

# PRINCIPLES OF RESILIENCE AND REGENERATIVE DESIGN IN COASTAL ENVIRONMENT

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## ABSTRACT

The paper explains critically principles, methodological approaches and strategic project actions for a greater resilience of the built environment. In particular, the concept of resilience is explored in relation to sustainability and Regenerative Design applied to the built environment. The theme of Regenerative Design is studied and promoted as an adaptive strategy in the planning phase, it requires, compared to Resilience's theme, that nature strengthens its capacity for self-healing and its integrity, trying to give us back what the industrial development has taken away from the natural system, through the use of integrated regenerative methodologies. We examine in depth the case study of Palma di Montechiaro, that is the creation of Guidelines for the resilient regeneration of the Marina di Palma's waterfront. The contribution is aimed at academics of architecture and technological design interested in examining in depth the principles and systems of resilient design and sustainable regeneration. These systems are absolutely innovative from a technological and morphological point of view also in the use of vertical gardens with particular local plant species.

## KEYWORDS

resilient design, regenerative design, built environment, technological design

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Resilience is the ability of individuals, communities and economic systems that structure a city to survive and adapt as a result of a disaster they suffered (The Rockefeller Foundation and Arup, 2014). The term 'resilience' should be interpreted as an admissible transformation-alteration of the environment to protect in safely its accessibility and usability. Architectural and urban resilience is the ability of a territory to adapt positively to change, «[...] the capacity to lead to a continued existence by incorporating change» (Folke et alii, 2002, p. 437), i.e. the ability of a city or building system to regenerate itself after an adverse event. The resilience's theme is linked to spatial and environmental conditions, procedural and technical-constructive aspects, which seek strategies for forecasting, preventing and adapting to impacts and planning mitigation measures.

The emergence of resilience among the priority objectives of the scientific debate highlights a particular interest in the possible transformations to be achieved in response to risk management, whether natural and/or anthropogenic. In fact, the resilient project must be able to combine conservative, adaptive and regenerative capacities aimed at limiting the impacts and fragilities resulting from extreme events: disasters, unbridled land consumption, etc. Urban systems show large degrees of inadequacy during the tragic seismic and/or environmental events that occurred in Italy recently and that have produced collapses and very serious damages, followed by social difficulties and direct and indirect local economic repercussions, caused by the total inability to react. According to this orientation, the 'resilience project' must analyse the differences that are found in a territory/city/building system, affected by an extreme event, and its ability to return to its state of equilibrium after disasters.

The natural event is not the only in determining catastrophic events as nature is not the only responsible for these events. It's interesting to observe the connection between the fragmented and disordered contemporary urban dynamics and the exasperated anthropization of the built environment, Faroldi writes: «The anthropized environments reveal their poor adequacy to respond to performance, technological and organizational levels related to a changing functional and behavioural composition of users and systems that characterize contemporary urban dynamics. [...] This phenomenon, together with parallel structural elements linked to building speculation, land consumption, marginalisation, peripheralisation, fragmentation and dispersion of urban fabric, highlights how the growing anthropic pressure is massively contributing to the modification of the socio-ecological balances of global urban scenarios» (Faroldi, 2018, p. 9).

And which scenarios have more environmental impact than the abnormal concretising of the sea coasts and riverbanks? The coastal environments in Italy and in Europe are the most affected by unbridled anthropization, in these places is more evident that nature has been violated by human irresponsibility and it is less recognizable in terms of identity. Coastal environments are places where it is built defying nature, but sometimes nature is dangerous because of the occurrence of sudden tragic events: floods, overflows, landslides, etc.

In light of these considerations, resilience must be designed and built by giving value to the strategic management of the emergency, through the ability of society to react to critical issues and adapt to change. In fact, these critical issues tend to penetrate all levels of the affected environmental context and expand into all aspects of living. In a city affected by a disaster, emergency management cannot, therefore, be limited to a single disaster. The management of the emergency must be extended to all ordinary living practices that are exposed to the risk and which cause serious problems for the living, production and recreational practices that take place in the city itself (Angelucci et alii, 2015).

Resilience can be increased by programming mechanisms that are inert until unforeseen impacts occur, in order to restore the performance of an affected urban system. Knowledge of the reasons for its inadequate responses is fundamental to designing resilience. These are the characterizing elements of the demanding-performance approach, aimed at enhancing the resilience factors intrinsic to the built environment, both in material and immaterial aspects. The substantial factor of the intangible aspects involved in the design of resilience is the social aspect. Social resilience can be assessed through resistance to external shocks and creativity in response (Adger, 2000). The approach to social resilience places the community at the heart of the project, as a whole capable of determining resilient processes. According to Lorenz (2013), social resilience lives in the adaptive and participatory capacity of the community affected by adverse events, i.e. the ability to cope with widespread hardship and to preserve and give continuity to its system of relationships.

In the resilient process, participation is to be considered as an action aimed at an active and responsible involvement of the user, who from a beneficiary of an asset becomes an active subject. Thus, the technical-scientific approach of resilient design must inevitably connect to the social values of cohesion and cooperation aimed at finding a new shared balance. In this participatory perspective, the capacity for regeneration and reorganization of the built environment will take place as a reinterpretation and attribution of new meanings and new functions, enhancing the identity characteristics of the environmental and social context. In the participatory project of environmental regeneration, the community itself defined the decision-making processes and objectives to be achieved. By promoting the participatory approach of users, the connections between aspirations, inhabitants' needs and project results are enhanced and the sense of belonging is strengthened. The objectives of the resilient project include on the one hand the right of the community to improve its urban environment, on the other hand, the attention to the needs of those in vulnerable situations and therefore the design of appropriate systems for accessibility.

**Regenerative Design** | As early as the end of 1970, Professor John T. Lyle, promoter of Conventional Thinking, introduced the concept of 'resource limits', making his students imagine a community where daily activities could take place within the limits of

available sustainable resources, without degrading the environment. Also in the 1970s and subsequent decades, R. Walter Stahel, one of the fathers of the circular economy, also made a decisive contribution to the development of re-generative theories as promoter of Eco-Efficiency and co-founder of The Product Life Institute in Geneva. The first theories of Regenerative Design, therefore, took shape from the principles of sustainable development integrated with environmental responsibility, economic sustainability and social sharing. The principles of regenerative design still focus on theories of environmental regeneration on the community scale. At different levels – inhabitants, families, communities – in case of earthquake disaster a resilient city can in some cases maintain sufficient conditions of adaptability and liveability. With respect to climate change disasters, however, resilience can sometimes not be sufficient to ensure adaptation to possible weather impacts (floods, sudden rise or fall in temperature, fires) and the associated vulnerabilities.

The issue of climate change is complex and constantly changing. Damages created by global anthropic pressure are considered largely irreversible «[...] firstly we know that the greatest damage to the Earth's atmosphere (greenhouse effect) is due to the use of fossil fuels and related combustion phenomena, generated by human activities; secondly, the increase in temperatures – together with an inadequate construction of buildings, which are highly dispersing – has produced a reckless use of cooling systems, whose production machines increase the phenomenon of ozone-thinning; in other cases, on the other hand, some forms of energy appear necessary to counteract the effects of climate change on a large scale, and finally, the sun, like other sources of pure energy, threaten to change their role on Earth, precisely because of overheating due to the greenhouse effect, as well as numerous environmental disasters in the soil and the atmosphere» (Francesse, 2018, p. 1). Preventive maintenance behaviour can restore new equilibrium and avoid disasters where the environmental context is not particularly tired because of past damages. Where damage has occurred or is in progress, Regenerative Design can be used, it is a contemporary design method aimed at activating 'regenerative' processes of restoration, regeneration and revitalization of an environment through the production of relationships between the daily needs of society and nature.<sup>1</sup>

In the Editorial of the first issue of 1978 of *Spazio e Società*, Giancarlo De Carlo, already anticipated some themes on the shared processes of transformation and regeneration of an environment marked by imbalances: «[...] The transformation of the physical environment passes through a sequence of events: the decision to create a new organized space, the revelation, the finding of the necessary resources, the definition of the organizational system, the definition of the formal system, the technological choices, the use, the management, the technical obsolescence, the reuse, the physical obsolescence. This concatenation is the entire spectrum of architecture and each of its parts is affected by what happens in all the others. It also happens that the frequency, amplitude and intensity of the various parts are different according to the circum-

stances and in relation to the balances or imbalances of the contexts to which the spectrum corresponds. Moreover, each spectrum is not exhausted at the end of the concatenation of the event, because the signs of its existence – ruins and memory – are projected onto further events. Architecture is involved in the totality of this complex development: the project it expresses is the starting point for a process of long duration and significant consequences» (De Carlo, 1978, p. 1). De Carlo was a forerunner of inclusive processes and transformative/regenerative issues used for those urban and suburban environments characterized by strong urban and social degradation.

In the social degradation that normally accompanies urban and/or environmental degradation, each project dropped from above is in fact not very effective and not at all decisive. Instead, urban regeneration processes must be implemented on the basis of consultation with the local community. Only in this case will the resulting project be long-lasting, not only because it is well accepted by the community that participated in its creation, but above all because it meets the needs of that community. The inclusive project is a resilient project because it is the result of a process that is formed from direct information aimed at capturing the different reactions of the community, its current and past aspirations and needs.

**Resilience, renaturation and regenerative design: the case of the Marina di Palma waterfront** | A new awareness of the fragility of natural balances, combined with an increasingly necessary environmental responsibility leads to further reflection on the role of architectural technology in the regeneration of the built environment and in particular of coastal environments degraded by an aberrant anthropization. For several years the University of Palermo has been making a significant contribution to the research on methods to be used for the regeneration of degraded contexts caused by natural and/or anthropic damages. From 2010 to date, several case studies have been carried out in the province of Palermo, Trapani and Agrigento and in parallel in the Greek islands of Kos and Rhodes thanks to a scientific research agreement signed between the University and the Aegean Archaeological Institute, a research institution responsible for the study and enhancement of architectural heritage and cultural and environmental heritage based in Rhodes (Greece) and now at the Ministry of Cultural and Environmental Heritage.

In this contribution, we have chosen to present the results of the research related to the case study of Palma di Montechiaro, and in particular to the regeneration of the waterfront of Marina di Palma, which for years has been affected by several dangers caused by whirlwinds, landslides, typhoons, floods and sea storms caused by the obsolescence of the port organisation and the ‘cementing’ of the coast due to strong building speculation (Fig. 1). The project for the regeneration of the waterfront of Palma was born from a precise request of the Municipality of Palma di Montechiaro, as a partner of scientific research, to create the Guidelines for the regeneration of the port. This regeneration has a dual purpose, on the one hand, the desire to repair the damage



**Fig. 1** | Marina of Palma di Montechiaro (credit: R. M. Vitrano, 2019).

present in the marina and its coastline, because of the continuous sea storms caused by the rising sea and the inadequacy of the breakwaters, on the other hand, the desire to redevelop the building facades and the coast by including new services for the local community and tourism. The collaboration of the technical office of the Municipality of Palma di Montechiaro with the University is regulated by an agreement that establishes the contents and objectives of the research project as well as the tools and phases of the design process.

The research project is characterized by this fruitful coordination between the Municipality, the university institution and the neighbourhood committees specifically set up to share the project process. The first part of the research concerned the analysis of the state of the art and in particular the study of two major international cases of the Dutch territory: the Rotterdam waterfront and the Amsterdam waterfront. The selection of these projects was carried out on a range of waterfront projects created in Northern Europe (illustrated in several meetings with the local community, representatives of the Municipality and the University)<sup>2</sup>. Rotterdam and Amsterdam are selected because they partly meet the high expectations of the Municipality of Palma, which sees the regeneration of the waterfront as an important tourist attraction. In particular, Rotterdam and Amsterdam are two cities characterized by a strong relationship with water, in which Palma identifies itself.

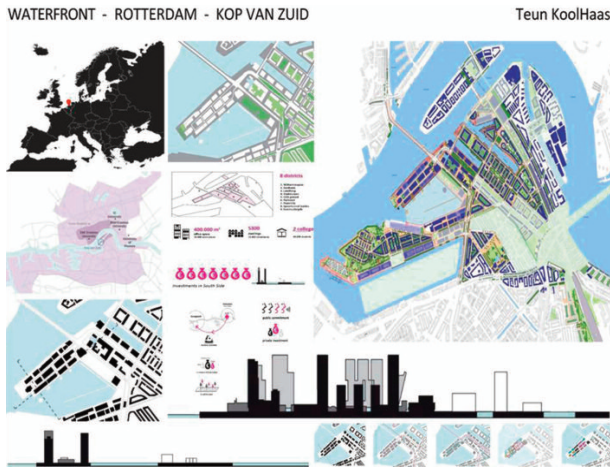


Fig. 2 | Rotterdam Waterfront, analysis table (credit: U. Trame, 2017).

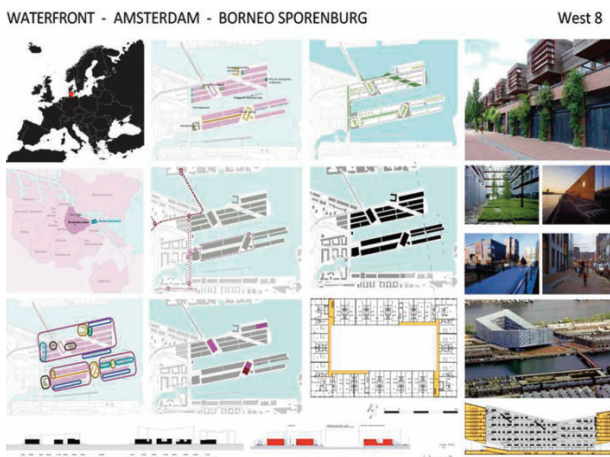


Fig. 3 | Amsterdam Waterfront, analysis table (credit: U. Trame, 2017).

Rotterdam and Amsterdam consider their waterfront a distinguishing feature of their identity. And it is also in this search for identity that Palma sees herself as a participant in the Dutch experience and at the same time, it's attracted by the technological innovation that the two projects express. The projects are united by innovation, and there are no critical points in them but only opportunities and interesting design ideas, which can be analysed and re-contextualized despite the geographical and climatic distance. The Dutch experience is selected above all because it is characterized by the desire to give a concrete response to the adverse environmental and climatic problems that afflict the whole of Europe. The Rotterdam and Amsterdam waterfront project has no critical issues related to their context, nor to the Sicilian context, which is perfectly aware of its spatial and environmental limits.



**Fig. 4** | Palma di Montechiaro Waterfront (credit: R. M. Vitrano, 2019).

The study of the Rotterdam waterfront regeneration project makes us understand the impressiveness of the design choices in terms of innovation and landscape solutions. Very unusual are the architectures on the water that offer interesting analogies in the design of the dock of Palma di Montechiaro. Thus, the study of the routes, the inclusion of services and the location of new poles of attraction is also peculiar. The study of the Amsterdam waterfront, on the other hand, shows how the relationship with nature is also a priority in the interpretation of this project, which takes advantage of the presence of a park on the water. The whole project is characterized by a constant search for the landscape, both in the construction of the park and in the existence of the green facades and hanging gardens created on the port buildings (Figg. 2, 3).

The waterfront regeneration project in Marina di Palma (Fig. 4) took advantage of this knowledge by analysing the selected projects always in relation to its original context. It is generated by the analysis of a large number of variables, intrinsic to the local system and climate variables. In the regeneration of Palma's waterfront, the technological design is not only a repair tool (as it creates technological systems capable of providing the port and quayside with new environmental quality services) but also an instrument capable of a strategic function in terms of resilience and 'naturalisation' of the existing building.

In the regeneration project what characterized the preliminary investigation process was the search for a direct and visual approach with the 'things' of the place and with the spaces of the social. This investigation into the urban context revealed the various design approaches that formed the basis for the Marina di Palma project, in particular: a) the need to transform the building facades in the relationship between the original building and the green technological system; b) the compatibility between the new architectural organism and the physical, social and cultural space that receives





**Fig. 5** | Marina of Palma di Montechiaro, analysis table (credit: R. M. Vitrano, 2019).

it; c) the opportunity to use eco-sustainable construction techniques in relation to the local material culture and environmental characteristics.

Compared to the environmental context, research has identified a privileged field of technological experimentation<sup>3</sup> by activating an integrated design policy aimed at the eco-sustainable redevelopment of buildings on the Todaro waterfront (Figg. 5-7). Plant façade are a particularly distinctive innovation tool on the urban scene. The use of vegetation as a collaborative element in architecture has a growing role, with multiple benefits (climatic, environmental, social, aesthetic, hygienic, etc.) brought by plant insertion.

The technical definition of the elements and subsystems that distinguish the use of vegetation in the architectural shell must represent the peculiarities of the system, in order to identify and correct its criticalities. The technical and functional development of these green shell systems will be the guiding thread of the methodological choices made during the research, with the aim of defining theoretical and practical tools to help the designer. The use of the green shell, as a system of new characterization of the coastal environment, is tested for the entire arc of the seafront. In this area, in addition to the renaturation of the buildings with the introduction of green facades, new urban centralities have been designed in the urban voids. These will act as connectors

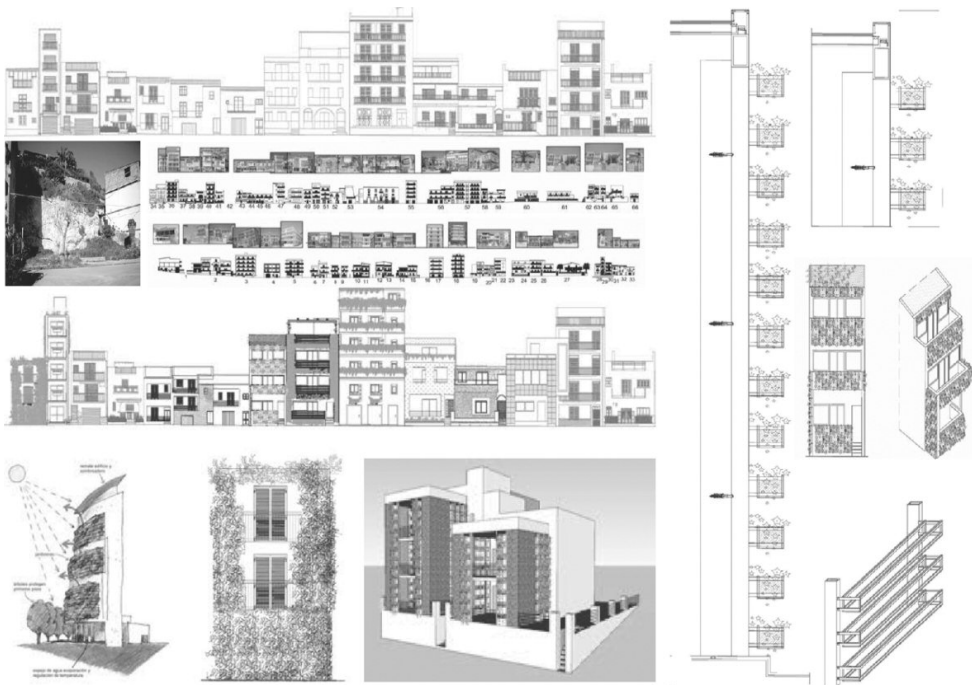


**Fig. 6 |** Redevelopment scheme of the buildings taken as a sample for the waterfront (credit: R. M. Vitrano, 2019).

for development and contribute to promoting the local reality, in a constant interaction between past identities, technological innovation and resilient transformation.

With these systems, therefore, new scenarios of the encounter between architecture, nature and resilience are opened up, which must be absolutely encouraged. These solutions require careful integration between the basic structural element (masonry, bases, balconies, loggias etc.), the technological support system and vegetation. The research, therefore, meets the interest of the international scientific community by introducing a different paradigm of urban regeneration, which promotes a resilient response to environmental risk through a great involvement of the generating force of nature. The research, therefore, cannot and does not intend to exhaust the topic of resilient coastal regeneration, but intends to be a contribution to it.

**Strategies of resilient transformation and natural development factors |** In order to be able to realize new conditions of the resilience of the territory of Palma, the factors that, by exerting pressure on environmental resources, hinder its resilient development have been examined in depth. The main criticalities found are related to the uncontrolled exploitation of the soil and the improper use of urban space, to the presence



**Fig. 7** | Regeneration of the buildings front on the coast of Palma di Montechiaro (credit: R. M. Vitrano, 2019).

of a strong building degradation and to anthropic pollution. These criticalities are contrasted by the factors of potential revival, of which the territory of Palma di Montechiaro is particularly well-stocked, determined by the existence of an attractive natural heritage. An analytical-comparative design methodology has been adopted, which has previously examined the following factors: a) the quality of the pre-existing structures; b) the use of environmental resources; c) knowledge and interpretation of the architectural and construction vocabulary; d) the preservation of the original identity; e) the articulation of space and usability; f) the identification of transformability thresholds; g) social expectations, performances offered and requirements.

The strategies of resilient transformation of the built environment that have been taken into account concern the following aspects: a) the improvement of the environmental quality of buildings on the seafront and the way in which urban space is used; b) the definition of innovative approaches and strategic actions for the management of the environmental requalification project; c) the promotion of territorial marketing as a strategic tool for development; d) the participatory involvement of citizens for a common construction of the priority of interventions and the sharing of responsibilities. In order to achieve a cohesion between the needs of the residents and the strategic choices of the city's development, a participatory public decision is

necessary, even in the initial planning phase, so that objectives are defined univocally, therefore, «[...] a synergistic action between resilient and sustainable design and conscious and active participation» (Lucarelli, Mussinelli and Daglio, 2018, p. 15).

The result of this study is the elaboration of the Guidelines for the resilient regeneration of the waterfront of Marina di Palma, starting, on the one hand the redevelopment of buildings on the seafront with the greening of the roofs and the seafront and on the other hand designing new functions compatible in the empty urban spaces, re-designing the quay and the seaside promenade in accordance with safety criteria. With the implementation of the waterfront regeneration project and creation of the Guidelines also in the economic aspects foreseen, future developments will lead to responsible use of the coastal environment at the service of the local community but also addressed to the tourism sector to increase the development of the territory of Palma di Montechiaro.

**Conclusions: designing regeneration for resilience** | Principles and aims of the resilient project must be interpreted in terms of compatible transformation and sustainable enhancement of the built environment. With this in mind, the environmental context is understood as the physical and material, but also social and cultural, which must be inspected and known to organize new balances. Knowledge of the environmental context means the examination of both the intrinsic characteristics and the functional and performance characteristics of obsolescence belonging to a specific system that has undergone an unexpected and/or extreme transformation. The identity factors that qualify a territory, their proofs recognised by the local community and the shared planning must be researched, studied and enhanced as fundamental principles for the resilient planning.

These principles are useful for developing the social awareness that is essential in the construction of an active role in managing transformations of the built environment. A resilient approach must identify ways of managing transformation, not as a result of an imbalance but as a manifestation of a ‘dynamic project’ that transforms the built environment respecting all its permanent characteristics even if these characteristics after the extreme event must be sought, reread and re-interpreted in the new condition of current equilibrium. Therefore, in accordance with much of the literature on the subject, only partly quoted here in some of its most current visions, it is considered that mitigation, adaptation and resilience measures should not be seen as a simple ‘technical response’ to environmental degradation at different scales, but should be the result of an integrated and shared process between serious planning and ‘appropriate’ technological design, i.e. based on effective technologies aimed on the one hand to protect and on the other to grow a healthy urban environment.

The research has also examined in depth the resilient design considering, also in methodological terms, the similarities with the principles of Regenerative Design. Regenerative Design is defined as a result of the evolution of environmental thinking and

mainly as a very ambitious cultural and scientific proposal present in almost all phases of resilient transformation processes. Regenerative Design aims to give back to the territory and the city what the aberrant anthropic development has taken away from the natural system. Through Regenerative Design and as a function of resilience, 'clean' production systems have been experimented, optimizing technological knowledge. The Regenerative Design method, being mainly focused on adaptive strategies and on the 'self-healing' abilities of territory, has achieved an important evolution both in the principles and in the practice of local sustainability.

Actions of Regenerative Design have been mainly focused on the efficient use of resources and the reduction of environmental degradation in the territory of Marina di Palma. The regeneration project of the waterfront of Marina di Palma wanted to invert the degradation of the natural systems of the territory and to conceive integrated systems able to evolve with the natural systems, improving reciprocally, this is undoubtedly the highest expression of the principle of life and resilience.

## Notes

1) Among the generative theories that constitute the original methodological matrix of Regenerative Design, there are: the Eco-Efficiency, which is one of the main tools to promote a sustainable transformation according to the Green and Sustainable Design's methods; the Restorative Design, which recognizes environmental damage and seeks to remedy it by restoring ecosystems through development; the Bio-Inspired Design, which studies the relationships between biology/ecology and human beings (it is used together with the Regenerative, Restorative, Eco-efficient or Conventional methods and it has great potential to assist Regenerative Design in achieving its objectives); the Ecological Design, which studies processes compatible with nature useful for improving human and non-human health on different types of ecosystems.

2) Analysed projects: The waterfront of Hamburg Hafen City, designer Kees Christiaanse and AS-TOC (2000); the waterfront of Oslo – Bjorvika, designer MVRDV+A-Llab+Dark Architects, NYT BYLIV (open spaces) (2004); The waterfront of Malmo – BoO1, designer Technical Office Administration of Malmo (1998-2001); the waterfront of Nantes – Île de Nantes, project Atelier de l'Île de Nantes Marcel Smets (2000). Selected projects: the waterfront of Amsterdam – Borneo Sporenburg, West 8 project (1993-97); the waterfront of Rotterdam – Kop van Zuid, designer Teun KoolHaas (1986-2030). An interesting study carried out at the IUAV by U. Trame was also analyzed too.

3) The study uses the Master Plan of the port of Palma di Montechiaro, and examines its contents and aims. The relaunch of the port as an important infrastructure for development is integrated with the port plan and with the renaturation of buildings on the seafront «[...] renaturation projects in valuable territorial areas, interventions for the rediscovery of the presence of water in urban contexts, the redesign of waterfronts, the creation of fountains and water games are experiences around which a rethinking of the 'rules' of the technological project is expressed, for the purpose of a stronger convergence of several disciplinary contributions and a close integration between different scales, themes and modes of intervention. Around the theme of water, the structural dimension of the environmental and landscape project is revealed, it also accounts for normative references and innovative procedural instruments capable of combining sustainability and active forms of socio-economic development» (Schiaffonati and Mussinelli, 2008, p. 21).

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