a simple use of resources, both in terms of construction and in terms of building management. The target to which the project must aim is the nZEB, that is to say a system whose minimum consumption tends towards self-sufficiency. In the case of existing buildings, a consolidation of the internal dispersion walls is planned by inserting stiffening panels with an indicative thickness of 14 cm and new plasters; the replacement of luminaires with more performance and also with integrated dimming elements for summer solar radiation. The new building is designed with useful materials to minimize heat loss. HVAC systems are designed with heat recovery units, with storage and integration with the photovoltaic system, they are also designed integrated with the geothermal system for any domestic hot water. The location of the new machines is planned on the (raised) roof of the seminar, out of sight of visitors and isolated from noise and vibrations.
The heating and cooling of the museum and the seminar are provided by mechanized ventilation machines which also guarantee assistance in the evacuation of smoke in the event of a fire, in addition to the fire-fighting system. The recovery of rainwater is also planned for interior hydro-sanitary purposes and for nursery purposes for exterior spaces. All buildings are designed to be managed by a BMS home automation control system to automatically manage temperature settings, lighting systems (indoor/outdoor) integrated with an indoor air humidity control system and the Co2 present to better preserve the exhibited works and the quality of the indoor environment for visitors and workers.
The proposed museographic layout shifts its design concept from the desire to create a dynamic and fluid space, in which the user can freely choose his visit experience. The first approach to the setting takes place on arrival, where the large central courtyard is designed as a first encounter with history and it is curiosity that guides the user to explore the space and what he tells. The archaeological remains are in fact placed under a large skylight that the visitor can cross freely when reaching the entrance. In addition, the centrality of the courtyard, around which the verticality of the building develops, offers the possibility of observing the archaeological remains even from the upper floors, triggering always different points of view.

**Fig. 7:** View of the Antiquarium and Cathedral

Once at the entrance, the user can choose the type of visit according to their interests and the time they have; In particular, they can visit the complete route made up of permanent and temporary exhibitions or decide on just one of the two spaces. This is made possible because the exhibitions are placed on two different levels and the system of vertical links and visitor circulation is made both autonomous and consistent, in no way compromising the historical reading of the exhibition.
The temporary exhibition space is reserved for the first floor, where the layout is designed to break with the character of the building in which it is located to promote the flexibility and heterogeneity of the possible exhibitions to be hosted.

**Fig. 8:** View of the Museum permanent collection

In fact, the user find a large double-height classroom in which temporary boxes are inserted to form a path in which the user immerses himself in a different space each time; this allows both to create a feeling of surprise for those who visit the temporary area since they do not know what they will see until access to the box, and for those who take care of the installation temporary who will be able to decide with maximum freedom to set up the exhibition, to reach until creating spaces of total multimedia immersion. In addition, the squares are arranged in such a way as to ensure a circular flow, so that at any time the visitor can also decide to visit the squares already visited several times. It is emphasized that this in no way affects the connection with the overall pedestrian flow of the museum, since from different points the user can reach both the main vertical connections and a central exit placed in relation to the side corridor of the nave .On the second floor, on the other hand, the largest space of the permanent exhibition is dedicated, where the historical moments of the history of Carthage are told.

**Fig. 9:** View of the Museum temporary section and general exhibition plans

The visitor's journey is parallel to the chronological trend, so from the entrance we immediately find the first exhibitors who tell the "foundation of Carthage" until the exit where on the contrary we conclude the visit with "Rediscovery of Carthage". In this case, the installation is designed as simple, dry and easy to read, so that the attention is focused almost exclusively on the exposed elements and the space in which they are inserted. The passage between the chronological phases of the exhibition is underlined by a detachment from the sidewalk, which emulates the chronological leap and the change in dating of the finds. From this follows the linear design of the visit route, with the only possibility of going around the individual exhibitors so that there is no risk of not understanding the exact chronology of it. Showcases of steel and glass that only change size depending on the diversity of the elements on display, characterize the space by delicately inserting themselves into the historical character of pre-existence. Particular emphasis is placed on the exhibitors who will host the statues, imagined at a greater distance than the others to allow the user to get further away and perceive all the statuary elements as a whole.

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# The scaling behaviour of cities and new urban communities

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## Abstract
Fractal urban aggregates constitute a new paradigm of interpretation, on a natural scale, of the planning process of a territory that evolves between the existing and the eco-compatible future. A fractal urban aggregate contains both the morphometric and environmental indicators of minimum sustainable urban development, and the laws of direct scale (self-similar and/or self-similar) for planning a vast area, the latter consisting of a finite number of aggregates, according to the physical scaling of nature. Fractal analysis in the context of strategic and territorial planning of large areas characterizes the urban aggregates in planimetric terms, as well as the identification of criteria for the development of urban systems that take into account the multiple components. In this sense, the fractal dimension is a descriptive criterion representing a design parameter.

**Keywords:** fractal geometry, fractal urban aggregates, the science of cities.

## 1. Introduction
It can be said that the City is a "complex system", as stated by Cristofaro S. Bertuglia in one of his essays: "(...) about twenty years ago, it should have been built in such a way as to come, to the conclusion, at the justification of the title itself “(…). Today, an exhibition on “the city as a system” “(…) if it doesn't want to repeat things said over and over and if it doesn't pretend to investigate some epistemological knots that who knows how long they will intrigue philosophers of science, must be constructed assuming the wording as a starting point. “(…). (Bertuglia, 1991). “So, the city can be conceived as a set of related parts: industrial workplaces, residences, tertiary workplaces, spread over a large chessboard, related to each other through communications and transport”. (Bertuglia, 1991). We will try to give a definition to the concept of "city: as a complex system". There is a large and widespread literature which, at least on an intuitive level, demonstrates that urban and/or territorial systems are complex realities. We assume that the "complexity paradigm" is based on concepts and principles, especially mathematical ones, which have a universal value and are applicable to all non-linear systems. In this context, it is necessary to verify the effective isomorphism between territorial systems and complex systems, given and considering that the Urban Systems respond to the two conditions of non-linearity and openness, necessary and sufficient conditions for any form of self-organization. There are conflicting opinions on this point. (Bertalanffy, 1969). Before delving into this topic, let's give the definitions of a complex system: “a system can be defined as a complex of interacting elements; interaction means that the elements, P, are connected by relations, R, such that the behaviour of an element p in R is different from what its behaviour would be with respect to another relation R'". For some researchers, Urban Systems are equivalent to complex systems, thanks to the non-linearity of the interactions between urban actors and the plurality of descriptions that such systems can be given. For other scholars, the application of theories of complexity to urban and/or territorial systems is impractical due to the difficulties that arise when trying to uniquely identify such systems, and distinguish them from their environment. It is also necessary to verify that the "city is a complex self-organizing system". Also on this point, there are fundamentally divergent positions between two branches of research: the first states that Urban Systems would be capable, at least in the presence of certain environmental conditions, of acquiring an orderly organization in the absence of top-down planning; complexity theories would make it possible to explain this ability and, possibly, to try to address it; the second trend states

that the bifurcations that can be found in the evolution of these systems are over very long time intervals. This concept would make the use of the concept of self-organization in urban research little justified (Bertuglia et al., 2000).

## 2. The city as a complex system

We will analyze these points in detail below, highlighting the different positions: the first point concerns the possibility of studying the city as a complex system; certainly, the interactions between urban actors are of a non-linear type, consisting of different forms ranging from competition, to cooperation, from economies of scale, to the propensity to agglomeration; or even competition for space, for resources and for the conquest of markets (Basili, 1997). Furthermore, the urban phenomenon can be interpreted according to different interpretations: economic, political, social and cultural, or even demographic, spatial or morphological dimensions. This multidimensionality implies that numerous, non-equivalent descriptions are possible for the city. (Pumain, 1997). The City, therefore, can be considered a complex system, both on the basis of the non-linearity of the interactions of its elements or, as Casti states, on the basis of the plurality of possible non-equivalent descriptions (Casti, 1986). And, in fact, the city has many of the characteristics that characterize the phenomenology of complex systems: from the exponential increase of political decision-makers, with consequent fragmentation and dispersion of effective authority (Bertuglia, Vaio, 1997) to the structuring according to several levels of organization (Pumain, 1997), from the multiplicity of time-scales "(...) in the same city numerous and different time scales operate simultaneously, for example, the times for commuting from home to work vary faster than the workplaces and residences, with the consequent phenomena of congestion in the communications network and in housing, as well as buildings generally have a longer duration than the functions for which they were designed) to the apparently acausal behaviour full of surprises. “(…) In certain circumstances, it can happen, for example, that a reduction in taxes and interest rates leads to an increase in unemployment, or that neighbourhood regeneration projects through the development of low-cost social housing give rise to neighbourhoods that are worse than those to be rehabilitated, or that the opening of a new road gives rise to an increase in traffic congestion” (…) (Bertuglia, Vaio, 1997). Another aspect to consider with respect to a systemic conception of the city is linked to the possibility of defining the limits of the city, in order to uniquely identify the urban system. “(…) By distinguishing between city systems and networks, do we indicate different agglomerations or do we highlight different aspects of the same type of agglomeration or even of the same agglomeration? “ (…). (Bertuglia, Vaio, 1997). The processes of technological innovation and decentralization, as well as the new communication systems, have weakened many of the factors, which previously bound activities to an urban location, and have, with the process of globalization of the economy, increased the freedom of movement of financial capital, goods, information and part of the population. In the past, the problem of the limit was mainly related to the minimum threshold that a city must have in order to be included in a hierarchically ordered taxonomy of settlements; today, however, this problem mainly concerns the higher level, i.e. the identification of the boundaries of the megacity, of the city-region (Tinacci, Masello, 1997). The second point concerns the effective capacity for self-organization of the city, if, on the basis of what has been said above, one accepts, albeit always with due caution, that it can be considered a complex system. According to Prigogine, the city has such capabilities. “(…) the simplest example of dissipative structures that can be evoked by analogy is the city. A city is different from the countryside around it; the roots of this individualization reside in the relationships it maintains with the adjacent countryside: if these were suppressed, the city would disappear”(…). (Prigogine, 1993) However, it can be admitted that, like dissipative structures, the City satisfies the two indispensable conditions for any form of self-organization: "the non-linearity actions between the elements", and the "openness towards the outside". The city is an open system, which exchanges energy, matter, people (migrations), information and decisions with its environment. This environment is constituted not only by the territory surrounding the city, but also by the system of cities to which it belongs. In other words, the city must always be considered as a system within a system of cities; precisely the exchanges with other cities, even distant ones, are by now predominant compared to those with the surrounding area. The degree of openness of each urban system depends on its situation within the system of cities: larger cities, and above all those specialized in activities of an international nature, are more open to the outside than the others. Among other things, this opening is one of the causes of the fluidity of the city's borders (Pumain, 1997). The theory of "complex self-organizing systems" also provides us with a theoretical framework that allows us to integrate two apparently contradictory aspects of cities: their "uniqueness" and their "mutual similarity". Each city is unique, it has an irreducible originality due to the specificity of its location, its history and the territory that surrounds it. At the same time, cities of somewhat comparable size often exhibit similarities in the location of activities, the distribution of growth and even changes in their organization. If we consider the city as a "complex self-organizing system", its evolution can be explained according to a bifurcation diagram with many branches: each branch represents an urban organization that differs qualitatively from the others, but at the base of all the branches there are the same evolutionary processes and mechanisms. In other words, the laws governing the development of

the city would be the same for all urban systems, but the existence of bifurcations, of trajectory jumps from one branch to another, would guarantee the presence, in such systems, of distinguishable structures: the fact that, in correspondence with the bifurcations, the choice of one or the other branches is unpredictable, makes the dynamics of each city irreversible and, in a certain sense, also determines its uniqueness. (Pumain et al., 1989) This interpretation of the evolution of the city, based on the mutual adaptation of the urban actors in their localization behaviours and on the diffusion of the innovation introduced by the various local actors, should still be considered, according to La Bella, in the state of hypothesis: "(...) the same the basic idea, ie that the evolution of human settlements, social systems and economies arises from micro-diversity due to errors in the transmission over time of the rules governing specific behaviours and techniques, is absolutely questionable"(…). (La Bella, 1997). Returning to the digital innovation processes, it can be said that they represent an opportunity for urban planning for the development of urban systems, both from the point of view of monitoring the infrastructures and the urban environmental state, and from the modelling and knowledge of the urban object. Digital technologies also appear useful as tools for citizen involvement and participation. Data-driven urbanism, i.e. urban planning based on data collected more or less automatically, opens up various scenarios for more efficient city management. This type of urban planning, oriented towards the best management of the city, finds its application in monitoring urban infrastructures. They can be green infrastructures, (as reported by Darte and DeSouza, 2020) which talk about the use of algorithms to analyze the images of google maps, in order to control the distribution and the state of health of the urban green. Analyses of this type could respond even more effectively to the demand for public transport that cannot be satisfied through current transport planning techniques (Macchi, 2006). To this type of analysis, we can add other possibilities for monitoring and collecting voluntary and/or participatory data. The best-known and most widespread case is represented by digital community mapping, i.e. the digital mapping of communities. The drawing of a map is not a technical operation, but rather the result of choices based on the value system of the designer (Poli, 2019). Taking an active part in the design of a portion of the territory and expressing one's values and desires in the urban space through this tool is an important participatory operation, whose possibilities of collection, expression and understanding have been expanded to the use of PPGIS (Participatory Public GIS). Mapping or self-mapping can be used in order to understand the entity and scope of the phenomena in which one participates, as in the case of the mapping carried out by the CiViSM project in Florence and described by Anna Lisa Pecoriello (Belingardi, Pecoriello, 2018). The intent of the process was to get to know all the practices of sharing and creating common goods in the city, together with other practices of hybridization and appropriation of public and private spaces. Strictly speaking, Digital Twin or digital twin is a faithful image of a physical process, modelled together with the physical process in question (Batty, 2018). A digital twin is the most accurate and complex reproduction of an urban environment, a part of the city, or all of it (Castelli et al., 2019). The goal is to collect and systematize as much data as possible on the city in order to have a complete vision as possible of the urban organism at a given moment and of its functioning. Given that the purpose of planning is the change of space and the quality of urban life, the digital twin also has the purpose of prefiguring some possible scenarios as a consequence of the choices made and the projects implemented. The idea is placed in the field of urban intelligence, adding the urban component, i.e. the Sensible city, to the computerized approach of the smart city. The sensible city tends to build highly computerized cities but, at the same time, it questions the human side of the city and how to include it, overcoming the predominantly technological approach of the smart city. A digital twin is not a true representation of reality, but it needs to be true enough to hold together enough data in order to discuss complex problems (Dembski et al., 2020) bringing together economic and social processes with the built environment, and linking physical processes and functional to socio-economic representations (Batty, 2018).

### 2.1 Analysis of spatial integration process

The strength of the reflections of Mela and Preto (Mela and Preto, 1997) lies in the assertion of the systemic and auto-poietic nature of the city. The identification of the processes that lead to the multiple activities that take place in a city allows us to define some criteria according to which it is possible that a "spatial aggregate" can be studied as a self-organized system. (Bertuglia and Staricco, 2000). We will try to define some of these criteria with reference to the spatial integration processes of a socio-economic nature. In fact, every action (economic, political, productive, etc.) of local or urban actors will have its own space-time dimension, with an interaction with other social subjects, with the birth of relationships of interdependence. These are systems of spatial interdependence, i.e. both abstract relational spaces. In fact, urban space is a physical and relational space. (Bertuglia and Staricco, 2000). As Mela and Preto state, the different systems develop on different spatial scales, depending on whether the urban actors are co-present or at a distance. These are the so-called integration processes, which are divided as follows: "(…) first-order integration processes that represent specific systems on a local scale (eg the urban economic system); processes of second-order integration of a horizontal type, which relate the various specific local systems (e.g. the economic system with the political system); second-

order integration processes of a vertical type, which relate specific local systems to other specific systems of the same nature, but located elsewhere (supra-local); the top-down and bottom-up approach can be differentiated; firstly, the integration depends on the initiative of the supra-local system (e.g. in which a large multi-lease company, having located one of the activities in an urban centre, activates the integration of the economic system of this center into a larger-scale economy ; secondly, on the other hand, the initiative is taken by the local economies themselves; third-order integration processes connect specific supra-local systems of a different nature, effectively generating corporate systems on a regional scale" (...). (Mela and Preto , 1997). It should be noted that vertical integration can influence the horizontal one, in positive terms, as for example, it has occurred in some cities, such as Amsterdam and Toronto, which have managed to have a position of relevance in the world economic system, involving local operators and decision-makers, implementing careful urban social policies. There are cases in which vertical integration can hinder horizontal integration, as occurs in some metropolises in the southern hemisphere, where a spatial split is evident, due to the contrast between the centre where all the economic and financial activity, and poor and degraded neighbourhoods. (Mela, 1996). The analysis of integration processes allows us to estimate to what extent a city satisfies the two conditions of non-linearity and openness, which, as we have said, represent the indispensable boundary conditions for any form of self-organization. (Bertuglia and Staricco, 2000) This analysis, therefore, allows us to formulate a judgment on the system of a city and its potential for self-organization. The results of this analysis could come out which indicate systems at the antipodes, for example, a positive opinion can come out, in which systemic properties of a city are deduced, or a negative opinion, equivalent to a third world city, as a mass of unrelated parts or of nodes that refer to separate and uninterconnected networks. (Bertuglia and Staricco, 2000) The results could be useful for policymakers, in both cases. (Mela and Porto, 1997). Only time will probably tell us who is right and who is wrong, among those whom today argue that our environments, lifestyles and the settlement models that inspire them will undergo profound transformations, for example, after the pandemic, so as to generate a decline of cities, and who instead believes that they cannot give up on cities, on the density of relationships, on the opportunities, on the exchanges that take place in them and which will be the challenges of the future to counteract the unwanted effects of density (congestion, pollution), to correct models and practices that have shown inefficiency and little flexibility, to return to topics such as public health to reduce the gap between people and places. Starting again after the pandemic will not be easy, just as it will not be easy to try to provide answers to the problems highlighted by the crisis. The dense city, elevated to a model of a sustainable city for the optimization of transport, for the intensification of social relations, and for economies of scale, according to some scholars has proved unable to protect those who live there (Ferrier, 2020), so much so as to reproduce the anti-urban utopia of fleeing the cities. Other scholars remind us, however, that the cities have survived the wars, revolutions and pandemics of the past because we cannot do without "urbanity" (Wiener & Iton, 2020); just as they cannot do without urban "density" (Amphour et al., 2001), "intensity" (De Cunha, 2009) and urban "diversity", as the prerogatives of cities, political, economic, commercial centres and culture of human society, in a potential perspective of self-organization. In the face of the crisis, however, the need to reflect on the critical aspects of cities that have also come to the surface emerges, such as: crowding, congestion, and social and health inequalities (Shiffers, 2020); as well as on the positive aspects that we had neglected and that we have begun to appreciate again during the lockdown, such as: the desire for nature, the rejection of the multitude, the sociability of the neighbourhood, the right and safety in going on foot or by bicycle, the possibility of positively influencing air quality with our daily behaviour. All these aspects are closely linked to another way of life, which we have shared, because we have been confined, forced into space and time (Gwiazdzinski, 2020), and which has benefited from the extraordinary acceleration of the integration between the urban phenomenon and the digital world (Balducci, 2020). The difficulty of movement and digital speed has changed the way of conceiving distances and will influence the future of the city, work, mobility, and the flow of goods and people. Strengthened by these recent experiences, we must be able to use the crisis and the economic resources, destined for the restart, to implement the transition theorized by the European New Deal (European Commission, 2019), focusing attention on the spatial dimension of public policies, which is often lacking in our country (Talia, 2020) and giving priority, with the help of structural and non-emergency measures, to satisfying people's needs and protecting natural and social resources (Raworth, 2017). Far from evoking epochal changes in the organization of the territory and cities, we will have to work to make urban systems more attractive, cooperative and safe, with people being closer to places of production and services. A possible answer could be that of organizing cities according to a network of complementary and hierarchical centralities, articulated in various degrees of compactness, relational intensity, proximity, temporality, and closeness to nature and greenery. (DA Cunha, 2007).

### 2.2 The pre-industrial city: morphological self-organization

After highlighting the conditions that an urban system must satisfy in order to be able to organize itself, we will consider both the ways in which urban self-organization is implemented and the tools that allow

it to be studied. Attention will be focused on two aspects of the city: the morphology (the destruction of the population); the spatial structure (the distribution of activities). The aspect of urban morphology will be evaluated, as the first form of urban self-organization. Some authors have attempted to interpret both the genesis of archaic cities and the development of historic centres that were designed and built without planning tools. (Donato and Basili, 1996). According to these authors, “(…) the unplanned order is the result of a large number of events; that is, it emerges from the sedimentation of a myriad of choices of minimal resistance made in response to a precise and limited set of housing, production, relational needs, etc. "(...). (Donato and Basili, 1996). In fact, the hypothesis on which this interpretation is based is that urban actors behave according to the "principle of least resistance". In complex systems, non-linearity, with its amplifying effect, underlies counter-intuitive and apparently not random properties and behaviours, which cannot be deduced from an analysis of the constituent elements. (Bertuglia and Staricco, 2000). Among these properties, the most interesting is the "capacity for self-organization". Complex systems are able to acquire an orderly and coherent spatial and temporal structure, without the need for an external controller, but on the basis of the pattern of interactions between the constituent elements. The elements each act according to the "principle of least resistance", i.e. trying to obtain the maximum benefit with the minimum effort. According to this principle, each individual belonging to an urban system would aim to satisfy his immediate needs, having no interest in contributing to the formation of an overall order of the urban organism. (Bertuglia and Staricco, 2000). Donato and Lucchi Basili affirm that “(…) the multiplicity of constraints and the complexity of their mutual relationships opens the way to an immense spectrum of possible adaptive responses on the part of the urban organism, for the most part totally or partially inadequate; the achievement of an effective organizational solution is thus the result of a long and tiring process of exploration, in which the casual element of discovery and the tension aimed at overcoming the limits of the current situation coexist"(...). (Donato and Basili, 1996) The process of adaptation, with respect to an overall organization of the urban system that does not respond to social needs, not allowing development, will not be short, indeed in the case of cities, it will be represented by a very long time lapse, both due to the difficulty and the cost of the localization changes. It must also be said that, as Lucchi Basili affirms, “(…) in the logic of least resistance it is certainly cheaper, in fact, to adapt to safe organizational solutions, because they are already tested and supported by a long cultural tradition; the choices of least resistance, in turn, are fixed in the collective memory of urban civilization, becoming its permanent and therefore reusable heritage”(…). Urban systems, with respect to the reasoning made, reach a critical condition when there is a social division of labour (Bertuglia and Staricco, 2000). The necessary conditions for a system to self-organize are two: “non-linearity of the interactions between the constituent elements (complexity of the system) so that small variations of the interactions themselves can amplify until they have consequences at a macroscopic level; the opening of the system, so that it can be subjected to external actions that move it away from equilibrium". It is evident that two fragments of urban systems will communicate with each other through relationships between the spatial and relational structures. (Donato and Basili, 1996). Without claiming to be exhaustive, the focus is on a "series of unplanned urban fabrics", from the archaic city to the pre-industrial city. The aim is to demonstrate how the self-organization processes have guaranteed the cities, even without the elaboration or application of urban planning tools, orderly and coherent morphologies. The different surrounding conditions, and the continuous processes of consolidation from city to city, have led to a multiplicity of urban forms. (Bertuglia and Staricco, 2000). The proto-urban settlements of the archaic cities of Mesopotamia (3500 BC) expanded uniformly over the plain, with random entrances to the houses and with free spaces, inside the urban agglomeration, devoid of any relational logic. The first real cities were built through the principle of the different functions performed by the different urban actors, in relation to the religious or government role; think of the first buildings (temples, royal palaces, etc.) to which a "public" social significance was attributed. (Bertuglia and Staricco, 2000) “(…) The main craft, mercantile, etc. activities then begin to concentrate in public spaces, causing a further evolution of the spatial organization of the city and the appearance of new urban functions… thus an elementary logic of definition and maintenance of public urban spaces which leads to the formation of a system of urban relations”(…). In public spaces, there was a ban on building, both to protect their practicability and because it was considered a usurpation of such spaces. (Frankfort, 1989). Returning to the concept of "least resistance", it can be said that this principle gives the process of spatial structuring a self-propulsive character. (Donato and Basili, 1996).

## 3. Results

The "processes of self-organization" concern not only the archaic city but also the historical one, and in particular the medieval one, certainly much less planned from above than the Greek and Roman ones. Indeed, it follows some principles of the Mesopotamian city. The urbanization process is concentrated along the street, creating compactly built fronts and, on the back, pertinent strips intended to serve the new homes; when the matrix path assumes high values, the connections between the extreme poles of the settlement become uncomfortable, due to the excessive distance; the "principle of least resistance" acts, which pushes further construction along the planting paths; connection paths are then created,

transversal to those of the plant, as communication between one plant path and another becomes difficult; the progressive saturation of the areas between the routes leads to the formation of quadrangular blocks. It is the result, not of a conscious planning process, but of a self-organization process based on the logic of least resistance. (Caniggia and Maffei, 1993). Instead, referring to some examples of network and tree road schemes, the difference in city typology can be seen; we refer to settlements of different urban civilizations, which make evident the social and cultural dimension of the notion of minimum resistance. In fact, the western medieval city and the Islamic one are taken into consideration. In both cases, the criterion against which "resistance" is evaluated is given by mobility. In the European city, this mobility is unconditional, in fact, travelling is of fundamental importance. In the Arab world, on the other hand, mobility is conditioned by the social bonds of family membership. This different relational logic is reflected in the structure of the urban road. In fact, in the western city, the different paths are connected by a network structure, aimed at minimizing the resistance to movement between any two points of the settlement. In the Arab city, the street is a space for relationships. The progressive transformation of a Roman colonial fabric into an Islamic city is evident in medieval Rome, which sees a close interpenetration of private and public space. The case of Rome shows how spontaneous self-organization processes can take over even in historic cities that have been planned according to a practical (rectangular grid) or symbolic (regular polygon) Euclidean rationality model. (Bertuglia and Staricco, 2000).

### 3.1 The contemporary city: the designed hetero-organization

A historical analysis was carried out with respect to the self-organization processes of the urban morphology, valid up to the pre-industrial era. With the industrial revolution, social, urban, political, etc. innovations are so many, that in many cases they cancel the processes of self-organization. According to the theory of "complex adaptive systems", a system can adapt to its environment only if the latter does not change too rapidly. (Bertuglia and Staricco, 2000). It is clear that the industrial city is not able to organize itself adequately. In fact, given that its growth is directly correlated to the innumerable interactions between urban actors, the result is a morphology that is no longer ordered and coherent, but fragmented and congested. A form of cooperation between those who plan from above (public decision-makers) and self-organization from below (local actors) becomes necessary. Cooperation, is commonly defined as: a designed hetero-organization. We will analyse, for example the case of urban morphology, one of the tools suitable for favouring this cooperation, which is represented by fractal geometry, an innovative field of experimentation for cities. (Bertuglia and Staricco, 2000). From the theory of dissipative structures, it can be deduced that every "self-organized complex system," which has external perturbations, if they reach a critical value, the system assumes chaotic behaviour. “(…) the urban organism is, therefore, able to respond to change to the extent that this remains within certain limits; in the presence of a radically changed context, and therefore of completely new needs and problems, which require a radical creative effort and therefore the search for entirely original organizational solutions, the self-organization capacity of the organic city goes into crisis and the danger of a chaotic degeneration becomes concrete (…)”. (Donato and Basili, 1996). In the case of urban systems, the "critical point" was represented by the industrial revolution. In such a context, the various parts of the city begin to organize themselves and adapt autonomously, without an overall coherence; if so, the system is no longer integrated enough to organize itself globally. (Bertuglia and Staricco, 2000). The very rapid social transformations, also in terms of economic growth and technological innovation that take place in a city, require particular attention from municipal governments, which find themselves having to deal with investments exceeding their financial resources. The evolution of migratory flows also modifies the ethnic and cultural composition of society. It can be said that the reaction times of the city, in exploring new organizational solutions, are much shorter than the speed of social transformation. Donato and Lucchi Basili argue that, even in such contexts, given that the self-organization processes fail to lead to truly effective solutions, there is a need for top-level planning, in order to make up for the self-organization deficiencies. (Donato and Basili, 1997). While, for Western countries, it is a question of ensuring effective integration between the various urban functions, in emerging and/or underdeveloped countries it is necessary to direct the processes of urban growth; the latter becomes increasingly rapid, manifesting itself through the formation of "degraded urban fabrics" (e.g.: favelas). (Bertuglia and Staricco, 2000). Lucchi Basili is convinced that whoever has the task of planning the city must follow the organizational logic of unplanned fabrics, adapting it to new needs; in doing so, the development processes are oriented towards the scales relating to the current transformations. Looking at unplanned adaptation mechanisms, no longer as constraints, but as opportunities, without tolerating phenomena such as illegal use, or other, as a non-adaptation mechanism from below, but rather, a game of interaction between the parties. (Lucchi Basili, 1997). The excursus made previously allows us to be able to extend the theory of fractals to complex urban systems. Fractal geometry comes to meet us, helping us to interpret this "hidden non-Euclidean order" related to the "morphological organization of the city". (Bertuglia and Staricco, 2000). Fractals are geometric objects obtained through iterative algorithms, i.e. a series of instructions repeated according to a predefined sequence. These objects

have some characteristics, which can be traced back to two properties: Self-similarity: “fractals are invariant under change of scale; that is, either by enlarging a detail of their structure, one finds the same identical starting structure in the case of strictly self-similar fractals (whose algorithm is made up of linear recursive equations), or a structure very similar to the starting one in the case of fractals not strictly self-similar (whose algorithm consists of non-linear recursive equations); in fact, they represent a morphological richness that is never exhausted, at any dimensional scale one observes it”; Fractional dimension: “with their irregular and jagged morphology, fractals occupy space in an intermediate way compared to Euclidean geometric objects; a fractal such as eg. the Koch curve occupies the space with greater efficiency than a one-dimensional line, but less than a two-dimensional surface; another example is given by Menger's Sponge which is more than a plane, but less than a cube”. Fractals, from an experimental point of view, help us in the "sciences of the city". In fact, these objects make it possible to reproduce articulated and only apparently disordered forms, which are governed by a hidden order, such as those generated by self-organization processes. (Bertuglia and Staricco, 2000). This infinitely complex morphology is obtained starting from compositional rules that are very simple, thanks to their iteration on several dimensional scales. It can be said that fractals follow a principle almost equivalent to that of "least resistance"; in fact, they are characterized by a self-similar morphology, just like the hierarchical structure of the city, based on the logic of the central place. Theoretically, they seem suitable for reproducing those compositional rules that make up collective memory, compressing them into an algorithm composed of a few simple instructions, almost like a genetic code, of "unplanned urban fabrics". Of course, we are still far from affirming that, also considering the relatively recent studies, the applications of fractal geometry to the study of urban morphology have given satisfactory results, with respect to the construction of designed extra-organization processes. Only future applications will allow us to understand if the current difficulties can be overcome, or if they are due to the fact that the morphology of the city does not actually have the characteristics of self-similarity typical of fractals. (Bertuglia and Staricco, 2000). In the context of urban research, two of the most representative applications are presented from the point of view of the scientific approach: “description of real settlements; simulation of urban growth processes through algorithms”. As regards the first point, it can be stated that if the city is defined as a set of built spaces, it can be considered as a two-dimensional object, i.e. a flat area, inside which there are voids of various sizes. If we transform cartographic surveys into digitized maps using a scanner, it can be verified with the help of computer tools that the surface of these voids, as the survey scale becomes larger, grows according to a constant exponential law: in this case, the exponent represents the fractal dimension of the city. Figure 1 shows an example of a city with a relative fractal dimension (figure reworked starting from Batty and Longley, 1994). “(…) We will naturally expect that the cities in which the design intervention is more marked and recent will in any case retain a lower degree of fractality, compared to those in which the aggregation of the fabrics took place in a substantial absence of external constraints and over a very long period of time” (…). (Lucchi Basili, 1996).

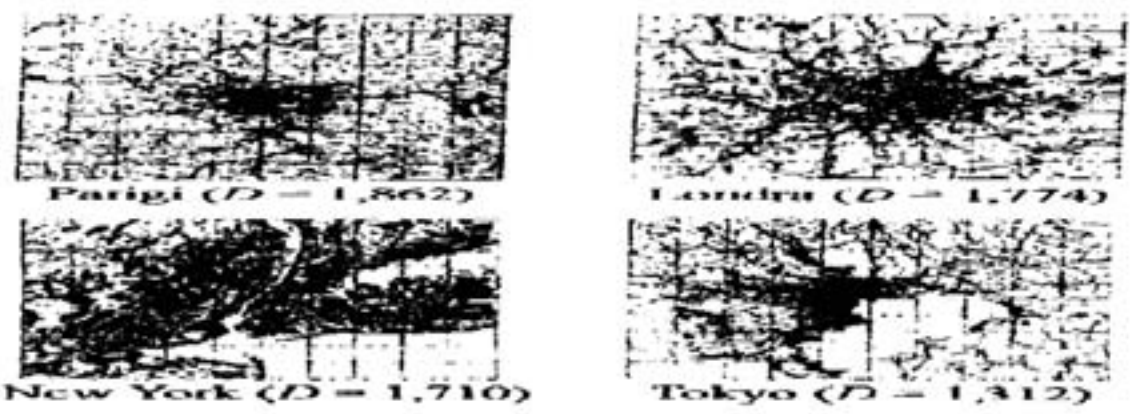


**Fig. 1:** an example of a city with its fractal dimension (figure reworked starting from Batty and Longley, 1994)

Another possibility is given by the possibility of measuring the fractal dimension of the urban road grid: this dimension will be greater the more irregular the grid is. Batty and Longley have taken into consideration and therefore studied the fractal dimension that the boundaries of the city of Cardiff had back in 1886, in 1901 and in 1922, discovering that this dimension does not remain the same for all measurement scales, but is variable. (Batty and Longley, 1994). Scientifically, they have demonstrated that this phenomenon was the consequence of the coexistence of multiple urban growth processes, which operate at different dimensional scales; in fact, the urban boundaries would be characterized by a "multifractal geometry". Furthermore, the fractal dimension, whatever the scale at which it is measured,

decreases from 1886 to 1922: “(…) it would seem that greater social and physical controls on the growth of the city at the end of the 19th century and at the beginning of the 20th century, together with increased accessibility due to improvements in transport, have reduced the irregularity of urban areas such as Cardiff”(…). (Batty and Longley, 1994). The descriptive use of fractal geometry, based on a simulative use, allows us to build laboratories, suitable for experimenting with the cooperation between the designer and spontaneous processes of self-organization. (Bertuglia and Staricco, 2000). A first possibility, even a very complicated one, consists in simulating the hierarchical structure of urban functions; it has been shown that all the different geometries of the central place can be obtained through the generalized Koch method. That is, through simple variations of the same rules that generate the Koch curve: at each iteration, this method replaces each rectilinear side u-v of the hexagon with the broken line u-v indicated above the arrow. (Donato and Basili, 1996). Since the different functions operate on different spatial scales, the hierarchy will have a multifractal geometry. In this case, if the designer were in a position to have an accurate fractal representation relating to the spatial articulation of the system of centralities, he could investigate how a redefinition of the functions present in a certain central location modifies the distribution of the functions in the other locality; at this point, the designer could remodel the central functions that may have disappeared. (Donato and Basili, 1996). A second possibility, as previously mentioned, is represented by the simulation of urban growth processes, with particular attention to the variations in the shape of the city. (Bertuglia and Staricco, 2000). Finally, we can state that these applications have many limitations, including: it does not seem to be able to simulate, within a hierarchical structure, the formation of those horizontal relationships between centres of the same level, which are foreseen by the reticular paradigm. (Lucchi and Basili, 1997). Furthermore, as La Bella pointed out, fractals are of little help in understanding the actual mechanisms and forces that govern social phenomena; it should be noted that the most suitable use of fractal geometry is operational and not explanatory: it can be useful, to reproduce extremely complex morphological forms, even without explaining what causes have generated these forms. (La Bella, 1997) "(...) the elaboration of methodologies and design tools that make an active and creative use of these data, aimed at a design that is fully aware of the repercussions and modifications it induces on the urban organization, is an ambitious but challenging goal for future research” (…).

## 4. The role of spatial self-organization models in urban planning

The "non-linear dynamic models" can be a useful support to better interpret the "designed hetero-organization". In this way we can deal with the urban structure, studying the distribution of the population as well as the activities, in the different areas into which the city is divided. Briefly, we will consider the evolution that urban models have had on a large scale. From the transition from the first generation to the second generation of these models, the role of the latter in a process of designed hetero organization is shown. Only towards the end of the 1950s the first large-scale urban mathematical models were born. They were based on the use of IT tools, with the simulation of the mobility system or the use of the land inside the city; these models have led to the conception of planning as an applied science. Lowry's model gave rise to many theoretical and experimental developments (Bertuglia et alii, 1987) that were criticized in the mid-1970s. Precisely in those years, we moved from the first generation models to the second generation ones; urban models, from that moment on, are studied in many research centers around the planet. (Wegener, 1994). These models are inspired by the study of complex systems (catastrophe theory, bifurcation theory, dissipative structure theory, synergetic process theory). The modeling developed on urban systems can represent an interesting research trajectory, with respect to the quantification of parameters and indicators, useful for urban programming and planning with a view to urban and environmental sustainability. The evolution of hardware supports and the development of software applications, as well as the updating of geographic information systems (GIS), make the outputs of the models more understandable. Recognizing the city as a complex system means recognizing that it must be treated as a non-linear model, i.e. as a system subject to continuous evolution, determined both by internal mechanisms of the system itself and by external forces, albeit to a lesser extent relevant. This innovative conception of urban systems has had a profound impact, both on the characteristics of the models and on the application of the models. For the first point, these models try to identify mechanisms of urban change, which have an exogenous and endogenous origin. These urban mathematical models aim to grasp the endogenous mechanisms of territorial transformation, deriving the urban macro-behaviours from the micro-behaviours of the various actors of the city. (Bertuglia, 1991). Therefore, they are dynamic models, in which the relationships between the state variables of the system are not of the algebraic type, but of the differential type and of a qualitative matrix. (Allen et al., 1984). In fact, from the 1970s onwards, there has been an urban growth that has slowed down considerably; that is why, we speak of qualitative transformations, which in any case attract the attention of planners and scholars. (Pumain et al., 1989).

## 5. Conclusion

These models tend to describe urban spatial structures, qualitatively different from each other. (Bertuglia and Staricco, 2000). “(…) Such an approach could then show us that New York, Brussels and Timbuktu correspond to different branches of solutions that the same model presents, for different values of its parameters relating to dimensional and environmental aspects, and for different past events. Only a model of this type, definable as transferable, can be used for predictive purposes in a specific case, while instead a model formulated in terms of a particular problem, and calibrated on it, is purely descriptive, and unable to identify the directions of the change; a model designed to explore the long term must be a transferable model, since the different types of cities we observe are the result of an evolution, and therefore each particular city must be potentially able, under certain conditions, to evolve towards one or the other of these types. It follows that a good model must be a metamodel”(…). (Allen et al., 1984). With reference to the second point, namely the application of the models, if the city is a complex system, then its dynamics is non-linear; in fact, it is impossible to perfectly define its initial state, accentuated by the presence of fluctuations. (Allen et al., 1984). According to this analytical approach, therefore, it is redundant to use urban models for predictive purposes; if, on the other hand, we refer to the growing speed of change and the growing importance of management tasks, for these reasons urban decision-makers have an even greater need for tools to be able to identify which action to implement or which action to choose between different actions. (Bertuglia, 1991). In fact, the appropriate use of mathematical models allows us to develop scenario analyses, as Bertuglia and Vaio affirm, "(...) models are fundamental for probing, investigating, deepening and, therefore, for defining scenarios, i.e. hypothetical sequences of events based on explicit assumptions and in a particular temporal perspective, which, properly examined, can allow us to put together useful elements on alternative choices and their potential impacts. In this sense, defining scenarios implies, in short, a consistent activity aimed at creating, recording, discussing, synthesizing, presenting and preserving information on future development processes"(...). (Bertuglia and Vaio, 1997). Unlike predictive models, scenarios include not only quantitative, but also qualitative aspects: based on the analysis of stability and criticalities, the models make it possible to identify possible futures, i.e. the branches in the evolutionary diagram that the system can adopt in absence of planning, or as a result of certain actions on it, for certain critical values of the parameters. The planner in his analyzes or evaluations relating to the elaboration of a "plan", must have the ambition to identify the branches of the evolutionary diagram of the given system, together with its current state and its past history, together with what it could adopt spontaneously, trying to push it, through appropriate actions, towards what appears more favorable. (Bertuglia and Staricco, 2000). This possibility consists”(…)…The role of the urban planner today can be seen as one in which he tries to nudge the system to nudge it towards a more desirable trajectory, rather than trying to force it to advance towards a predetermined and fixed pace . He must decide the best course of action at this precise moment, taking into consideration the long-term context and being ready to continually review his set of decisions”(…) (Bertuglia et alii, 1992). In an essay, Rabino stated that "(...) the boundaries between analysis, planning and management, that is, become less and less marked, outlining a real process of co-evolution between plan and planned system"(...). (Rabino, 1997). It is in this perspective that "non-linear dynamic models" can make an important contribution to a process of "ethreoorganization design". Among the second generation models, those of spatial self-organization are particularly interesting in this sense. These aspects have been studied and analyzed by some authors: Britton harris and Alan Wilson, as well as by a group of the Department of Physical Chemistry directed by Ilya Prigogine, at the Université Libre de Bruxelles, under the guidance of Peter Allen. It should be emphasized that these models, although highly significant, are only particular cases within a field, that of large-scale urban modeling, which is extremely vast and articulated; a research path, with respect to which there are cities that lend themselves to an easier fractal reading, compared to others.

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# Studies on the Domitio-Flegreo coast: project proposal in the Masterplan

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## Abstract
In Italy the emergency linked to the degraded territory is now a reality that involves many areas of the country. This phenomenon is the result of years of wild urbanization, scarce attention to the environment and lack of effective interventions by the institutions, often too slow in protecting the contexts that surround us, favoring processes of degradation against a territory that deserves respect and protection.
The consequences of this environmental degradation manifest themselves in many ways, from difficulties in waste management and in the protection of water and air, to the loss of biodiversity and the destruction of natural and cultural landscapes of great value.
Furthermore, degraded territories often represent areas where poverty and unemployment are widespread, making the task of finding effective solutions for their recovery even more difficult.
In this article we will explore the current situation of the degraded territory in Campania, in particular in the Domitio-Flegreo littoral area, analyzing the causes of this phenomenon and the consequences it entails for the health and well-being of people and the environment. Furthermore, we will focus on some initiatives and projects that are trying to address the emergency of degraded land, exploring possible solutions and challenges that still need to be overcome to address this emergency in an effective and sustainable way.

**Keywords:** Planning, degradation, redevelopment, city.

## 1. Masterplan project of the Domitio-Flegreo coast
The project, curated by the urban planner Andreas Kipar and elaborated by the Campania Region, aims to revitalize a vast area of the Campania region.
Embracing 14 municipalities, involving a total land area of approximately 741.47 sq km and involving a resident population of over 370,000 inhabitants, it is presented for the first time in Milan on 09/05/2019. Three fundamental project axes: the redevelopment and enhancement of the ecological and landscape-environmental system, enhancement of the historical-cultural and agricultural system, the development of sustainable and integrated mobility. Before being a landscape architect, Andreas Kipar is a real avant-garde. His model of the Green Rays in Milan, intended to connect the center and the suburbs through green paths that promote slow mobility, has been an internationally recognized model. Today his ideas and his green humanistic projects find application in several urban contexts with diversified needs. Urban contexts that however have a common and shared problem. Cities need to "breathe" in order to be livable. And this is only possible by looking at nature. Kipar is known for his work on various high profile urban design projects across Europe, Kipar's work emphasizes the integration of nature and sustainable design principles into urban landscapes, creating vibrant and livable spaces that connect people with the surrounding environment.

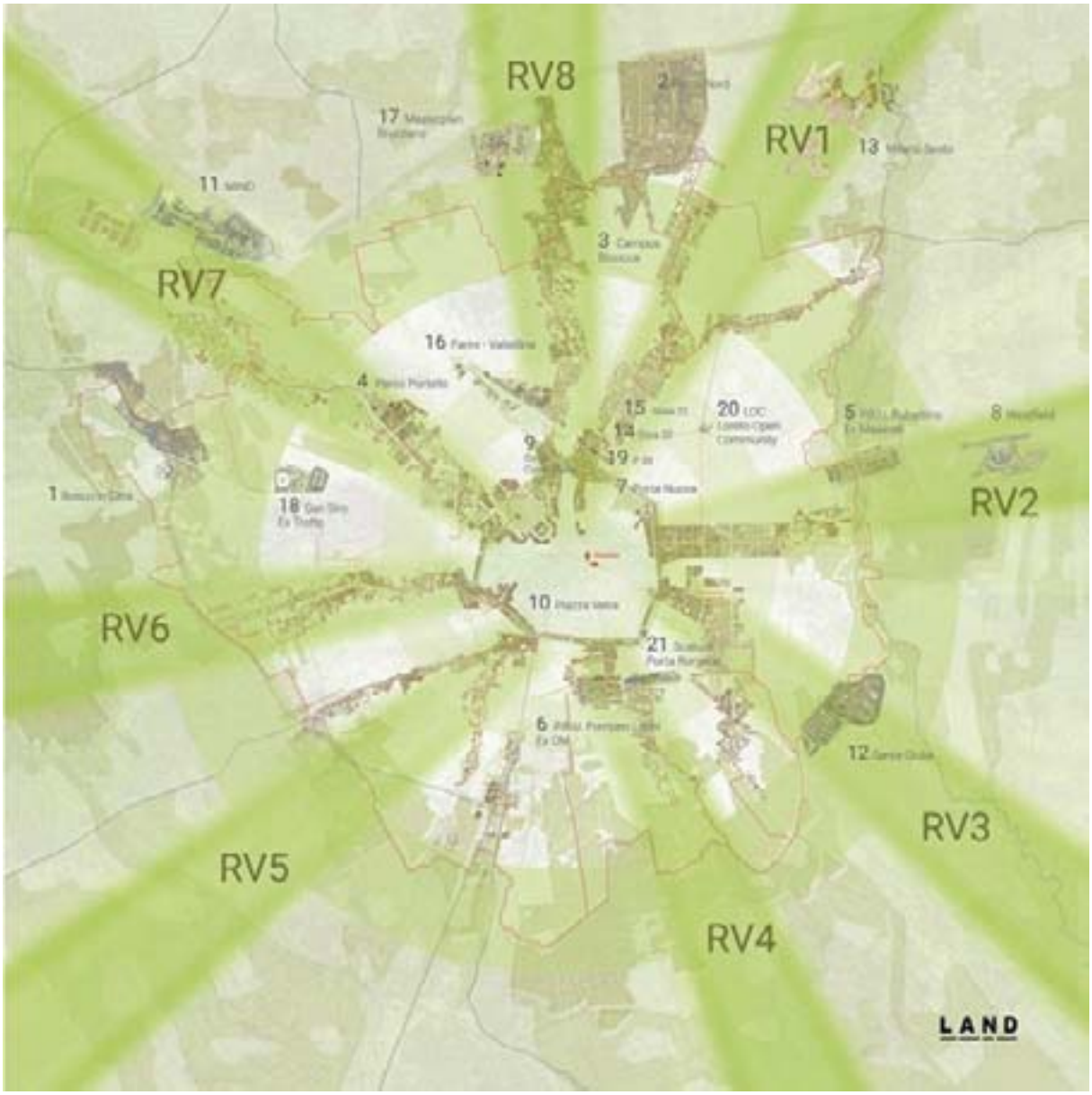


**Fig. 1:** Image of the project "Green Rays" Andreas Kipar, Milan.

Overall, Kipar's projects focus on integrating nature and sustainable design principles into urban areas, creating accessible and vibrant public spaces that improve people's quality of life. Here are some of his best-known projects:

1) Navigli Canals, Milan: Kipar worked on the redevelopment of the Navigli canals in Milan, creating a series of public spaces along the canal banks and introducing new pedestrian and cycling zones. The project has transformed a degraded area of the city into a lively and attractive place for residents and tourists.
2) Porto Marghera, Venice: Kipar worked on the redevelopment of the disused industrial site of Porto Marghera, transforming a degraded area into a public park that includes cycle paths, green areas and zones for recreational activities.
3) Palace Square, St. Petersburg: Kipar assisted in the redevelopment of St. Petersburg's historic Palace Square, located in front of the former Russian Emperor's Winter Palace. The project created a large pedestrian public space and integrated sustainable design elements such as the use of local materials and LED lighting.

**Fig. 2:** Essen Krupp Park, Essen, DE

Kipar has clear and distinguishable strengths. The sustainable approach, in fact, places a strong focus on ecology and sustainability in its projects. It works to integrate green areas and public spaces to create healthy and livable urban environments. Kipar is known for his innovative design and for his creativity and his ability to come up with innovative solutions for the projects he tackles. His work is based on a solid understanding of the history of architecture and urban planning, but at the same time he is always on the lookout for new ideas to improve urban spaces. Kipar is a strong believer in teamwork and believes that only through collaboration with other disciplines and with residents can successful projects be achieved. Kipar has worked in many parts of the world, from Milan to St. Petersburg, from Rome to Doha. This experience allows him to understand the cultural differences and specific challenges of each project, and to adapt his ideas to the needs of the place. Kipar has an eye for design and aesthetics, and believes that landscaping should be both functional and beautiful. His work focuses on creating public spaces that are welcoming, inviting and beautiful to look at.

## 2. Domitio-Flegreo Coast

The geomorphology of the place is a wonderful combination of sea, rivers, lakes, mountains and volcanic lands. From the highest peak, the Roccamonfina volcano (1,006 m), the landscape slopes down towards its 73 km of coast, through flat surfaces, partly used (31,000 hectares of agricultural land), and partly characterized by dune surfaces and thick pine forests along the coast and chestnut groves in the areas closest to the mountains. An exclusive typicality is given by the volcanic nature of the area, evidenced by the craters; in some lakes have formed (Averno, Fusaro, Lucrino); some semisubmerged have provided natural port infrastructures (Bacoli, Ischia, Nisida); others are precious nature reserves (Astroni Oasis), up to more dynamic expressions that represent their liveliness: the Solfatara and the phenomenon of bradyseism. It is no exaggeration to say that this territory offers landscapes, data and scientific elements of worldwide interest. The richness of history of this land is testified by a vast cultural heritage that has followed one another over time and can be found in the form of innumerable testimonies such as buildings, settlements and even infrastructures, built since

ancient times by the civilizations that settled and settled strong identity characteristics of the place of the people who still live there today. Suffice it to recall the Rione Terra, the Castle, the Baths and the Baia Park, the Flavian Amphitheater and the stadium of Antonino Pio and, last but not least, the Olivetti factory.

**Fig. 3:** Domitio-Flegreo littoral classification

## 3. The strategy and the project of a multifunctional center in the Sinuessa Underwater Archaeological Park in Villa Romana Punta San Limato, Sessa AuruncaCellole (CE)

The Masterplan-PIV Program aims at very specific objectives such as the redevelopment and regeneration of coastal areas, enhance the quality tourist-accommodation offer, regenerate, protect and conserve agricultural and natural landscapes, increase accessibility and enhance sustainable mobility,thevalorisation of the agricultural economy with particular reference to typical local products and organic crops and finally to widely improve the quality and environmental safety of the territory. The operational strategy of this macro-project has gathered a substantial volume of ideas and proposals for intervention, also from private entrepreneurship and the private social sector. This planning can be briefly summarized in:

10 emblematic projects that can reverse the trend of decline

93 projects of public interest

159 private investment projects and propensities collected following the public notice

63 projects, operational proposals and listening to the territory**.** The total economic value of this project "volume" is estimated at over €3.8 billion.

**Fig. 4:** Masterplan of emblematic projects.

The intervention of the multifunctional center in Sessa Aurunca-Cellole is part of one of the public projects of the Integrated Development Program triggered by the Campania Region in collaboration with the architect Kipar. The project, part of the Masterplan of the Domitio-Flegreo coast, goes into detail, designing an innovative multifunctional center that includes a hotel, a museum, a spa and a

visitor center, designed to offer visitors a complete and unique experience, immersed in nature . The multifunctional center with its cutting-edge materials and technologies aims to merge aesthetics with functionality. The intervention guarantees a high level of sustainability and respect for the surrounding environment. The various activities are developed on several levels, favoring slow mobility with a ramp placed on a different level from that of the road in such a way as to be able to give free movement to pedestrians.
The designed buildings fit perfectly into the surrounding landscape, combining art, culture, well-being and relaxation. The combination of these services and activities makes this multifunctional center an attraction of tourism, which will certainly bring wealth to the entire territory, triggering the process desired by the designer Kipar.
This design solution is configured by setting the theme of the project on a composition of intertwined circles, which generates a system of annular flows placed at different heights which allow to reach the different functions placed with the various entrances at staggered levels. This generates a system of fluid and sometimes choreographic flows, which give the project itself an interesting sinuosity.

**Fig. 5:** Photoinserimento del masterplan

**Fig. 6:** Photo insertion of the masterplan as seen from a bird's eye view

**Fig. 7:** Longitudinal section.

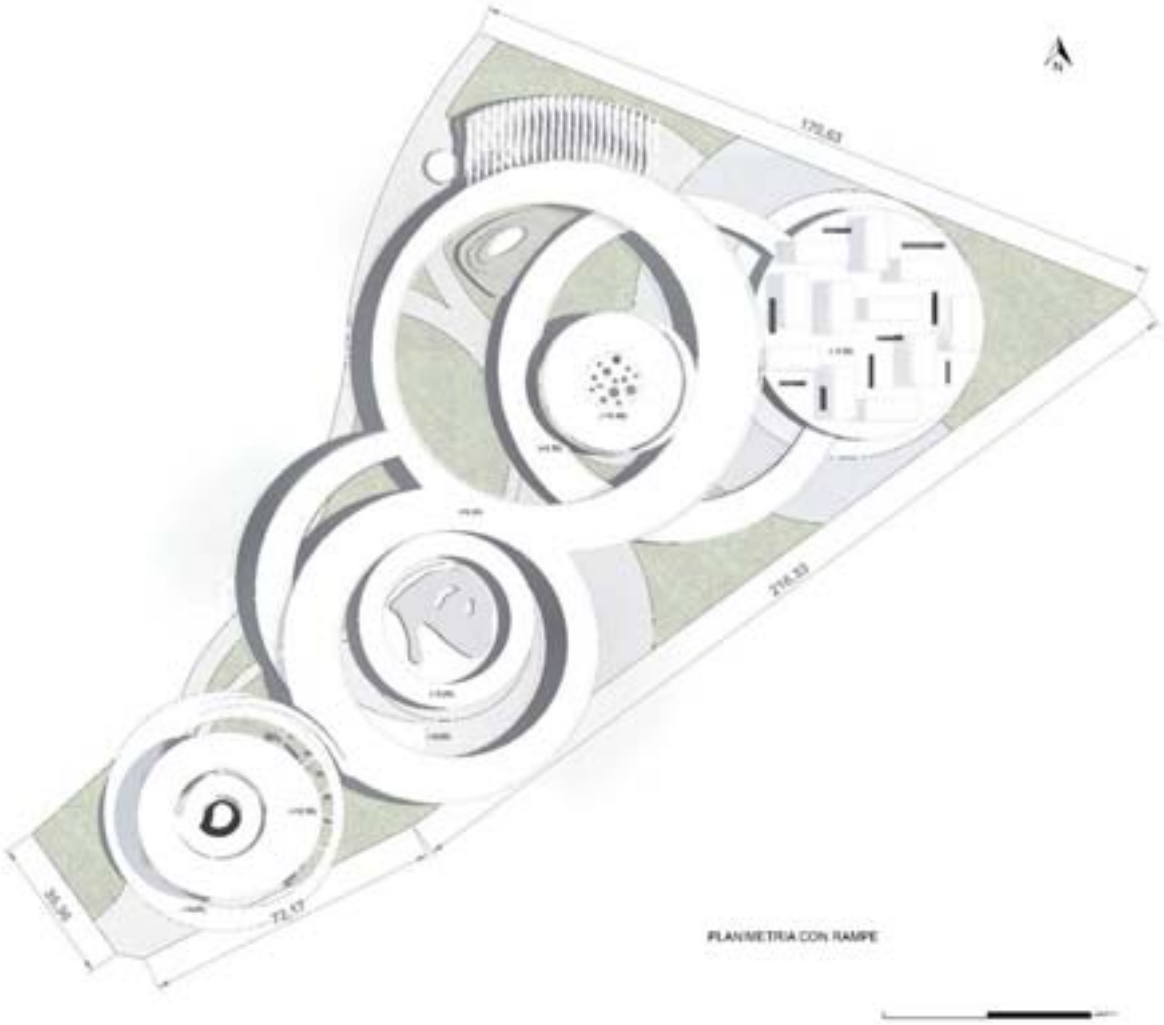


**Fig. 8:** Masterplan.

**Fig. 9:** Project model.

**Fig. 10:** Vista nadirale.

**Fig. 11:** View of the ramps.

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# Valorising public and private spaces with murals

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## Abstract

'Art does not reproduce what is visible, but makes visible what is not always visible'. I believe that Paul Klee's statement can be extended to all disciplines of complex representation, from complex drawing to innovative digital representation techniques, which include and are not limited to the fields of architecture, design, landscapes, territorial government, urban and territorial planning. In this logic, in the relationship between landscape, architecture and art, in the paper I present some murals that have had the ability to enhance public and private spaces in the Campania region and abroad: proposal for the donation to the Republic of Colombia of a 300 square meters mural dedicated to the Nobel Prize in Literature Gabriel Garcia Marquez at the UNESCO World Heritage Property of Cartagena; murals of 400 square meters for the Nobel Peace Prize winner Denis Mukwege in the Municipality of Sant'Antimo (NA) commissioned by the Honorary Consul of the Congo in Naples; murals of 200 square meters for the city of Tiriolo (Catanzaro) at the entrance to the ancient village; open-air gallery on the Luise pier in Naples for Carpisa and Yamamay brands as part of the project 'promotion and enhancement of Campania's artistic heritage; murals in the artistic and cultural center In Arte Vesuvio, on the seafront of Naples; murals in the MegaWatt headquarters in Casoria (Naples), Leonardo da Vinci conference room; and murals at the external entrance of KFC (Kentucky Fried Chicken) in Sant'Antimo (Naples).

**Keywords:** valorising, cultural heritage, art, cultural identity, territorial promotion

## Murals as a tool to promote the territory

The murals created by the author for public and private spaces address the relationships between art, architecture, beauty and the impact of the representations on the local community and on visitors, including foreign ones, in the context of cultural tourism.
Aware that with freehand drawing it is not possible to analyze and represent all the components of the architectural structure, in the many material and intangible aspects, the author belives however that this paper can contribute to deepening the reading of the immaterial aspects underlying the design idea of the murals.
Freehand drawing is therefore part of the process of acquiring knowledge which, specifically of the works analyzed in the territorial context, involves the relationships between technology, society, politics and the economy.
The hand drawing technique, as an integral part of the complex and multidisciplinary representation process, is based on the concept of measurement: 'measuring and discretizing in batches means detecting in the sense of managing a complex heritage, as historically already indicated by Luca Pacioli. In this sense, the infinite reasons Cassirer talks about are the n dimensions that make up reality and in this dynamic and continuously implementable meaning of knowledge that cannot be exhausted in any

degree, the infinite reasons must be combined with technological interfaces, such as applications of knowledge, to externalize its integral as knowledge to date' [1].
The murals created are inspired by visions of cities, cultural landscapes and architectures that draw lessons from the great past and contemporary architects.
In the relationship between people and built spaces, public and private, Wright, in an essay dated 1908, writes that good architecture, as well as a good pictorial representation that characterizes public spaces, should promote the democratic ideal of the 'maximum possible expression of 'individual as a unit not incompatible with a harmonious whole'.
This vision certainly animates the Guggenheim Museum in New York. In defining the project for the Guggenheim Museum, Wright brings together his constant ability to interpret the wishes of the client with his innate gift for dialogue with the various players in the construction process of the work, just as the murals need to dialogue with clients and local, public and private actors [2].
Another important source of inspiration for the creation of the murals comes from the architectural poetics of Mies van der Rohe. The German architect joins the Bauhaus avant-garde design school as director of the architecture sector: adopts and develops the functionalist theoretical assumption of the use of simple geometric shapes in the design of useful objects, just as in the design of the murals the author uses simple and synthetic shapes to express the sense of the landscapes and architectures represented.
Mies van der Rohe is attracted by simple, rectilinear and planar forms, by clean lines, by the pure use of color and by a concept of extending the space beyond the walls in the internal-external relationship; theories expressed by the Dutch Neoplasticism art movement De Stijl [3].
The design theories of Adolf Loos found resonance with Mies, in particular the idea of eliminating superficial and unnecessary decorations, replacing elaborate ornaments with the simple use of construction materials that defined the forms of the works.
Loos had famously declared, with the ironic humor of the time, that 'ornament is a crime'. Also, Mies admires Loos' ideas about the nobility that could be found in the anonymity of modern life.
In the murals created by the author, architectures, including historical ones, are synthesized through synthetic lines and volumes, bright colors that express a dynamic sense of frenetic contemporary life.
Mies painstakingly studies the great philosophers and thinkers of history to further his understanding of the character and essential qualities of the times in which he lives. Probably more than any other practicing pioneer of modernism, Mies draws on the writings of philosophers and thinkers to develop ideas relevant to his mission of representing architectural space. The conceptual principles of Mies' architecture are defined at a high level of abstraction and the generalized descriptions of the theoretical principles intentionally leave ample space for interpretation [4].
The colors of the murals created often recall a typically South American culture with examples of similar works in terms of shapes and colors in Brazil, Venezuela and Colombia. An important cultural reference is certainly represented by the Brazilian architect Oscar Niemeyer, who was considered by many, in the United States and in Europe, as a precursor of modern rationalism, characterized by a profound influence of South American, and specifically Brazilian, culture. In the fifties, Gillo Dores believed that Niemeyer's Brazilian architectures expressed a 'neo-baroque' character, while Reyner Banham described them as the first national expression of modern architecture [5].
His declaration of love for the shape of buildings cannot be dissociated from a tribute to the lesson of his master, Lucio Costa, which Niemeyer constantly recognizes in the search for his architectural language. In this design and inspirational matrix, he develops, in his own functional and decorative style, a repertoire of constructive and decorative elements which have the beauty and the plastic form of the artefact as parameters of comparison [6].
Niemeyer was therefore a pioneer of modern Brazilian architecture, which combined pragmatism and organic and sinuous forms, expressed through suspended curved roofs and dynamic interpenetrations, while always remaining in contact with the functional work of great masters such as Le Corbusier. Niemeyer says ‘The right angle, or the straight, hard, inflexible line invented by man, does not attract me.
The free, sensual curve attracts me. The curve that I see in the mountains of my country, in the meandering rivers, in the waves of the sea, in the female body that I love. Curves make the universe’ [7]. In this framework, the murals created by the author are characterized by curved lines that find their matrix in the signs of nature, in the curves of landscapes and in the bodies of women.
Another important aspect that characterizes all the murals described in the paper is the theme of cultural contaminations. The architectural reference is, in this sense, the architect Zaha Hadid, whose works are characterized by numerous cultural contaminations: the identity influence of her Iraqi culture; the fluidity of Arabic calligraphy; and the influences of architectural and artistic schools, including Suprematism and Deconstructivism.
Her early projects reflect the ideas of deconstructivism, which draws on influences from various sources such as suprematism, constructivism, parametric architecture. Nature is the primary source of inspiration for the creation of sculptural images and volumes. Hadid was influenced and inspired by Rem

Koolhaas, Elia Zenghelis, Kazimir Malevich, Chinese and Japanese architecture. The Iraqi architect understands the roots of modernism, believing in a new structure and a new expressive language.
Even if her projects are contaminated by the ideas of modernism, they represent an overcoming of it: she breaks down the inherited rules of architecture and presents, through hes works, freedom through drawing and architectural representation [8].
Hadid has challenged rules and conventions, creating daring works between architecture, industrial design and art, which seem to go beyond the same principles of static equilibrium. She created her own expressive language through radical design rules influenced by his rationalist experience. The architect seeks aesthetics in art, nature and architecture and applies it in the design of her works. And this is exactly what happens in the murals described in the paper where dreams and reality merge in a dreamlike representation that goes beyond the boundaries of descriptive and naturalistic representation, transfiguring people, architectures, cultural and urban landscapes
The reference to the iconic symbols of the murals draws inspiration from the architecture of Frank O. Ghery, as well as the ability to redevelop urban districts, fragments of the city, or even promote cities worldwide through art as in the case of the Guggenheim in Bilbao. According to Evans, the Guggenheim Museum in Bilbao can be considered the 'first global museum' [9].
He argues that if on the one hand the Pompidou Center in Paris has triggered the regeneration process of an urban area with its creation, it is true that the Guggenheim in Bilbao has triggered a regenerative process for the entire city, which becomes, in the collective imagination, one of the most iconic symbols of urban landscape creation in recent decades.
Bilbao's renaissance has also been boosted by public investment in new rail, air and road systems, including an airport terminal designed by Santiago Calatrava, and a new underground metro running along both banks of the river, designed by Richard Foster. Sklair believes that the main feature of the Frank Gehry Museum is that it has transformed the city into one of the main weekend tourist destinations in Europe, also thanks to other iconic architectures such as the airport and the Calatrava bridge, and the metro system designed by Foster [10].
Also, Muratovski points out that Gehry's Guggenheim Museum in Bilbao is one of the clearest examples of brand promotion in the field of cultural tourism [11].
Although the Museum has several functional disadvantages, such as limited exhibition space, its branding represents an extremely effective marketing tool for the city of Bilbao.
In fact, from the outset the architectural complex had not been conceived simply as an art museum, but in the strategic intentions of the city administration, it had to create a symbolic structure to promote territorial identity and stimulate cultural tourism in order to make revive the city and its economy, through a creative industry involving commercial activities [12]
The murals created, obviously with the right proportions, try to recreate points of reference for the entire community, also thanks to the recognizability of the pictorial stroke, between fantasy and geometric rules, between architecture and art [13, 14].

## Murals as a tool to promote the territory

The author proposes the donation of a 300 square meter mural in honor of the Nobel Prize for Literature Gabriel Garcia Marquez in the city of Cartagena.
The work has the moral patronage of the In Arte Vesuvio art, cultural and entertainment center (IAV Club) on the waterfront of Naples, of the UNESCO Chair on Landscape, Cultural Heritage and Territorial Governance at the Benecon University Consortium and the financial support of the Yamamay international brand.
The proposal has already been sent to the Colombian Government through the Colombian embassy in Rome, and the honorary consulate of Colombia in Naples. This is the synopsis of the work: Parthenope, the founding siren of Naples, has yellow wings, a symbol of Gabo's magical poetics. The work is a gift from San Gennaro to the words of love that overcome time. Vesuvius explodes the colors of Colombia and Italy that intertwine in a friendship that has the tones of passion, frenzy, life.
The Torre del Reloj is the symbol of Cartagena, a tree of life and the colored arches of the colonial architecture follow different inclinations and reflect on themselves, because perspective diversity is a new and ever-evolving perspective on the world.
The boat of the eternal journey, the Latin sail of Mediterranean contamination, a shower of flowers that marks the transition between life and death, a sweet melody cradled by the waves of the sea.

Photo-rendering in honor of the Nobel Prize for Literature Gabriel Garcia Marquez in the city of Cartagena

## Mural dedicated to the Peace Nobel Prize Denis Mukwege, Sant'Antimo (Naples)

The work was commissioned in 2022 by the honorary consul of the Congo in Naples Angelo Melone to celebrate the visit of the Nobel Peace Prize winner Denis Mukwege to the consul's native city. The murals on the facades of two buildings cover a total of 400 square meters: 200 square meters per building. A mural is dedicated to the cultural contamination between Italy and the Congo with material and immaterial symbols of the city of Sant'Antimo and the culture of the Congo. The second mural is dedicated to the figure of the doctor Denis Mukege and his work in the fight against violence against women.



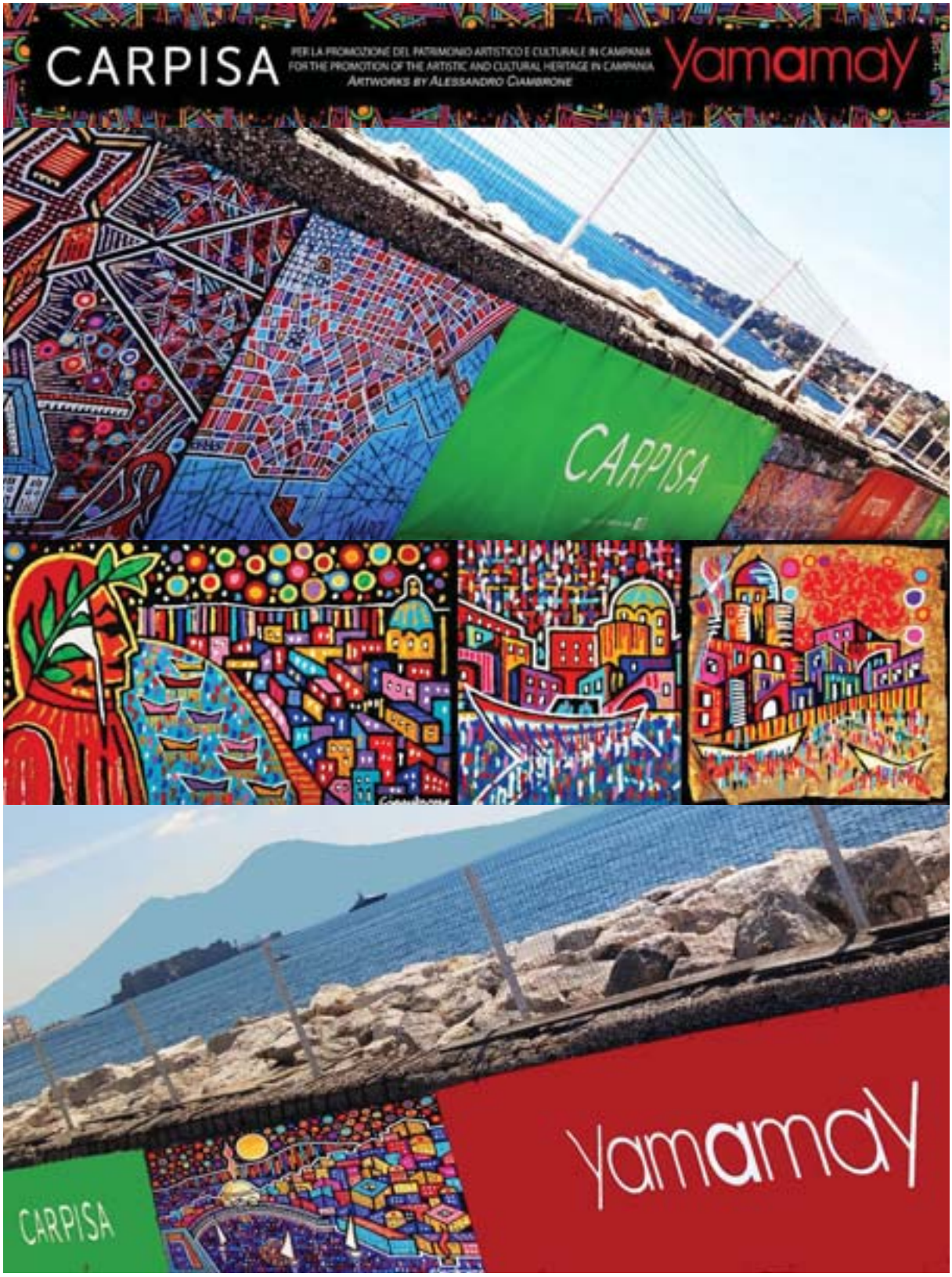

Mural dedicated to the Peace Nobel Prize Denis Mukwege, Sant'Antimo (Naples)

## Murals at the entrance to the ancient village in the city of Tiriolo (Catanzaro)

The work, created in 2022, extends over a wall at the entrance to the ancient village for about 200 square meters and was donated to the city of Tiriolo in the Calabria Region. The work was created with the participation of the local community and represents the most important elements of the city's architecture, but also the symbols of faith, such as the Madonna della Neve, and of ancient tradition, such as the good luck masks.

## Open-air gallery on the Luise pier in Naples for Carpisa and Yamamay brands

The work consisting of a mobile installation of 200 square meters, has been present on the Luise pier in Naples since 2020 and is the emblem of a project entitled ‘For the promotion of the artistic and cultural heritage in Campania: artworks by Alessandro Ciambrone’ financed by Carpisa and Yamamy brands. The author elaborated differend drowings to celebrate the six World Heritage Properties of the Campania region [Naples, Caserta, Pompei, Amalfi Coast, Cilento, Benevento (Church of Santa Sofia)] and the islands, Capri, Ischia and Procida, Italian Capital of Culture in 2022.



## Murals in the artistic and cultural center In Arte Vesuvio (IAV), Naples

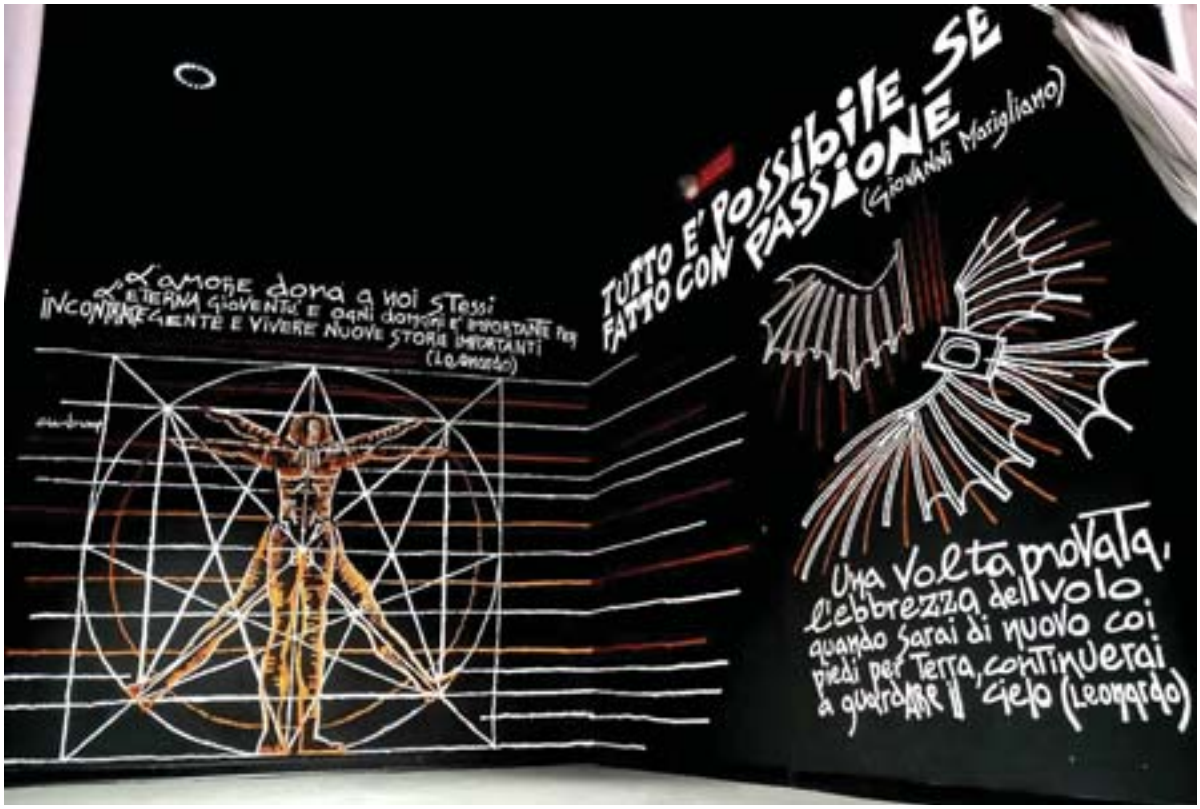
IAV enhances the creativity of Naples and Campania, and promotes art, culture, training and creative enterprise. The splendid location of 1500 square meters located on the waterfront, in via Nazario Sauro, enjoys a breathtaking view of the gulf and Vesuvius, and consists of: panoramic restaurant, theatre, cafeteria, lounge bar, kids play room and art laboratories. The multifunctional and dynamic structure, unique in its format, conceived and founded by the sisters Angela and Lucia Andolfo, is characterized by the the murals of the author. IAV represents an extraordinary and innovative creative enterprise, a raging river, magmatic and impetuous, between art and genius, which flows between the millenary stones of Naples that surround the artistic pole: Castel dell'Ovo, kingdom of the legendary Sirena Partenope, Santa Lucia, Vesuvius, Piazza Plebiscito, the San Carlo Theater.




YAMAMAY
JOVA 2022
Beach Party

## Murals in the MegaWatt headquarters in Casoria (Naples)

The murals were created in 2023 for the Leonardo da Vinci conference room of the Megawatt headquarters and represent, in the atrium of the conference room, interpretations of Leonardo's drawings: the Vitruvian man and the flying machines. In the ‘regia room’, on the other hand, a work entitled ‘Plebiscito Square of scene at the San Carlo Theatre’ was created.




## Murals at the external entrance of KFC in Sant'Antimo (Naples)

The work was created in 2023 at the entrance of the KFC complex in Sant'Antimo, on the ancien Appia road, which represent one of the main axes to the entrance in the city. It has an extension of 30 square meters and the completion of the entire external wall of the structure is expected to be realized soon for another 100 square meters with lettering and icons typical of pop and Mediterranean art culture.

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