Francesca Ciampa

REGENERATION WAVE

Appropriate technologies for the waterfront built environment to cope with flooding

La scuola di Pitagora

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To my father and my mother

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Foreword

Robert A. Beauregard
Emeritus Professor, Columbia University (USA)

Across the world, coastal cities have come to recognize their vulnerability to both rising sea levels and increasingly severe storms and the accompanying tidal surges. The solutions fall into three categories: wholly abandoning those areas that are most vulnerable; developing technological responses such as sea walls, movable gates, and pumping stations; and finding ways to adapt to the new climate regime through greater recognition of the need for a co-existence between culture and nature, between humans and their built environment and the plants, rock formations, weather patterns, animals, soil patterns, tides, fish, and birds of the natural environment. Drawing from one or another category, or developing hybrid approaches, is a matter not just of politics and economics but also a matter of a basic understanding of reality itself.

In this monograph, Francesca Ciampa adopts a socio-material approach to mitigating waterfront vulnerability. For her, the choice is not between a technological or a landscape solution, but one that recognizes the benefits of technology and the necessity of accommodating, as much as possible, a 'natural' solution. By taking this perspective, she implicitly adopts the position that land values should not be decisive in what solutions to adopt. Land is not just a marketable commodity but also a natural resource that has too often in the making of cities been sacrificed to the dictates of economics and construction. She wants us to recognize that land has possibilities as a response to flooding and these possibilities should not be sacrificed to lure of returns on investment. This issue is particular the case in New York City where she did her research. With land values high in Manhattan, for example, neither property owners nor the city government are inclined to set aside land for absorption and drainage during storms. Land is simply too valuable. In cities and countries where capitalism is not as strong and governments not as weak in relation to it, it might well be possible to explore a broader range of solutions.

To say this a bit differently, the choice is between deploying technological solutions that are costly, need constant maintenance, and to which 'nature' will respond in ways we cannot fully anticipate, and 'natural' solutions that remove land from development (and the market) and accommodate the tendencies inherent in nature such as coastal erosion, groundwater flows, plant colonization and migration, and wind patterns. Ciampa, though, encourages us to believe that the choice is not that stark. She harbors the potential for a balance of sorts between technological and natural solutions. Cost-benefit analysis is not her preferred metric but rather an understanding of the proper relation between two worlds, one human and one non-human.

Ciampa's approach, it should be said, is not narrowly architectural. It is not about an architecture confined to the design and construction of buildings and structures for the use (predominately) of humans. This, she suggest, is not an appropriate architectural response to climate change and waterfront regeneration. Rather, her work offers an alternative definition of architecture, one that mobilizes responses that duly recognize the porosity of built things and their dependence on and interaction with elements beyond their exterior membrane and over which they have hardly any control. This perspective thus implies that architects have to work with, not against, nature. They need not abandon their technologies, but they need to recognize when their technologies simply postpone nature's reckoning. In the end, nature wins. Or, humans so destroy it that they lose as well.

Humans are not going to adapt to or slow down climate change by imposing themselves, once more, once again, on nature. Doing so might yield short-run benefits and protect property values, but the long-term consequences will be more costly than beneficial. Future generations will be unhappy. Francesca Ciampa is pointing to ways in which we can avoid this scenario.

Premise

Maria Rita Pinto

Francesca Ciampa's book is set against a current and problematic backdrop: the need to establish new ways for processes of the mitigation of vulnerabilities in the built environment to become opportunities for regeneration in coastal cities, affected by the impacts of climate change. The study of these processes lays the groundwork for reflecting on the human-technology-environment relationship, which is conditioned by the climate crisis and this industry's push for technological solutions that progress at different speeds than the adaptive capacity of communities.

The central theme addressed in Ciampa's book is the appropriateness of technologies, concerning the environmental, technological, cultural, social and economic subsystems, to guide the choices of transformation and conservation of the built environment. The goal is to create powerful channels of communication between actors, to share responsibility for actions to respond to the climate crisis with innovative strategies for flooding mitigation. The research, therefore, expands the concept of integration in the meaning proposed by the UNI standard, by examining the complexity of dimensions – environmental, technological and human – that interact in the city. The book yields the relationships that can be triggered within a settlement system as a result of regeneration actions that address the issue of mitigating the effects caused by climate change. The proposed method works on complex and flexible networks that can generate action directions, adaptable and transferable to different coastal settlement systems, to mitigate their vulnerability. The research question turns out to be highly topical, investigating the appropriateness of technologies through the construction of thresholds of integration between vulnerable settlement systems and innovative technological systems, with a focus on rebalancing imbalances between the built environment and citizens. The threshold constitutes the limit within which innovative technological solutions, chosen to mitigate the effects of flooding and climate change, are considered appropriately capable of increasing the performance levels offered by the physical space; while not producing negative outcomes on the city, especially in terms of social and economic inequalities. Technological innovation, if appropriately integrated, can optimize existing resources; it is able to enhance and hybridize relational connections within the settlement system, incorporating the actors responsible for the actions of transformation and conservation of the built environment.

The methodological approach is based on Actor-Network Theory, a model that recognizes the city as a complex network of relationships between human and non-human, "actants." The originality of the book lies in recognizing that actions on vulnerable settlement systems turn out to be caused, not by human intention alone, but rather strongly conditioned by the relationships that make them possible. The actor can change the relationships in a network, thought of as a dynamic heterogeneous and hybrid whole.

The field research, conducted by Francesca Ciampa, at Columbia University to study settlement processes in the scenario of the climate crisis affecting the coastal areas of New York City and the North American East Coast, gives significant value to the book.

The extracted data, with articulated participatory tools, provided the basis for the development of complex indicators that measure thresholds of integration between innovative technological systems and vulnerable settlement systems. The indicators are aimed at constructing thresholds of integration that are intended to guide the processes in which technological innovation helps support cities that welcome these projects to defend against the negative effects of climate change. Making a very interesting movement on the methodological level, Ciampa provides the directions for the choices to be followed to combine the specifics of the experimental cases with the generality of cities heavily invested by the effects of climate change.

The originality of the book lies in addressing process innovation as a participatory form of relations between humans and non-humans, regenerating the city as a reticular model composed of multiple levels of interconnection.

By examining, on the one hand, strategies for mitigating the effects of climate on vulnerable settlement systems, and on the other, the phenomena of social inequality that these processes entail, the author rethinks the technological system working as a mediator between these two issues; a weaving element between nature, technology, community and economy.

Through the entry key of Architectural Technology Design, Ciampa looks at the use of cutting-edge technologies not as a salvific or neutral solution, but as an adaptive system to be declined from time to time concerning the specifications and constraints of the built environment, an opportunity to mitigate vulnerabilities through practices focusing on the identity of context. In pursuing the goal of innovation in the process of preservation/transformation of settlement systems, the book invokes the typology of the Hybrid City. It is developed as an experiment to cope, on the one hand, with the consequences of climate change on the environment; and on the other, with the vulnerabilities that settlement systems face in adapting to this new climatic era.

The book provides a significant contribution to guide coastal regeneration processes and arrives at innovative results in returning a governance tool for design choices aimed at realigning the performance levels offered by the settlement system; managing its vulnerabilities and mitigating the asynchronies between climate deterioration, technological evolution and the growth of cities and communities.

List of Abbreviations

ANT
Actor-Network Theory
ARIM
Antarctic Rapid Ice Melt
CO
Carbon monoxide
DEP
Department of Environmental Protection
DOP
Department of Parks
DOT
Department of Transportation
ESCR
East Side Coastal Resiliency
FDR Drive
Franklin D. Roosevelt East River Drive
FEMA
Federal Emergency Management Agency
GCM
Global Climate Model
GDP
Gross Domestic Product
HUD
Housing and Urban Development
IMAT
Incident Management Assistance Team
MIT
Market – Implementation – Technology
MLP
Multi-Level Perspective
MMHW
Mean Monthly High Water
MOMA
MOre MAnhattan
MOSE
Electromechanical Experimental Module
MTA
Metropolitan Transit Authority
NFIP
National Flood Insurance Program
NPCC4
New York City Panel on Climate Change 4
OneNYC2050
One New York City Plan 2050
PTSD
Post-Traumatic Stress Disorder
SODA
Strategic Options Development and Analysis
STS
Science, Technology, Society

Introduction

The World Cities Report of the United Nations [1] returns on the global extent to which the recent impacts of the climate crisis and human evolution have aggravated transformation processes of the coastal built environment. In particular, the Water for Sustainable Development Action [2] highlights the need to find new tools for controlling the choices undertaken by actors of waterfront regeneration projects. According to the need-performance approach [3], coastal transformation dynamics bind the need to realign the performance of the built environment with the new natural, social, and technological order. Using the systemic concept [4] as a key to understanding the coast, waterfronts and their stakeholders acknowledgment of technological innovation with higher inertia than the adaptation requirements expressed by the market and the climate crisis [2]. Seeking a different model of technological integration, this research focuses on the study of solutions to mitigate flooding catastrophes as an opportunity to renovate coastal regeneration processes. In facing this transition, water represents the transformation key and the material of the project to begin regenerating the coastal built environment.

The research methodology adopts the Actor-Network Theory [5], using cutting-edge tools of participatory inquiry. The combination of this method's application with scientific experimentation has led to the investigation of complex indicators. These have been interpreted as the limit within which different systems interacting in the regeneration processes integrate with each other. The research outcome defines thresholds of integration as tools for performance improvement and governance innovation in the transformation processes of the built environment.

This research provides multi-level tools for the regeneration project facing the socio-technical transition in the Multi-Level Perspective (MLP) of vulnerable coastal settlement systems [6]. These tools are utilized by the decision makers involved in the choices regarding the transformation processes of the built environment, who are held to account for the appropriateness of the integrability of technological solutions for climate mitigation.

The book is articulated into five chapters. The first chapter contains an innovative interpretation key of the built environment: concerning coastal cities, it studies the conflicts between the climate emergency, large investments, and social inequalities. The scientific idea underlying the first chapter is structured according to the intermingling of various theoretical frameworks, leading the investigation of the time, spatial, and value-related dimensions in terms of needs, requirements, and performances.

The second chapter deals with the experimentations developed during my experience in the United States at the Graduate School of Architecture, Planning, and Preservation at Columbia University. The experience abroad was aimed at conducting research in a place where the most advanced products of the reflection on innovation are studied, which allowed responding to the demand for integrability and hybridization of innovative solutions in vulnerable contexts. Starting from the damage caused by Hurricane Sandy, the book examines two of the many regeneration projects of New York City, characterized by high technological innovation: the South Bronx and Manhattan's Lower East Side. These are the best practices of human-centered projects [7], replicable and transferrable. Through holistic approaches [8], these practices show the coordination of stakeholders and decision makers in coastal cities and their decision making process as well as the additional consideration for the relationships between the built environment, the community, and technology. The analysis of these two cases, respectively characterized by great poverty and richness, highlights the construction of wide urban parks as a solution for coastal regeneration. These represent infrastructures that can determine significant impacts on the evolution of the transformation dynamics of the coastal built environment.

The third chapter describes the methodology adopted in the research concerning the individualization of models and tools for an appropriate coastal regeneration process. With reference to the Actor-Network Theory, founded on the idea of assembly and integrability as a design requirement, the research work rethinks the role of stakeholders and decision makers in the coastal regeneration process. In particular, it elaborates complex indicators as suitable tools for constructing thresholds of integration between waterfronts and technological solutions for mitigation. The application of the method allows for defining an Integrated and Reticular Model to keep together issues of governance, investments, innovation, inclusive technologies, and physical, economic, and social transformations of the vulnerable built environment outlined at the research's onset.

The fourth chapter describes the validation of the research outcomes on continental cases in Europe (Venice) and Asia (Baghdad). By applying the identified tools to an event that has already occurred, the book proposes evaluation to improve the performance of regeneration processes, demonstrating the efficacy of the thresholds of integration.

The fifth and last chapter opens new research perspectives of scientific investigation by hypothesizing the use of the model and the developed tools in the transformation of other typologies of the waterfront built environment. By expanding this replicability, the research involves the settlement model of the Hybrid City, where thresholds of integration govern the appropriateness of technological innovation, transforming the single parts of the vulnerable built environment into hybrid systems while coping with climate change.

1. The waterfront built environment: a vulnerable and complex system in the regeneration process

1.1 The performance of vulnerable waterfronts as an opportunity for coastal regeneration

The systemic conception adopted by the American school [9-10-11] allows for breaking down the built environment into various dimensions: space, time, and value. In the European meaning of Architectural Technology [12], these can be translated as the requirements for the innovation of the performances over time [13]. Indeed, the two schools share the interpretation of the built environment as a dynamic and complex system, where each part is at the same time in evolution and in relation to one another [14-15]. Yet, they differ in their interpretation of the possible relations between those parts. On one side, the American approach views single parts as connected and interacting, establishing connections to orient transformation processes and aiming at conserving the overall balance of the built environment [16-17-18]. On the other, the European approach focuses more on the reworking processes of these connections, characterized by the typical iterative trend of adaptive reuse [19-20-21]. Starting from this dualism, the research embraces and integrates the two systemic concepts, considering that every time an event, limited in time and space, disturbs the built environment, its reactive capacity is key for the improved regeneration of the lost connection [22-23]. This process is exemplified in coastal cities, as this book considers them a privileged observation framework for the manifestation of the main causes of connection loss between the parts. These must be sought in the performance alignment of the coastal built environment, which reveals itself as the interaction between the climate emergency, large economic investments, and social inequality [24]. As stated by Tim Smith, the waterfronts are vulnerable hubs [25] with heterogeneous resources, resulting from the temporal stratification of environmental, cultural, and social experiences that have defined their morphological features and identities [26]. Yet, according to Kimberley Kinder, waterfronts are hubs of cultural, economic, and infrastructural richness [27] thanks to their strategic geographic location, which is capable of attracting investments, goods, and people to model new skylines [28]. This research aims to keep together the vulnerabilities and potentials of the coasts, considering the relationship between climate change and scientific progress within the phases of the regeneration process. In particular, this book aims to focus on the modalities of the interaction and implementation of technological progress in the evolving built environment [29].

As anticipated by Commoner in 1972, in his essay "The Closing Circle" [30], appropriate technological integration can foster social well-being, improving the quality of the built environment and mitigating dysfunctions in the human-environment relationship. This concept, taken up and improved in 2015 by Olgyay in his manuscript "Design with Climate" [31], focused on achieving this continuity as the condition for the mitigation of the metabolic process of the built environment. Coastal regeneration fights the negative acceptance of circularity: when the city can no longer consume land (hence, nature), it starts consuming itself, with processes of decay and abandonment (2 sq. m per second) [32]. Hence, the research considers the complex system of relationships between technological solutions and coastal areas as a fulcrum generating just as many transformation models of the built environment [33].

Historically, the earliest transformations date back to the first great American coastal regeneration in 1970 [34], exported to Europe over 20 years later [35]. It provided waterfronts with a nodal role in the transformation and demolition plans of large industries and productive infrastructures [36]. Indeed, during the economic recession, the deficit of the public economic power facilitated private developers' investment policies, leaving wide freedom for interventions, which increased market competitiveness [37].

The waterfronts of Boston and Baltimore [38] are examples of that time's transformation modalities. In those cases, the need for an immediate regeneration intervention was turned into an opportunity for private investments. On the one hand, the settlement requirements of profit optimization, and on the other, the performance attainable by experimenting with a functional mix of spaces (from port infrastructures to leisure spaces, from financial offices to third-sector facilities, from business activities to luxury residential buildings). The multifunctionality of these high-density places impacted the epicenter of financial districts, whose core resulted to be decentered on the coast, enriched by the connections with collateral leisure services. This led to a massive movement of residential populations toward areas of segregation and poverty, with dramatic effects on the social fabric due to the impossibility of affording the expenses caused by the rise of the real estate market and the need to adapt to the new lifestyles' cost.

When the American model reached the Old Continent's coasts, these transformation processes affected the image of European waterfronts. The Docklands in London is a key example of the requirements imposed by the power of private economic investments for the regeneration of the built environment [39].

The intervention involved 23 sq. km of docks, which had been progressively dismissed over 20 years while the businesses located there were being moved to the area of Tilbury [40], 30 km away from the Thames. On the one hand, the results of the waterfront regeneration processes led to gentrification [41]; on the other hand, to an influx of large private assets invested in an area close to the financial urban center of the City to experiment with early forms of a coastal skyline. The main multinational corporations moved their headquarters along the coast, leading to the rise of skyscrapers such as the HSBC Tower and One Canada Square, the symbol of capitalistic action on English coasts [42]. In the following years, two meaningful actions inspired by the American culture were adopted, marking London's evolution from being a historical stronghold of the working classes' rights to a world-level capitalistic metropolis. The first one was the approval of the establishment of a corporation for coastal redevelopment in 1980 called the Urban Development Corporation. Its task was to acquire, regenerate, and capitalize on areas with high potential for development [43]. This corporation was at odds with citizens' associations, such as the Southwark community, which uselessly attempted to oppose the push for gentrification with a bottom-up urban approach [44]. The second action is the adoption of Enterprise Zones[1]: buildable areas where private subjects could invest with tax incentives, consisting of a partial exemption of land development fees [45]. Nowadays, the transformation processes of the coastal built environment must deal with the legacy of this industrial culture and the involved stakeholders' needs, market interests, and climate change impacts [46]. The outlined waterfront reuse cases have been based on land rental exploitation and delocalization of main businesses, forcing the coastal built environment to deal with natural events that could have previously been neglected [47]. For this reason, the attractive potential of waterfronts has produced an economic interest in the management of flooding phenomena [48], modifying not only the 'meaning of water' but also the human way of relating to it. According to Andy Keeler, this has brought the coastal built environment to a "waterfront renaissance" [40]. This term refers to the American-Canadian tendency where regeneration interventions follow a man-proofed approach for the realization of new waterscapes [49]. Erik Swyngedouw defines these as coastal landscapes that make water 'accessible' [50] by using technological tools to reconcile the need for protection, market requirement, and coastal performance. In the framework of the coastal built environment regeneration projects, the environmental interest,

[1] One example of this tax incentive was the redevelopment of the industrial section of the sugar storage of Canary Wharf into 1,000,000 sqm of offices to host around 40,000 new workstations. This transformation involved numerous developers, among which the Canadian real estate corporation Olympia&York. They applied a capitalistic principle of profit and reinvestment and strongly increased the values of their properties until their own economic collapse. The high capitalization of the investment circuits in these areas entered a crisis due to the several economic bubbles of that time, which highlighted the negative effects of tying urbanization practices to the large investment of the globalized financial market.

recreational play [51], and local community's needs are often subjugated to the requirements of regeneration models tied to market profitability [52]. Indeed, according to Di Battista, the transformations from industrial brownfields to areas for the new global elites have often led investors' expected performances to monopolize the built environment's transformations and growth agendas [53]. Europeans have attempted to reduce the water/land ratio from its pre-industrial form, drying out and stemming canals; Americans have managed excess water to extend and model waterfronts. However, in both cases, transformations have been opportunities for the renovation of the meanings and potential of the coastal built environment.

1.2 Needs in the time gap condition of the waterfront built environment

The outline of the previous paragraph shows that the coastal built environment is an evolving system whose dimensions, organization, economic structure, users, and settlement forms change according to the requirements and needs of each period. According to Giuseppe Ciribini, these transformations follow a system of actions affecting the characteristics of the spatial and temporal order of the elements making up the built environment [54]. This vision, taken up and advanced by Virginia Gangemi one year later, illustrates a settlement as a system defined by its physical layout and multiple temporalities, hosting various use dimensions [55]. For example, despite being a physically limited part of the coast (spatial elements), a waterfront can serve different functions (environmental units) over different phases of the same day. This leads the present research to consider a "multiple time" – composed of functional pluralities, divided and overlapping – influenced by the velocity of the transformation processes imposed on the built environment by technological development [56].

While Leonardo Benevolo argues that innovation favors and triggers physical changes [57]; Romano Del Nord asserts that it produces conflicts and inequality, exposing compromises to crises due to the speed of this development [58]. Hence, technological innovation follows sectorial principles of investment and research; these continuously introduce new solutions to the market, not fitting the complexity and inertia of the time required for their acceptance; integration in the built environment. These adaption processes are made burdensome by the rapid obsolescence of technologies, which are often outdated even before governance can appropriately integrate them into the built environment [49]. This is due to both the cutting-edge complexity of the introduced technological products and the capacity to relate them to the transformation processes deriving from them. According to recent studies in Architectural Technology [59-60-61-62-63-64], the main difficulty of this integration lies in creating compatibility between the actions needed to preserve the previous technological culture and the transformations needed to evolve and regenerate the built environment.

Users' intuitional capacities and technology's deductive capacities lead to interpreting the built environment as a system more sensitive to evolutive than radical innovations [65]. Hence, this research analyzes the possibility of relating the waterfront's environmental and technological inertia with the accelerated pace of climate change, tied to radical and sometimes catastrophic events. At the same time, it is necessary to study how to anticipate the future design scenarios of climate mitigation in the short, medium, and long terms for the built environment. Considering the new climate horizon described by the Intergovernmental Panel on Climate Change [66], this temporal asynchrony is enhanced by the incapacity of integrating the designed technological systems to deal with the environmental emergency [67]. The transformation driver of the coastal built environment becomes the need for mankind's protection and survival, which addresses technological integration toward innovative approaches for the mitigation of perturbative criticalities [68]. Considering the deriving integration process as the result of a historical sequence of human actions to make inhabited places suitable to each time requirement [20], this book signals two distinguished times: the technological time and the time of cities. These different temporalities diverge as determined by diverse transformation velocities and preservation dynamics, which often conflict with reality [69]. Technological solutions become the research subject matter of the transformation processes of the built environment where they take place, and the tool to control their impact on human life, displaying the expression of a given society at each time [70].

These mechanisms determine the development of new regeneration methods, contributing to the individualization of suitable modalities for connecting and integrating the interrelated systems that make up the built environment [71]. When assembled, these have repercussions on the wider network of connections where technology intervenes as a scientific [72] process to plan the transformations of the coastal built environment

Inspired by this vision, the research reflects upon the origins of this temporal asynchrony, focusing on the rift between humanism and science due to the incapacity of correlating social change with the scientific revolution. Starting from industrial capitalism [57], technological innovation has precociously affected the late changes that characterize the adaptation of the coastal built environment [73].

Historically, this temporal gap between technological development and governance transformation for coastal regeneration is rooted in the mature phase of the late 19th century Industrial Revolution [74]. The pre-industrial built environment changed so slowly that it remained unchanged for a significant period, and this allowed approximation of its image when identified with the distinctive characteristics of its reference historical period [75]. This approximation disappeared with the impact of technological innovation and its related industrialization processes. Jointly with late-Enlightenment utopias, 19th century settlements proved to be unprepared for the magnitude of the emerging criticalities and could not deal with this transformation velocity [76]. In Owen's interpretation of the built environment as a machine [77], the latter was considered a productive tool for spatial coordination and management efficiency, aimed at the pursuit of social well-being, potentially unscathed by progress speed [78]. This vision marked the emergence of the abovementioned temporal gap, requiring operating on the built environment's social and economic dynamics and the connections, which, in turn, influence and modify spatial relationships.

With the advent of the 20th century and the Second Industrial Revolution [79], albeit less radical than the first, technological innovation has established a continuous and constant enhancement of regeneration models.

In the 21st century, the digital revolution has pervaded and reformulated the relationships between human beings and the built environment in a more perceivable yet less tangible way [80]. According to Tim Bunnell, 'inhabiting' means to find one's definition in space – and above all – deal with a new temporal order [81], rethinking the built environment in systemic elements that relate to it and change its meaning [82]. Regeneration interventions follow physical transformations, hence assuming a repairing role in the conflict originating from the misalignment between expected performances and current requirements [83]. This delay has lasted over time up until the contemporary age, with an incremental deviation due to the increase of the ever-evolving innovation velocity [84]. The contemporary built environment lives in a condition where time acceleration is associated with the power of innovation, hence with market forces. As of today, the technological debate [85-86] and the temporal gap push research toward a new formulation of the relationships between human activities and the built environment, aiming at the individualization of a suitable integration modality of transformation processes concerning technological advancement [87].

From industrial cities to large contemporary metropolises, the coastal built environment has experienced the action of technological progress in its own physical and social dimensions [36]. Hence, the integration of technological innovation can generate a renovation process of performances and associated requirements, producing changes in the management and organization of built environment regeneration dynamics [88].

1.3 The value of flooding as a requirement of climate mitigation strategies

Following the individualization of the performances and needs of the coastal built environment, the research is oriented to consider requirements as necessary and expected values to preserve.

According to Joe Ravetz, the climate crisis is the incipit of the criticalities of the coastal built environment, with waterfronts as the epitome of this crisis [89]. He ties vulnerability – intended as the probability of the coastal system receiving damage [90] – to the catastrophes [91] and the gentrification risk caused by unsuitable technological solutions for mitigation [92]. This vision is also supported by David Harvey, who highlights a paradox like the coastal city, whereby waterfronts are among the most vulnerable areas to climate change, but also the most desired ones for capitalistic purposes [93]. Hence, the catastrophic event is associated with a market value related to the introduction of innovative solutions for mitigation: the regeneration process acquires the ambiguity of reacting to climate change while gaining profit from the instrumentalities of flooding [94].

On the one hand, the resulting projects loom as cutting-edge technological research and experimentation [95]; on the other, one placed these devices produce new issues of environmental justice [96].

Indeed, flooding is the main drive for the experimentation with protection devices for communities and the built environment, requesting a high technological response from the high economic productivity market [97].

According to Maria Kaika, the transformation following a coastal regeneration project affects the collective vocation and the social production of waterfronts, which are considered both a relational connection and a physical conjunction between individuals and the coast [98].

This produces conflicts between the various values attributed to the waterfront, which depend on the historical, social, cultural, political, or economic conditions that produce new configurations of the coastal built environment.

Be they public spaces or private spaces for public use, the waterfront's material and immaterial values make them a common good as a stratification of needs of the time [99]. Considering the instances of our century [100], the transformation processes of the coastal built environment involve otherwise ignored figures and objects [101] due to the variable strategies and technologies of the climate emergency. These processes are rendered into specific transformation circuits (founded on coalitions between political subjects, investors, designers, communities, and transnational enterprises) that can be associated with a specific type of technological solution. In other words, each climate hypothesis corresponds with a different environmental, technological, and social scenario prediction. The years 2050, 2080, and 2100 are associated with given flooding states, which will be faced with different technological solutions that will, in turn, affect the pre-existing physical and social dynamics. According to Bruno Latour, this connection between the technological choice and the abovementioned dynamics produces a peaking friction of cultural resistance due to the constitutive ambiguity of these projects, promoted as sustainable, and yet harbingers of social and environmental conflict [102].

Water takes different values in the regeneration processes of the coastal built environment, as testified to by the case of circularization [103] of water currents in Athens; water flow privatization in England and Wales [104]; conflicts on urban water supply in Barcelona [105]; as well as water's social power and ecological modifications in Guayaquil [106].

Water, associated with a time factor, can represent the natural measurement of climatic emergency, as its rise is a requirement for coastal transformation [107]. The resulting technological integration produces its development, differing from the natural one, caused by the intrinsic acceleration indicative of the progress of cutting-edge technologies discussed in the previous paragraphs [108].

Associated with an economic factor, water can serve as a measurement for capital, as the epicenter of the triangulation of the economic model MIT (Market – Implementation – Technology) [109]. Indeed, as stated by Gordon Walker, since a technological solution is the concretization of a useful idea that catalyzes profit, water produces a flooding economy, it has a price given the cost of the innovation and transformation strategies of the coastal built environment [110]. The difference between the realization price of innovative solutions and the cost of technology integration can represent the incidence margin of water and the requirement for its market impact, recognized in the international scene and politics [107]. This vision is particularly relevant in the international scene, as Eugene Fitzgerald's studies prove. He states that in the regeneration process, climate change is a great business of tomorrow, based on the price speculations concerning its value [111].

2. Technological solutions in response to climate emergencies: the two sides of the New York flooding

2.1 The dialogue between climate and the built environment: how flooding affected the Atlantic Coast

In 2023, the Ellen MacArthur Foundation proposes a new vision of the regeneration process related to the circular reuse of the coastal built environment in which vulnerability mitigation linked itself to the definitions of strong and weak sustainability [112]. The latter emphasizes the role of technological progress in increasing social capital, attributing to it the ability to generate welfare. According to this meaning, it is not necessary to preserve natural capital but to increase the number of other forms of capital that sufficiently compensate for its exploitation [113]. Yet, strong sustainability assumes that the stock of natural capital cannot further decrease because it generates welfare, and other forms of capital cannot replace it [114]. The research interprets technological innovation as a hinge between the two types of sustainability. While technological innovation helps to deal with several issues successfully, it also leads to new risks for potentially sustainable development [115]. According to Serge Latouche, sustainable development is at the same time a pleonasm (in its definition) and an oxymoron (in its content) since its growth is neither durable nor sustainable [116]. In her report "The Limits of Development" Donella Meadows claims the only way for technological innovation to contribute to sustainability is through adopting a culture of maintenance [117], which this book addresses as a process of coastal regeneration. Conducting research on places where climate change produces more incisive effects than in others, and experiencing the convergence of multiple connected factors, it is possible to generate a mapping of emergencies. The research identifies the coastal built environment as one of the primary nodes of climate change by linking it to storm and flood phenomena [118]. Among all waterfronts, the research focuses on those on the U.S. Atlantic Coast of New York, where there is significant experimentation with innovative designs in response to flooding emergencies. The area includes several showcases where innovative technological solutions graft into vulnerable settlement systems with verifiable potentials and impacts through the co-presence of the most variable exceptionalities from which to trigger regeneration actions (Figure 1). According to the Climate Resiliency Design Guidelines for Waterfront Revitalization Plan [119], there are five different types of flooding, distinct from each other by cause of manifestation and impact of the phenomenon. Each of these types, which can also affect the same built environment simultaneously, coinciding with an economic response by allocating funds for different regeneration practices. The actors of allocating funds depend on the damage's severity (in some cases, emergencies are declared at different territorial levels) and on the jurisdiction of the damaged site. Moreover, as diverse types of flooding may co-occur, different forms of economic aid may be allocated simultaneously to regenerate the affected built environment.

The first type is coastal flooding [120], mainly caused by a surge of rising water levels related to strong storm winds and low atmospheric pressure. In this type, the wave occurs when a cyclone or hurricane crashes the coastal surface: the waves break over the coastal edges, and the released flows flood inland areas. The impact of this type of flooding can increase significantly if the storm hits during high tide, causing the erosion of coastal edges through the combination of wind and salt energy. This flooding type leads to national and regional funding support for coastal regeneration actions aimed at the performance realignment of the spatial elements of waterfronts.

The second type is tidal flooding [121], caused by normal variations in the lunar cycle that change the water level due to gravitational forces, resulting in peaks in the spring season. This type of flooding leads to the allocation of national and regional funds for the recovery of affected communities and the performance realignment of buildings.

The third type is river flooding [122], caused by heavy rain or storm, which increases the basin capacity of rivers, lakes, and streams, resulting in overflow from their respective natural or manufactured channels. Similarly, for the previous type, the actors mentioned above supplant the allocation of funds for the same purpose.

The fourth type is inland flooding [122], more commonly referred to as flash flooding or urban flooding, caused by short-duration but high-intensity rainfall and often associated with sudden thunderstorms or wide-range storms. Inland flooding can also be caused by moderate rain, lasting for some days over the same area. Often high housing density, associated with the increase of sealed surfaces in the coastal built environment, reduces the drainage and absorption capacity of the soil, increasing

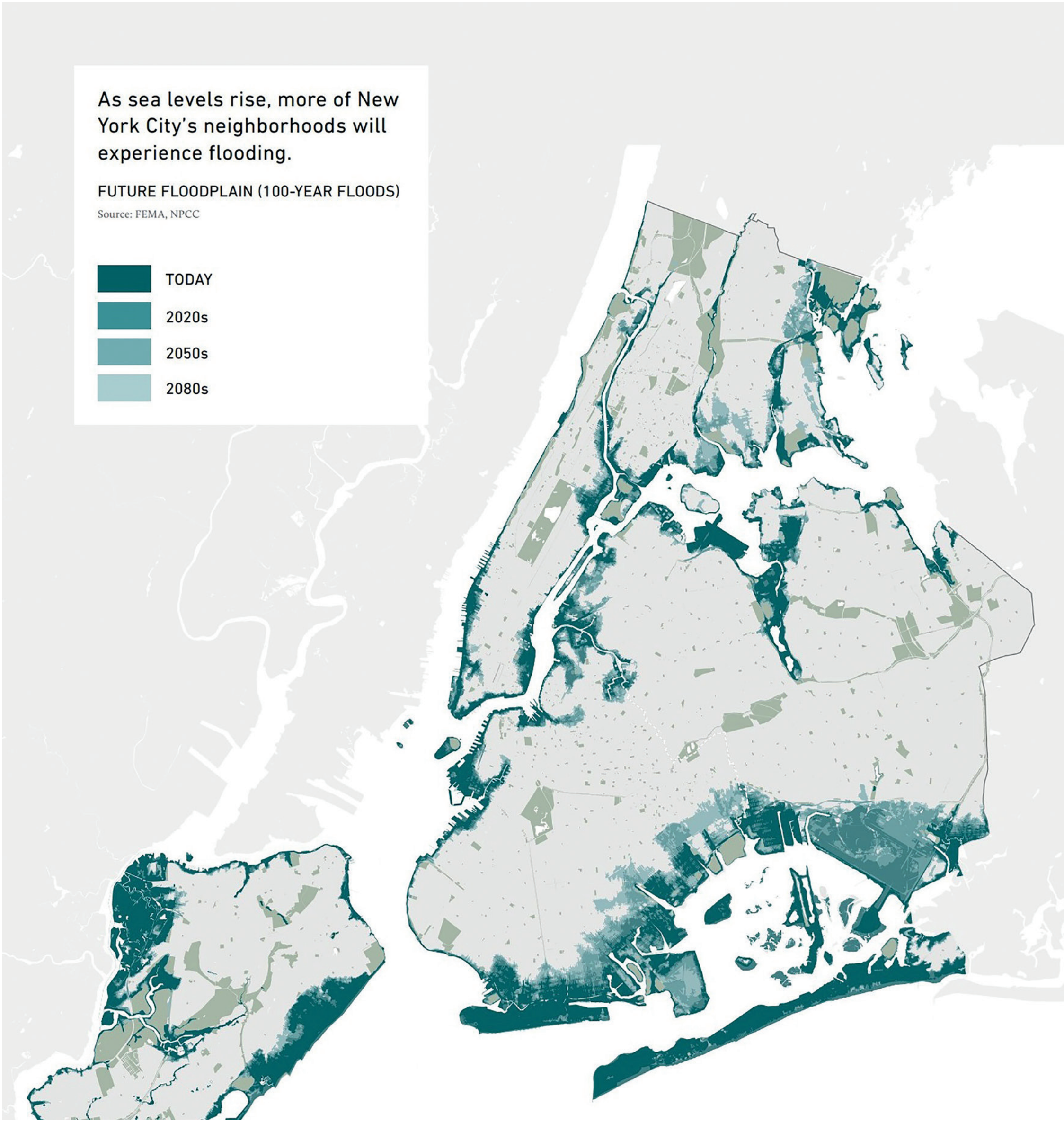

Fig. 1 Future Floodplain (100-year floods), A Livable Climate section of OneNYC2050, page 25. Excerpts from OneNYC 2050 Report, used with permission of the City of New York OneNYC 2050 Report' ©2019 City of New York. All rights reserved.

the risk of inland flooding. This typology leads to the allocation of municipal funds for damages incurred to preserve building systems and infrastructural performance maintained [122].

The fifth type is localized flooding [122], caused by the design capacity overcoming of sewer infrastructure for stormwater containment. Depending on the area's natural drainage conditions and surface characteristics, including topography and soil absorption quality, the effects of this typology can worsen. This type of flooding leads to the allocation of local funds to assist with the damage incurred to the technical elements of the built environment [122].

When any type of flooding occurs, there is a resulting flood hazard [126], which puts the built environment, infrastructure, real estate, and human life at risk. To understand flood risk, the research looks at the probability of flood events, the extent of site exposure, and the potential impact of temporally overlapping types of flooding [122]. The likelihood of a flood event changing over time as climate change worsens and additional aggravating factors on the built environment become dynamic, so mitigation systems sometimes do not appropriately integrate with coastal transformations.

This research identifies New York State as a scientific setting where the issues above are empirically ascertainable through the study of innovative information tools and the return of detailed sector documents. According to Ciribini [67], data knowledge underpins the ability to govern the complexity of the coastal built environment in the regeneration process. The identification of consistent and updated knowledge determines the preliminary data structure required to individuate the actions to improve the performance levels of the coast. Therefore, the research brings together critical information to construct knowledge for considering the waterfront's objectives, resources, and constraints as a whole system.

Beginning with the New York City Panel on Climate Change (NPCC4) [122], a report established to limit the margin of climate prediction error, the research looks at the analytical tools available to observe, map, and monitor climate events in support of coastal regeneration projects in the long (2100), medium (2080), and short (2050) term. The paper supports regeneration design actions taken at the transformation points [122] of the built environment, focused on the occurrence of phenomena that generate substantial changes in the balance between coastal conservation and transformation (Figure 2).

All climate factors that can guide the governance of decision-making are derived from the correspondence between current climate trends and what has been assumed in previous reports, making forecasting tools very accurate. The research looks at the Report by taking up Ciribini's view [67], whereby the observation of sectorial documents determines the identification of objectives as a systematic intention set by the planning action to change according to significant factors. The latter, expressed in the performance quantified NPCC4, are represented by the worsening values of temperature, drought, precipitation, and sea level rise

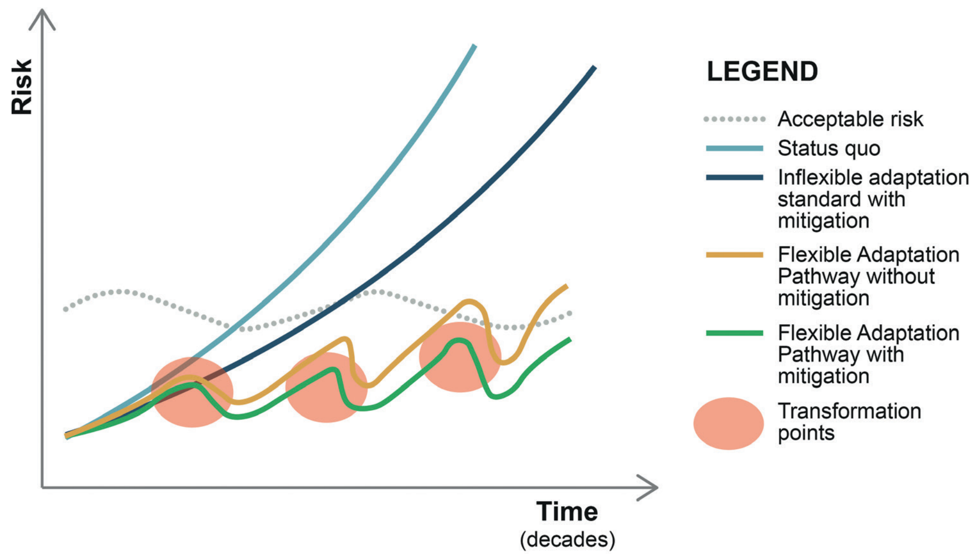

Fig. 2 Author reinterpretation of NPCC Report Executive Summary of New York Government on Transformation points.

between 2010 and 2039. These factors will affect the models and actions of the coastal built environment regeneration [122]. The knowledge of these factors aims to unify the multiple information to optimize the overall quality of possible alternatives through the correspondence between these data and the UNI systemic classification of the built environment [123].

The first factor is warming, analyzed through data provided by the number of weather stations in the Global Climate Model (GCM) and focused on the values of the summer months in a decadal trend framework and the annual number of days with the temperature below zero. These have decreased at a rate of 1.9 per decade, with about 22 fewer days in 2023 than in 1900 [122]. Therefore, the temperature is expected to increase from 4.1 to 6.6 °C by 2050 and from 5.3 to 10.3 °C by 2080 [124]. The frequency of heat waves is expected to triple by 2050 and then increase from 5 to 8 occurrences per year by 2080 [124]. The high resolution of these future projections supports expert knowledge (engineers, planners, institutions) in projecting the order of the extent of global warming. On the one hand, there is increased water rise due to melting glaciers; on the other, increased hurricanes due to the extreme mix of winds at different temperatures. For coastal regeneration processes, these are all critical factors, which affect the design choices of materials concerning the horizontal closures of building and infrastructure systems, precisely ground and roof floor slabs [125].

The second factor is drought, causing the disappearance of buffer zone vegetation suitable for absorbing and mitigating flooding phenomena. The parameter to analyze this factor is tree ring growth, which depends on its climatic season history. From 1770 to 2023, there have been 8 periods of drought lasting about 5 years in the New York City watershed region [125]. This factor affects the availability of existing natural and mechanical resources, which can affect the regeneration process of the technological units concerning vertical and horizontal retaining structures.

The third factor is precipitation, analyzed by the number of daily floods each month compared to annual tropical cyclones (e.g., hurricanes) and rain events. These phenomena will increase between 4 and 13% by 2050 and between 5 and 19% by 2080 [126]. Meteorological data intersected with those of the community, which contributes to the individuation of the actions to monitor, manage, and maintain the built environment [126] by making complaints on the damage to the building systems. The effects of this factor concern the technology unit classes related to service delivery facilities that can affect the regeneration process of specific technology units of liquid, solid, air, and water disposal facilities [127].

The fourth factor is sea level rise, parametrized through the Antarctic Rapid Ice Melt (ARIM) [126]. This assesses the destabilization of the Antarctic ice sheet over this century, so sea level rise follows a rate of 27 millimeters per year since 1850 [126]. Compared to the global average, the data is exacerbated in New York City by progressive land subsidence accentuated by the retreat of Ice Age glaciers and proximity to warm ocean waters [126]. The city will experience a scenario of elevation from 31 to 53 centimeters by 2050; from 45 to 74 centimeters by 2080, and up to 2 meters by 2100 [126]. Realistically, this assumption gets worse well beyond this forecast as the longevity of CO_2 in the atmosphere commits the planet to experience increasing water levels and temperatures. Therefore, New York City will be subjected to an average monthly water rise (Mean Monthly High Water, MMHW), with flooding affecting the neighborhoods of Jamaica Bay by 2023 and the South Bronx and Lower Manhattan by 2050 [126]. This factor affects the technology unit of the equipment for the regeneration of external partitions, service delivery facilities, and security facilities [127].

The coastal built environment regeneration project must consider that climate vulnerability also increases with social vulnerability, which varies according to the ethnic groups, economic levels, and the decay conditions of the neighborhoods of the affected communities [126] (Figure 3).

Specifically, in New York City, the highest levels of climate vulnerability correspond precisely to areas of high social vulnerability. Moreover, the neighborhoods with the most economically fragile communities, subjected to high stresses of pollution and gentrification, are located close to some of the most

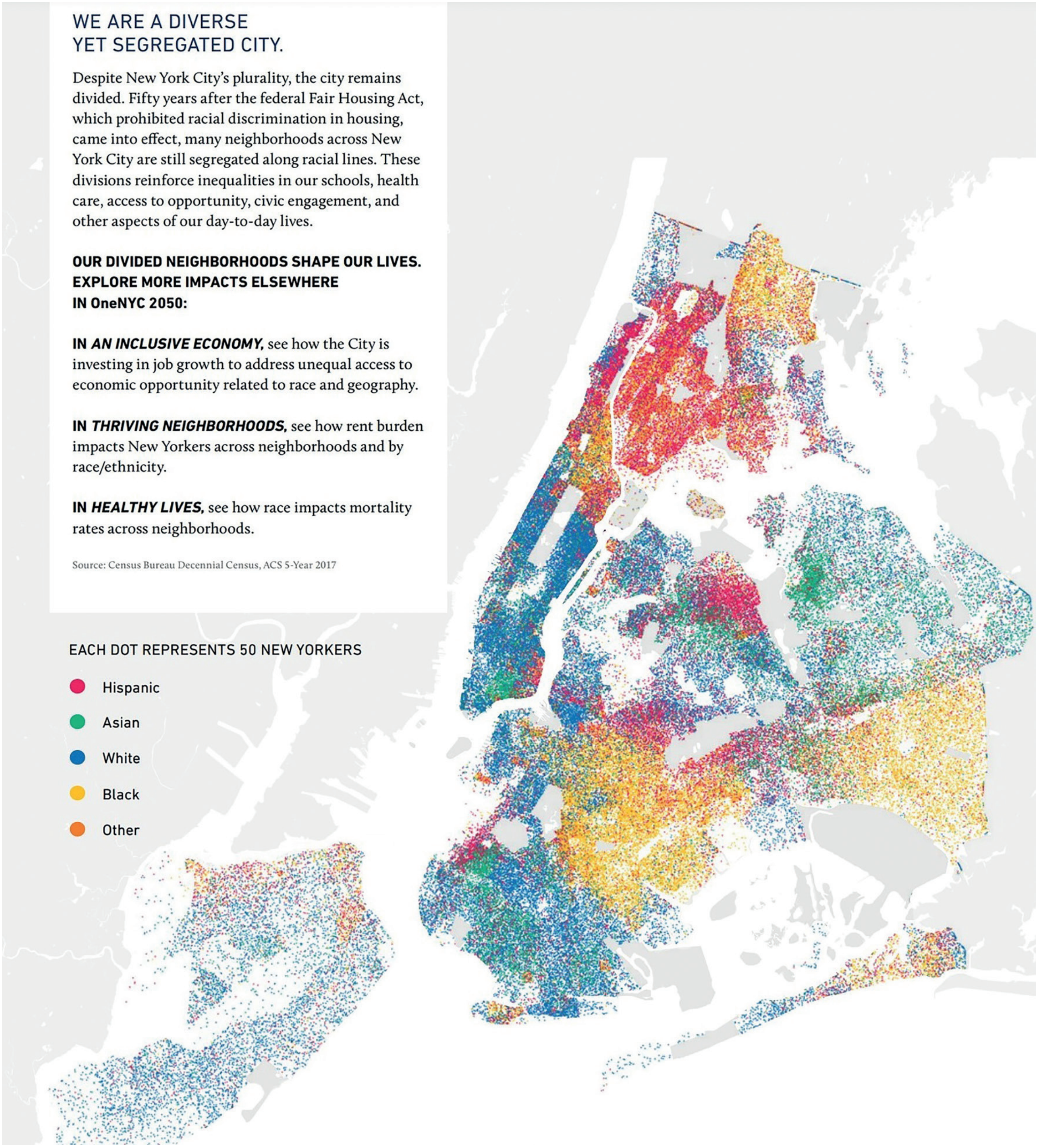

Fig. 3 We are a diverse yet segregated city. OneNYC2050, page 31.

Excerpts from OneNYC 2050 Report, used with permission of the City of New York OneNYC 2050

Fig. 4 Downtown Manhattan, helicopter survey in which economically advanced neighborhoods are distinguished by height from vulnerable ones.

influential financial districts on the Atlantic coast (Figure 4).

To mitigate the critical issues described, the One New York City Plan 2050 (OneNYC2050) [124] proposes an inclusive, bottom-up action-based regeneration strategy to address the climate emergency, trying to ensure safety and achieve social equity with participatory justice projects [125] (Figure 5).

The plan demands that citizens, grouped into a centralized and coordinated monitoring system, help detect trends and differences among climate events to enable effective comparisons, made consistent and comparable

Fig. 5 Statue of Liberty, community symbol.

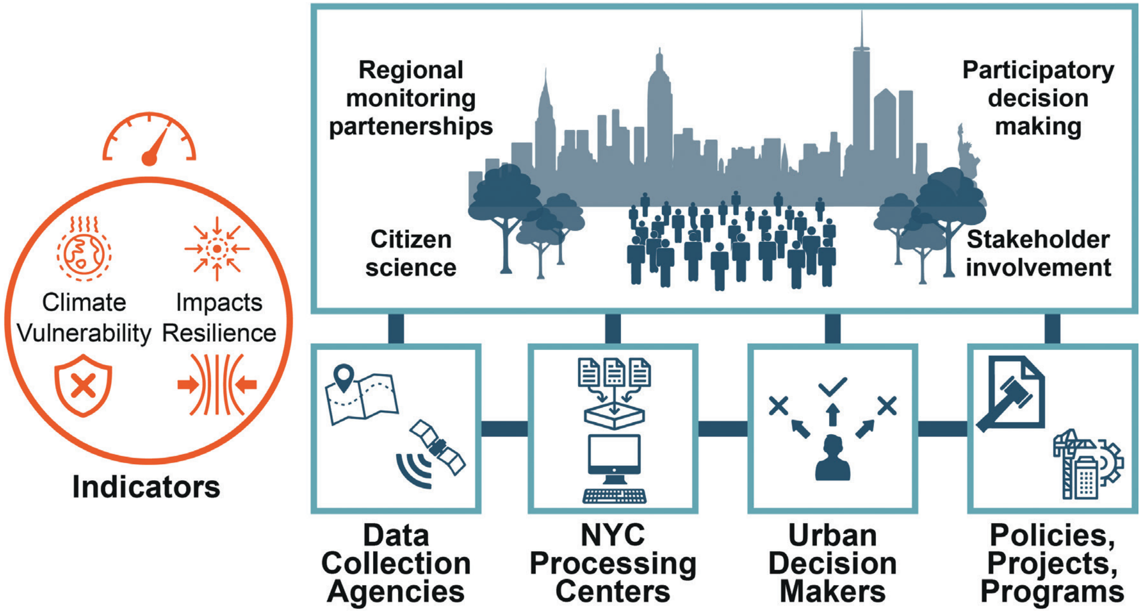

Fig. 6 Author reinterpretation of the bottom-up action model proposed by the OneNYC2050 urban plan.

at spatial and temporal scales. This rating is refined with each catastrophic climate event based on experience accumulated over the specific damage. Comparing different catastrophic climate events and understanding which sector was less vulnerable can return the margin for improvement and priority actions (Figure 6).

For this reason, it is useful to introduce the factors related to destructive catastrophic phenomena among the most aggravating ones in the described scenario. In fact, according to Ciribini [67], since the choice of regeneration project actions is related to probabilistic forecasts, disruptive factors can distort them. The research complements the discretized knowledge at the beginning of the paragraph with the study of hurricanes as equal conditioning factors concerning the remodeling of the regeneration project. They are not as predictable as other factors but are now characterizing the U.S. climate season [126]. The research selects events that have significantly affected the built environment over the past 11 years, resulting in flooding and gentrification. Each of the hurricanes was analyzed by period (year and month) [127], type [128], designation [129], location [130], and description of the event concerning its impacts on the technology units of the coastal built environment [131] (Tab. 1).

Year	Month	Type	Designation	Location	Description
2022	September	Hurricane	Ian	Florida, Carolina	**Category**: 5 **Personal injury**: the death of 107 people **Economic damage**: $50 billion. **Damage to the built environment**: performance decrease of building systems.
2021	June	Hurricane	Elsa	Florida Georgia	**Category**: 5 **Personal injury**: the death of 1 person **Economic damage**: $875 million. **Damage to the built environment**: performance decrease of building systems.
2021	August	Hurricane	Henri	Long Island	**Category**: 1 **Personal injury**: / **Economic damage**: $87 million. **Damage to the built environment**: performance decrease of building systems.
2021	September	Hurricane	Ida	New York, New Jersey Maryland	**Category**: 4 **Personal injury**: the death of 50 people **Economic damage**: $10 billion **Damage to the built environment**: failure of primary infrastructure due to 80.01 mm of rain falling in just 60 minutes (Atlantic record).
2020	October	Hurricane	Delta	Lousiana	**Category**: fourth record-breaking storm of 2020 to hit Louisiana and the 10th record-breaking storm to hit the United States. **Personal injury**: hundreds injured **Economic damage**: $10 million **Damage to the built environment**: performance decrease of foundation, elevation, and containment structures of building systems.
2020	September	Hurricane	Sally	Alabama	**Category**: the first destructive hurricane to make landfall in the U.S. state of Alabama since Ivan in 2004. **Personal injury**: the death of 45 people **Economic damage**: $1.6 billion **Damage to the built environment**: performance decrease of vertical closures, lower horizontal closure, upper horizontal closure, and outdoor spaces related to building systems.
2020	August	Hurricane	Laura	Lousiana	**Category**: 4, along with Hurricane Last Island in 1856, is ranked as the strongest hurricane ever recorded in Louisiana. **Personal injury**: the death of 21 people **Economic damage**: $12 billion. **Damage to the built environment**: performance Decrease of building systems and infrastructure.
2019	July	Hurricane	Barry	Lousiana	**Category**: 1 (tropical cyclone), 5 (hurricane), rainiest ever recorded in Arkansas and fourth wettest in Louisiana **Personal injury**: the death of 107 people **Economic damage**: $200 million. **Damage to the built environment**: performance decrease of vertical, horizontal, and inclined exterior partition systems and infrastructure.
2018	October	Hurricane	Micaeal	Florida	**Category**: 5, the first hurricane in this category to hit the United States along with Andrew in 1992. **Personal injury**: the death of 13 people **Economic damage**: 130 million dollars. **Damage to the built environment**: performance decrement of disposal service supply facilities.

Tab 1. Table of storm and flood climate events in the United States (2011-2022).

2017	October	Hurricane	Nate	Louisiana and Mississip pi	**Category**: 1 **Personal injury**: the death of 43 people **Economic damage**: $120 million. **Damage to the built environment**: performance decrement of safety facilities and infrastructure.
2017	September	Hurricane	Mary	Puerto Rico	**Category**: 4, landed in 155 mph winds that devastated the entire island. **Personal injury**: the death of 3,059 people **Economic damage**: $60 billion. **Damage to the built environment**: performance decrease of outdoor equipment and infrastructure.
2017	September	Hurricane	Irma	Florida	**Category**: 4, the first major hurricane to hit Florida since Hurricane Wilma in 2005 **Personal injury**: the death of 82 people **Economic damage**: $50 billion. **Damage to the built environment**: performance decrease of outdoor equipment and infrastructure.
2017	August	Hurricane	Harvey	Texas	**Category**: 4 **Personal injury**: the death of 107 people **Economic damage**: $125 billion. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2017	April-May	Internal Flooding	Midwest Spring Floods	Missouri, Illinois, Indiana, Ohio, Oklahoma and Arkansas	**Personal injury**: / **Economic damage**: $5 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2017	January	Internal Flooding	Pacific Winter Floods	California, Neva-da, and Oregon.	**Personal injury**: / **Economic damage**: $2 million. **Damage to the built environment**: performance decrease in outdoor equipment, infrastructure, and building systems.
2016	October	Hurricane	Matthew	Cuba, Bahamas, and Florida	**Category**: 4 **Personal injury**: the death of 900 people **Economic damage**: $125 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2016	September	Internal Flooding	2016 September Northern Plains Floods	Northeast Iowa, southeast Minnesota, and southwest Wisconsin	**Personal injury**: / **Economic damage**: $2 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2016	August	Internal Flooding	2016 August Loui-siana Floods	Louisiana	**Personal injury**: / **Economic damage**: $4 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2016	March	Internal Flooding	2016 Southern Spring Floods	Texas, Louisiana Arkansas, and Mississippi.	**Personal injury**: / **Economic damage**: $3 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.

Tab 1. Table of storm and flood climate events in the United States (2011-2022).

2016	January	Coastal Flooding	2016 January Noreaster	Mid-Atlantic coasts	**Personal injury**: injuries due to blizzard conditions that extended from the Midwest to the Northeast. **Economic damage**: $2 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2016	January	Internal Flooding	2015/2016 Winter Floods	Central and Southern United States.	**Personal injury**: / **Economic damage**: $2 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2015	Septem-ber-October	Indoor Flooding and Hurricane	2015 Autumn Appalachia Floods and Hurricane Joaquin	South Carolina	**Personal injury**: the death of 4 people and the impact pervaded the southern Appalachians and then intensified in early October, becoming Hurricane Joaquin and causing record flooding in many areas. **Economic damage**: $200 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2015	May-July	Internal Flooding	2015 Summer Central floods	South Dakota to Oklahoma, Texas, and Ohio River Basin	**Personal injury**: / **Economic damage**: $3 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2014	August-September	Internal Flooding	2014 Aug-Sep Southwest floods	Arizona	**Personal injury**: the death of 4 people **Economic damage**: $93 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2013	September	Internal Flooding	2013 Septem ber Southw est floods	Colorado, New Mexico, Arizona, and Utah.	**Personal injury**: / **Economic damage**: $13 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2013	May-June	Internal Flooding	2013 May-June Midwest floods	Missouri, Illinois, Oklahoma and Arkansas.	**Personal injury**: / **Economic damage**: $31 million. **Damage to the built environment**: performance decreasing in outdoor equipment, infrastructure, and building systems.
2013	April-May	Internal Flooding	2013 April-May Midwest floods	Missouri, Illinois, Wisconsin, Michigan, and Indiana	**Personal injury**: injuries from heavy April rains (locally up to 8 inches in some locations), resulting in severe flooding of several rivers. Late snowmelt in the northern Midwest added to flooding in late April and early May. **Economic damage**: $13 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2012	August	Hurricane	Isaac	Gulf Coast	**Category**: 1 **Personal injury**: the death of 19 people **Economic damage**: $50 million. **Damage to the built environment**: performance decrease of outdoor equipment and infrastructure.
2012	October	Hurricane	Sandy	Atlantic Coast	**Category**: 5 **Personal injury**: the death of 104 people **Economic damage**: $65.5 billion. **Damage to the built environment**: performance decrease of outdoor equipment and infrastructure, building systems and facilities.

Tab 1. Table of storm and flood climate events in the United States (2011-2022).

2011	April-July	Internal Flooding	North Dakota snowmelt	Souris, Red, and Missouri River basins.	**Personal injury**: / **Economic damage**: $13 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2011	April-July	Internal Flooding	2011 Missouri River flood	Missouri River	**Personal injury**: / **Economic damage**: $14 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2011	April-July	Internal Flooding	2011 New Madri d Flood way Activa tion	Ohio-Mississippi River	**Personal injury**: / **Economic damage**: $16 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2011	April-July	Internal Flooding	2011 Mississippi River flood at Memphis	Mississippi River	**Personal injury**: / **Economic damage**: $13 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems. Also occurred failure of systems to monitor flooding and production of flood maps during the record-breaking floods of 2011.
2011	April-July	Internal Flooding	2011 Mississippi River flood in Arkansas	Arkansas	**Personal injury**: / **Economic damage**: $63 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2011	April-July	Internal Flooding	2011 Mississippi River flood in Louisiana	Gulf of Mexico	**Personal injury**: hundreds were injured as the Mississippi River overflowed and flooded the Gulf of Mexico, placing itself beyond the control of federal agencies, including the USGS. **Economic damage**: $13 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2011	September	Tropical storm	2011 Tropical Storm Lee	East Coast	**Personal injury**: / **Economic damage**: $2.5 million. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.
2011	August	Hurricane	Irene	East Coast	**Category**: 3 **Personal injury**: the death of 56 people **Economic damage**: $10 billion. **Damage to the built environment**: performance decrease of outdoor equipment, infrastructure, and building systems.

Tab 1. Table of storm and flood climate events in the United States (2011-2022).

The investigation illustrates the need for urgent action, considering the reduction in time between events and the increase in their destructive force. These factors affect the adaptive capacity of the coastal built environment starting from the iterative information-decision-making process that characterizes the regeneration project.

2.2 From Hurricane Sandy up to the present day: damages, responses, impacts, and solutions

Among the climatic events examined, the research identifies Hurricane Sandy, whose diameter of 1,800 km, classified it as the largest Atlantic hurricane ever recorded on the East Coast of the United States [132]. It holds the additional record, immediately after Hurricane Harvey, of also being the most expensive Atlantic storm, having caused $65.6 billion in impact damage and disruption [133]. The cataclysm originated on October 22 from a tropical wave in the western Caribbean Sea, moving slowly northward toward the Greater Antilles. Two days later, it became a full-fledged hurricane, affecting first Kingston, Jamaica, and then Cuba, moving up the coast. The most significant damage was when the hurricane moved over land mutating into a tropical post-cyclone with the name "Superstorm Sandy". During the evening of Oct. 29, the cyclone developed into a record storm that swept through New York City. The hurricane assumed an extent of more than 3,200 kilometers, leaving 4 million Americans without electric power. Much of the U.S. East Coast in the Mid-Atlantic and New England states found themselves in flooding, rain, and even snow, suffering the so-called Fujiwhara effect, an appellation derived from the hybridization between a cyclone and a storm [133]. President Obama signed the emergency declaration, allocating millions of dollars in federal aid and flood mitigation supplements. New York Governor Andrew Cuomo had declared a state of emergency for every county in the state. New York City Mayor Michael Bloomberg also ordered the closure of public schools, the mandatory evacuation of the area including areas near shorelines or waterways, and the opening of 76 evacuation shelters around the city [133]. Despite all these preventive forms, the consequences were devastating: the East River overflowed, flooding the South Bronx and Lower Manhattan with waves of about 4 meters above sea level. In the aftermath of Hurricane Sandy, and downstream from the $100 billion in total damage, the government sought to record losses in all sectors to determine the amount of funding in federal aid to distribute for actions of built environment regeneration (Figure 7).

The study of damage, response regeneration actions, and multiscale protection hypotheses related to Hurricane Sandy represent a climate resource. According to Di Battista [134], the latter is an integral part of the built environment. Information related to catastrophic events can become the subject of the regeneration project by directing choices and preparing

Fig. 7 The East River coastal built environment represents one of the most vulnerable sites to flooding and most severely affected during Hurricane Sandy.

new demand conditions of safety, well-being, and usability [135].

All the types of damage sustained because of the event affected the set of safety conditions related to the safety of users, as well as the defense and prevention of criticalities depending on accidental factors in the built environment [136].

Infrastructure damage led to the closure of most institutional offices and courthouses. At the same time, major airlines canceled more than 6,000 flights to and from John F. Kennedy International Airport, La Guardia, and Newark-Liberty. In addition, Grand Central Terminal and the seven subway tunnels were closed. They were inundated by

10 feet of flooding with the worst destructive consequences in 108 years, according to the Metropolitan Transportation Authority [136]. Access to parks was denied as potential tidal reservoirs (Battery Park and Central Park) and some 39 fuel depots (almost all existing in the city) were shut down. Natural gas supply lines on the islands were destroyed, making up an estimated damage of $97 million [136].

This gas shortage throughout the region led to a significant effort by the U.S. federal government, which transported up to 10 liters of gasoline, free of charge, to the affected populations for electricity or other basic needs. This caused traffic congestion for about 20 building blocks, aggravated by the deposit of around 8.5 million cubic meters of mixed debris (including 2.5 million cubic meters of sand and silt) on roads and waterways, impeding mobility for days. Eventually, medical services and surgeries were canceled from NYU Langone Medical Center, and about 300 health facilities were closed, leading to economic damage of $1 billion [136].

Damage to businesses involved some 113 establishments out of the 565 municipalities that recorded a commercial property loss of $382 million. Also, 11 oil terminals and 2 pipelines were shut down, damaging 95% of food distribution (by truck), which was stranded due to lack of fuel [136].

Damage to property affected 88,000 residences, including 37,000 owner-occupied homes. About 9,300 rental units were destroyed, while another 2,000 were declared uninhabitable due to mold. In addition, there were 2.7 million small explosions due to short circuits; 10 out of 14 wastewater management plants ceased performance, and 88% of steam heating systems suffered failures [137].

Damage to citizens affected about 104 people, and hundreds were injured. Most of the population was affected by the consequences of the flood in terms of health and housing impacts.

All types of responses and related regeneration actions from the event have affected the set of conditions of the built environment to adapt to the life, health, and performance of users' activities. The State responded immediately through two national incident assistance teams: the Federal Emergency Management Agency (FEMA) and the regional firefighting team IMAT. Fourteen emergency support points were deployed throughout the territory as an activation of the federal disaster recovery coordination. In addition, 16 FEMA mobile communication vehicles and 34 Mobile Emergency Response Support officers were dispatched. The latter and 650 U.S. Corps of Engineers personnel created a team to cope with the disaster, ensuring that wastewater treatment plants were drained. In addition, 100 clearing teams were mobilized to transport and remove debris. The team installed 106 power generators compared to the 335 required at the height of the emergency. On Nov. 1, 2012, FEMA Community Relations Specialists offered assistance and informational materials in nine languages in storm-ravaged neighborhoods. A few days later, on Nov. 5, about 432 specialists and 222 FEMA members were dispatched to some of the hardest hit areas to coordinate 520 volunteers in tree removal, clearing 1170 km of roads and main access routes. Finally, 113 emergency shelters were opened, serving 6,477 storm survivors [137].

Regeneration actions began on April 23, 2013, the day of the Flood Resilience Text Amendment [138], which encouraged the reuse of flood-resistant buildings in all FEMA – designated flood zones. This document removes regulatory barriers that hinder or prevent the reuse, redevelopment, and maintenance of storm-damaged properties. In addition, this document allows new or existing buildings to comply with new requirements under FEMA codes. To fulfill this performance realignment, the government enacted the Federal Hurricane Sandy Law (113–2, 2013) by funding $50 billion for Atlantic Coast regeneration. Out of that amount, more than $13 billion, the most extensive sum, was allocated to New York City through Federal Emergency Management Agency grants (more than $9 billion) and a Housing and Urban Development grant ($4.21 billion). In addition, according to the Insurance Information Institute, New York State received more than half of the government's private claims (totaling $18 billion), covering New York citizens' car, home, and business insurance payments. The tracker, aimed by the New York City Housing Authority to demonstrate how federal grant was spent, testifies that through 2018 regenerating 250 housing units within 30 buildings damaged by the storm [138] has used $2.9 billion of the total $5.9 billion.

However, the most economically significant regeneration actions are those for infrastructure. Several public and private hospitals damaged during the storm received nearly $3 billion for performance realignment and maintenance operations after the failure. NYU Langone received $1.1 billion to regenerate electrical, plumbing, and security systems at multiple sites within its campus. Staten Island University Hospital received $28 million to regenerate and elevate its electrical systems. Precautionary forms of a weekly closure for schools stretched for months, forcing students from 57 institutions to conduct itinerant classes around the city. Because of this, the Department of Education had more than $37 million to regenerate damaged school facilities. The School Building Authority also received $686 million to rebuild and regenerate 24 school buildings entirely inundated by the storm. New York City University received $25 million to fund evacuation shelters opened during the storm and to regenerate its waterfront facilities [138].

Green infrastructure also suffered considerable damage, but buffer zones were essential for partial flooding absorption. For this reason, the Parks Department received $480 million to regenerate 9 sq. km of coastline and upgrade harbor extensions (from wood to concrete) designed as a barrier to future storms. An additional $19 million was allocated for Atlantic Highlands Harbor reconstruction, $12 million for Belmar waterfront regeneration, and $7.6 million for Seaside Heights waterfront regeneration. Less than $100 million supported the resulting 430 mission operations in direct federal assistance, and $40 million were destined for federal operational support and technical assistance. Mitigation actions were conducted in more than 28 district sections along the coast, passing 1,300 reuse compatibility regulatory inspection visits to date by 406 federal, state, and local technicians. Therefore, the Parks Department received an additional $120 million to redevelop such significant coastal properties as the Tiffany Street Pier in The Bronx, the Friends Club, Wolfe's Pond Berm and Midland Beach Comfort Station on Staten Island, 79th Sea Street in Manhattan, playgrounds at Rockaway Beach and the Sea World's Fair at Flushing Meadows-Crown Park. Finally, a grant from the Federal Highway Administration awarded more than $35 million to the Department of Transportation for needed repairs to road infrastructure. This sum was insignificant compared to the $174 million spent to regenerate the road system, bridges, and interchanges, including nearly $40 million to fix traffic signals throughout the city and over $250.8 million to build new Staten Island Ferry boats [139].

Housing regeneration actions were $317 million of the $4.21 billion allocated by Housing and Urban Development. This sum was aimed at regenerating the so-called "Red Hook Houses", an early postwar affordable housing type built of red brick and distributed along the coasts. The amount was deferred as $240 million for Red Hook West residences and $197 million for Red Hook East. In contrast, the Ocean Bay and Edgemere homes, which include oceanfront and bayfront buildings, received more than $347 million for their redevelopment [140].

Regeneration actions to protect the population comprised $1.1 billion in Superstorm Sandy Response checks and $388 million for housing assistance and other needs. In addition, $262.9 million was appropriated as the total mandatory federal share for public assistance. More than $334 million in grants were approved for housing assistance to help reuse or redevelop residential buildings damaged or destroyed by Sandy, with an average award of $6,088 per applicant. A mission assignment was also issued through the U.S. Corps of Engineers to regenerate 114 temporary housing units at Fort Monmouth, a former military base, at an estimated cost of $3.3 million. At the same time, 480 volunteer agencies were activated for individual assistance in disaster recovery operations, reporting a total of 866,400 volunteer hours, equal to nearly $24 million in labor value. For all other assistance needs, more than $53.4 million was approved for the 18,433 survivors of Sandy. Temporary shelter assistance was provided for 195,000 overnight stays in 435 hotels and motels at a cost of more than $23 million [125]. From an employment perspective, 3,365 applications for assistance were approved to facilitate those who remained unemployed, and $4 million was distributed to survivors who became unemployed due to the storm. Regarding public assistance, 1,707 applications from the public sector and private nonprofit organizations were accepted, and of the 2,879 applications, 2,051 were granted. Finally, FEMA supported with a total of $79 million the applicants of 84 projects for the regeneration of the coastal built environment aimed at constructing green walks, protection, and emergency measures, marinas, beaches, bulkheads, and dams [128].

The outlined cognitive framework of damages, responses, and regeneration actions aimed to build a scenario of the impacts generated on the market and regeneration strategies for the coastal built environment. In addition to jobs, hurricanes can also have a long-term effect on property values, but in a manner that is strictly dependent on the type of property. Although the impact lasts only a few years, it affects market values on five property types (residential, industrial, hospitality, office, and retail). The economic values attributed to them can be altered by changes in the supply and demand for space, which influence rental and capitalization rates, occupancy, and property value growth. The analysis also considered factors of market changes and location, as well as the dimensional characteristics and year of construction of the properties. The hurricane decreased all property types' values by 6% from the year after the storm. The effect worsened negatively in the second year, with a 10.5% decrease in value.

Office buildings were the sector found to be the most significantly declined. However, unlike the previous type, the deficit seems to be short-lived. After the first year, the value declined by 32%, but 24 months later, it was down only about 10% (not statistically significant). Apartments are valued opposite to office types. One year later, the storm reduced values by only 5.4%, the lowest impact of any sector. But two years later, values had decreased by nearly 16%. This occurs because home damaged residents are forced to look for new apartments after a hurricane, increasing market demand. Hurricane usually causes a surge in regeneration-related construction. After two years, most of the rebuilding is complete: many workers leave the area, residents return to their newly livable homes, and the rental market softens. The drop in hotel values went from 9.5% to 13.4% (statistically insignificant in both years). The industry fell from 7.9% to 6.6% and was statistically significant in both years. Retail was flat, going from 6.1 to 6.5 %, but was not statistically significant. Hurricane insurance usually rates to increase dramatically following a major impact. Some types of properties with industrial, manufacturing, or corporate focus tend to put this expense on tenants, resulting in higher expenses for common area maintenance. This in its entirety means that hurricanes and floods are another risk factor. Properties can be insured against actual damage but not against loss of value due to changes in the supply and demand for space [141].

From an economic perspective, these kinds of events reshape market dynamics; yet, from an Architectural Technology perspective, they foster all the regeneration process actors toward the need to protect the built environment from further vulnerabilities. By investing $472 million in technology solutions of flood mitigation [142], the infrastructure of coastal urban parks is involved in major projects to protect waterfronts and their margins. About $14 million is currently invested in constructing a double dune system at Breezy Point to mitigate strong tides during a storm. About $338 million is invested in the East Side redevelopment project to redevelop, protect and innovate the neighborhoods along the East River, from Montgomery to East 23rd Street. This plan includes adding flood protection for facilities, elevating Franklin D. Roosevelt East River Drive sections, constructing a protective berm, and opening pedestrian connections and loops to allow people access to the waterfront [143]. About $45 million is being used to fund the Hunts Point Waterfront Resiliency Project in the South Bronx to reclaim the shoreline and redevelop affordable housing [126].

Since Hurricane Sandy, the city has significantly improved coastal regeneration and governance processes, hypothesizing innovative climate mitigation solutions with cutting-edge technologies described in the Flood Resilience Text [142]. Dealing with dynamic and rushed events involves identifying strategies that adopt experimental solutions in which the regeneration of the built environment is contained within a potentially absorbable regime of variation [143].

All types of protection adopted to cope with events similar to the one that occurred affected the set of conditions related to the ability of the built environment to be adequately used by users in carrying out their activities [139].

To protect the natural environment [144], mitigation solutions have been adopted to naturally absorb energy from storm surge inundation and offer varying degrees of protection for coastal structures [126]. Shorelines could be natural buffers, where the stabilization technique combines plants, sand, and soil with minimal infrastructure to protect the coast. This helps reduce erosion while preserving valuable habitats belonging to coastal vegetation. The latter is often integrated with artificial wetland systems, which use plants and soils to retain and filter water, generating habitat for wildlife [126]. Such solutions help slow the impact of storm waves through the physical friction their presence brings and reduce, depending on their size, the varying speeds, and the intensities of flood heights. In New York City, the many benefits of wetlands have led to the development of this solution, aimed at hard infrastructure protections and ecological improvement of the sites where they impact. Finally, beach nourishment provides a natural protective element as a sandy barrier. The dunes that connote them collectively act as a buffer that dissipates storm wave energy and blocks rising flood water in low-lying areas [137].

To protect the waterfront [144], the Flood Resilience Text [142] traces five different solutions of mitigation.

The first technology solution refers to bulkheads, usually made of stone or concrete, which compact the position of the land and stabilize the shoreline to resist erosive phenomena. They are generally not designed to defend the shoreline from storm flooding but to respond to fluctuations, currents, and daily tidal waves. Since the early 20th century, many sections of the Upper Bay and Hudson shoreline have been extended through bulkheads located along the industrial areas of the city's waterfront, becoming commercial and residential areas to support the current parks (about 25% of New York City's shoreline is protected by bulkheads) [142].

The second technology solution refers to berms, generally used in combination with multiple flood protection systems. They include levees, parapets, and pumps, offering increased protection from storm surges [137]. All flood barriers require extensive maintenance and monitoring. They are mainly used along the U.S. East Coast but, despite this, are still absent in New York City except for Gowanus, Newtown Creek, and Coney Island, which adopted them in the aftermath of Hurricane Sandy to explore their feasibility [142].

The third technology solution refers to live, also called dikes, built on the shoreline to provide flood protection [137]. In New York, in 2000, the U.S. Corps of Engineers built a similar solution between Staten Island and Oakwood Beach [142].

The fourth solution refers to floodwalls, which are permanent or deployable vertical structures anchored in the seabed and arranged along the shoreline to prevent flooding from storm surges [137]. The permanent kind could be an extension of a levee. In New Orleans, to add or provide protection, these solutions defend the waterfront where the shoreline is insufficient. Most floodwalls require human intervention to install, but in some cases, they operate automatically in response to flood conditions [142]. For example, New York University's Langone Medical Center, an emergency facility along the East River, is currently rebuilding the site using the technology described through flood protection funding [142].

The fifth type refers to breakwaters, offshore structures parallel to the shoreline, typically made of rock or other nature-based materials [137]. They can reduce coastal flooding and wave force by breaking on them before they reach the coast and adjacent neighborhoods [142] (Figure 8).

To protect infrastructures [144] various solutions have been adopted with different types and elevations, according to the flooding extent. The most significant proposals include:

- the elevation of air vents on subways to prevent flooding from entering the system;
- the improvement of pumping capacity in train and car tunnels;
- the elevation of electrical equipment to ensure emergency power supply in hospitals;
- enhancing the redundancy of additional power supplies and distribution transformers outside flood-prone locations.

Proposed solutions for flood protection of New York City's critical infrastructure systems have increased dramatically in the wake of Hurricane Sandy. They are being undertaken by many agencies (the Department of Environmental Protection, the Department of Transportation, the Health and Hospitals Corporation, the Metropolitan Transporta-

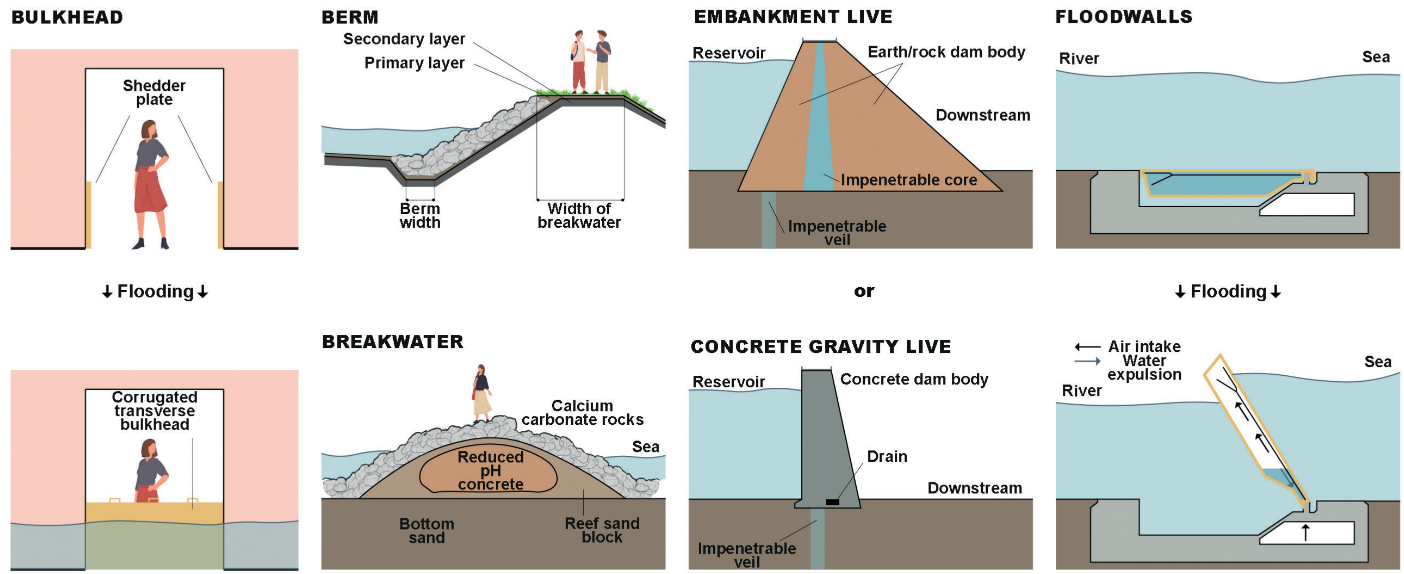

Fig. 8 The five different solutions of mitigation for waterfront protection according to Flood Resilience Text.

tion Authority, and the Port Authority of New York and New Jersey) and service providers (Edison and PSEG) [142].

To protect buildings [144], sealing solutions have been adopted, encouraging watertight construction methods such as installing temporary shields or barriers that keep water out of the technical elements of the housing unit. Building protection can also be achieved with deployable or permanent parapets, with a berm (a mound of earth) either outside or around the site's perimeter, or by waterproofing operations on the building to protect. These protections act on structures with materials that can resist flooding, allowing water to flow through without causing significant damage. Additional essential preventive measures are those related to the actions of structural elevation of buildings or elevation of mechanical equipment. This is aimed at placing the lowest floor of the building above the design flood height (equal to the height of a 100-year flood at a given location added to the centimeters of the safety margin for the freeboard [144]). Relocating equipment to upper floors involves placing such systems on a raised platform or suspending them on an overhead structure. Buildings may also use a system to avoid elevators' operation during extreme events, thus preventing them from descending into floodwaters that submerge the lower floor levels. These mechanical or building elevation measures are coupled with ground and road surface elevation actions to assist in coordinated flood discharge [144].

Fig. 9 Main vulnerable sites of New York City coast compared to potential flooded waterfront where the latest technological solutions are tested.

2.3 The competitiveness of New York State experimentations on the global scale

The intersection of the different aspects analyzed drives the U.S. approach to holism [145] i.e., the synergistic interaction between different specialisms that, by combining their respective regeneration approaches, foster innovative solutions [126] (Figure 9).

To implement the performance of the coastal built environment by meeting flood defense requirements and the need to make water accessible to all without discrimination, Housing and Urban Development announced the Rebuild By Design competition [146]. This was activated to initiate the redevelopment of the New York and New Jersey coast through a program of six interventions as best practices to address the problem. The required scheme to address was based on five key points:

- the construction of a system of marshes and live/dams to channel water in case of flooding;
- the design of a system of public spaces with attractive and recreational functions to shield the area from floodwaters' action;
- the establishment of education centers for the protection of land and natural species;
- the construction of a drainage system to ensure the management and expulsion of excess water within the coastline through a set of pumps and floodwalls;
- the design of a new public green and roof garden system for rainwater harvesting [147].

On July 23, 2013, six of the ten candidate projects were declared winners, proposing solutions for geographically different areas yet pooled by the same vulnerability and intervention criteria. The six winning projects are the Living Breakwaters for Staten Island; the Resist, Delay, Store, Discharge for Hoboken; the New Meadowlands for Newark; the Living with the Bay for Nassau County's South Shore; the Hunts Point/Lifelines: Greenway Open market for South Bronx and the Dry Line (or BIG U) for Manhattan. All the typological solutions offered by the winning projects refer to the form of the urban coastal park. They are analyzed by discretizing them using a critical analysis that follows circular logic. Facing the impactful event will require the built environment to adopt solutions that establish a new balance and produce feedback capable of strengthening it in anticipating the next disruptive event. This information is enriched and integrated through three phases in which winning solutions can be investigated: the impact of the catastrophic environmental event, the rebalancing of the built environment, and the integration of the new solution. These phases reveal the need to investigate vulnerabilities to meet the new requirements imposed by the climate emergency while remaining attentive to integration needs at different scales. Finally, the outcome of the appropriateness of the innovative technological solution is verified in the form of feedback on the enhancement of the built environment, allowing the establishment of criteria to evaluate the effectiveness of the intervention hypotheses. These criteria follow the principle of integration to make the waterfront a dynamic and adaptive built environment in which human beings, technological services, and natural elements work together to maintain a balance that benefits each of the parts described.

The data collection consists of:

- the identification (selecting the name of the project, the proposed defensive system, and the name of the designers who built it);
- the objective (defining which vulnerability it aims to solve);
- the strategy (defining the policy adopted and what the project promotes with its implementation);

- the technologies (focusing on the solution adopted and on the degree of innovation and sustainability that characterizes it);
- the prize (referring to the amount of money awarded for the realization of the project and the construction stage for the completion of the solution);
- the strengths and weaknesses, looking at the perspective of Architectural Technology concerning the perceptual-cultural, material-constructive, and morphological-dimensional constraints as project impacts [21].

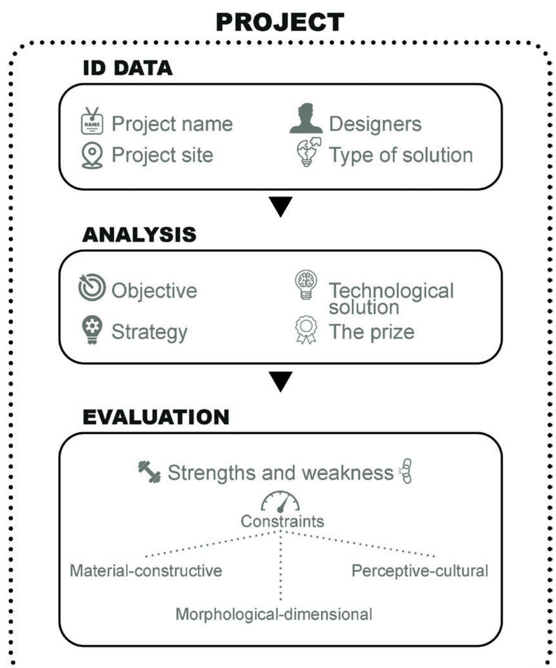

Fig. 10 Methodological outline for the analysis of winning project.

The perceptual-cultural constraints are related to the preservation of the aesthetic values of the intervention site; to the respect of historical instances, recognizable in the stratifications of documentary character that have succeeded one another over the centuries; to the preservation of the psychological and perceptual values of the built resource, recognized by all those who enjoy it, directly or indirectly [17]. Morphological-dimensional constraints are associated with the geometric configuration of the site and its built heritage to be respected in intervention strategies [21]. Finally, material-constructive constraints are based on respecting the behavior of materials and technologies on the site where the intervention is planned [148].

The interpretation and comparison of each solution project let identifying the emerging criteria as the result of a deductive process (which derives from the primary data and characteristics of the winning project); the evaluation in terms of positive or negative impacts (determined by the comparison of dominant solutions as what was required); and the identification of emerging criteria.

Placing the various projects in a system with the emerging criteria determines a matrix highlighting their presence in the other projects, even if in a minor form. The emerging criteria represent adaptable and transferable guidelines for selecting the two case studies of the research (Figure 10).

The first project is Living Breakwaters, a system of eco-sustainable swamps and docks built on Staten Island by "Scape / Landscape Architecture."

The project's objective aims to safeguard the southern shore of Staten Island, which is vulnerable to the action of the waves that break on the coast, thus causing coastal erosion.

The project strategy promotes the creation of underwater natural obstacles whose protective coating is made up of oyster shells, which, composed of calcium carbonate, allow recreating of the habitats that have been destroyed and allow regeneration of the chemical composition of the original ecosystem. In the wake of the environment, education centers for the culture of settled species and support areas for controlled fishing and water sports have been created.

The technological solutions are breakwaters and eco-sustainable concrete quays.

The prize awarded is $60 million, currently invested in the project, which is still unfinished [149].

The strengths of the project concern the layered system based on the fusion of marine and terrestrial strategies through the creation of flanges that mitigate the action of the wave, preventing coastal erosion. A further strength is the low material-constructive impact, as the creation of "cliff roads" (made of ecological low pH concrete) regenerates the original habitat of the area without affecting the pre-existing flora and fauna. In addition, the perceptual-cultural impact is minimal, as the barrier is below sea level. Furthermore, the use of oysters aims to recall the collective memory of the historical value of the New York mineralogical composition. Finally, the management and maintenance costs are included in construction costs and guaranteed for the entire life cycle of the technology.

The weakness of the project concerns the morphological-dimensional impact, due to the technology can attenuate the tidal flow during the storm but not contain or repel it.

The second project is Resist, Delay, Store, Discharge – A Comprehensive Strategy for Hoboken, a protection, absorption, and exhaust system made in Weehawken, Hoboken, and Jersey City by "The Oma Team."

The project's objective aims to safeguard the city of Hoboken and the adjacent areas from any floods caused by heavy rainfall or violent storm surges (Hurricane Sandy caused the flooding of 80% of the area).

The project strategy promotes the integration of infrastructural elements, in particular, the vegetation terraces that act as protective walls and garden roofs that guarantee excellent resistance to rainwater.

The technological solutions are based on a drainage system equipped with pumps to expel excess water.

The prize awarded is $230 million, which is currently invested in its implementation phase and hence not fully completed [150].

The strengths of the project concern the system of natural elements, which absorb and filter the excess water. Its positive morphological-dimensional impact as the system of green walls and garden roofs benefit the cemented face of the city; its material-constructive impact related to the use of biocompatible materials; its perceptual-cultural through the pleasant urban landscape produced by the green roofs and natural terraces, hiding the underground drainage system.

The weaknesses of the project concern the high costs of adapting the buildings to the pre-existing urban fabric (Figure 11).

Fig. 11 Helicopter survey of the Hoboken project area.

The third project is The New Meadowlands – Productive City + Regional Park, a protection system built in Meadowlands by "Mit Cau," "Zus" and "Urbanistein."

The project's objective aims to protect and increase the marshy area between Jersey City and Newark at the southern end, up to Hackensack in the northern part.

The project strategy envisages the creation of a system of embankments and swamps aimed at protecting the territory in the event of sea level rise and collecting rainwater to limit the overflowing phenomena of the sewage systems of the adjacent cities. In addition, the project promotes growth thanks to a mixed use of the area and the construction of road networks that give direct access to the park, public spaces, recreational areas, and residential areas.

The technological solutions are systems of water collection to protect existing species.

The prize awarded is $250 million, currently used to realize the project, which is expected to be completed in 2022 [151].

The strengths of the project are new systems designed would increase the creation of new habitats and recreational places, and the material-constructive impact, which is minimal as the creation of these spaces protects local species.

The weaknesses of the project are numerous: the morphological-dimensional impact is impressive, given the increase in the population density that follows the redevelopment of the site, which is followed by the rise in road connections and public transport, yet producing unbridled overbuilding. The considerable perceptual-cultural impact worsens the assessment result, as a virgin site is transformed into a densely populated center. This implies significant costs for the community and the government, which should be further allocated for the construction of the project (Figure 12).

Fig. 12 Helicopter survey of the Jersey City coast.

The fourth project is Living with the Bay – Resiliency Building Options for Nassau County's South Shore, a dam and marsh system built in Nassau County by "The Interboro Team."

The project's objective is to create an eco-sustainable protection system that reduces the action of waves breaking on the coast and protects the bay from storm surges and sea level rise, all factors caused by the frequent storms that hit the Nassau County coast.

The project strategy involves the construction of a large greenway (located in the upper area of Long Island) of areas used for recreation spaces and a network of infrastructures for the protection, containment, and channeling of water to allow its expulsion away from the inhabited centers.

The technological solutions are connection systems between dams and marshes that channel the water toward the bay, cleaning it and supplying the aquifers.

The prize awarded is $125 million, fully invested in the construction of the site expected by 2023 [147].

The strengths of the project are the eco-sustainable materials used to construct the protective barrier. By the material-constructive impact, they guarantee more excellent water resistance than all the projects analyzed so far.

The weaknesses of the project are due to the shape and size of the barrier by the morphological-dimensional impact. It would thus become a visual limit; the perceptual-cultural impact as the intervention would change the site's geographic configuration and the urban landscape's historical identity, resulting in very high costs.

The fifth project is The Hunts Point/ Lifelines: Greenway and Open Market, a backbone of green infrastructure and food distribution centers built in the South Bronx by "Penn Design / Olin."

The project's objective aims to safeguard the coastal strip of Hunts Point in the South Bronx, guaranteeing the protection of the food distribution centers of the industrial area in the neighborhood in the event of flooding. Furthermore, the project strategy promotes the creation of a greenway that allows the transport of goods and the achievement of areas for leisure and the use of open places. In addition, constructing a new food distribution center is planned, a pivot of economic attraction and source of livelihood in the event of a natural disaster.

The technological solutions are based on a vegetation system comprising aquatic plants that block and filter the water.

The prize awarded is $20 million; however, these have been invested in renovating the district's heating system. For this reason, new funds are expected to be allocated to redevelop the site [152].

The strengths of the project are the layered system based on aquatic plants and tree-lined roads that mitigate the action of water. Another positive item is the material-constructive impact, thanks to the creation of "green roads" which, in case of danger, shield food distribution centers and guarantee the transport of food; the perceptual-cultural impact is minimal since the tree-lined streets represent not only the technology introduced but, at the same time, are places of recreation and social rebirth.

The weakness of the project concerns the morphological-dimensional impact about the entire image of the site is distorted by the project (Figure 13).

Fig. 13 Helicopter survey of The Bronx project area.

The sixth project is Dry Line/ BIG U, a defensive barrier system defined by integrating the Lower Manhattan Coast design. The Bjarke Ingels Group won the call and expanded its team by incorporating heterogeneous experts to develop the plan based on a holistic approach. The concept arises from a reflection on the climate emergency. They conceive crisis as both a time of great urgency and a great opportunity to devise a resilient infrastructure for Lower Manhattan without creating separation between the city and the water but instead developing a series of interventions designed for specific neighborhoods as a form of protection for their respective communities. They try to design technological and social infrastructures as part of a great global strategy rooted in local communities.

The project's objective aims to safeguard the island of Manhattan from coastal floods and increasingly frequent hurricanes, such as the passage of Irene in 2011 and Sandy the following year.

The project strategy involves the creation of a 16-kilometer-long green infrastructure barrier, where plants are defense tools compatible with the marine environment. The vertical vegetation system, which shelters from waves (for about ten miles), is located close to the coastline and is raised above sea level to accommodate areas with attractive or recreational functions, such as pedestrian spaces, cycle paths, and commercial and cultural premises.

The technological solutions are walkways, raised platforms, and absorption basins that can act as a zone of friction and containment during disasters representing the technologies used.

The prize awarded is $335 million and resulted in quickly completed by the construction of a large attractive recreational center for the entire Lower Manhattan area [153].

The strength of the project is the protective vegetation system, which determines the creation of new habitats, parks, walks, and nature reserves. Furthermore, the design area can be divided into three compartmentalized areas that communicate with each other but work independently, precisely, to allow greater site protection in case one of them is damaged. A further strength regards perceptual-cultural impact, as the site looks like a walk surrounded by greenery, which changes its function depending on the neighborhood it crosses. Furthermore, an excellent sealing and water absorption system do not violate the visual continuity between land and sea. Finally, maintenance and management costs are considered included in construction costs.

The weakness of the project is the high material-constructive impact: in the event of a disaster, relevant systems are introduced, such as macro tanks and immersion pumps, in disagreement with the will of the community. A further weak is the high morphological-dimensional impact of realizing a mobile protective barrier system encompassing the coast. Furthermore, the engineering project is based on a last-effort forecast equal to that of the most destructive storm in the last 100 years. However, in reality, we know that the destructive potential will increase over time. Finally, the large economic expenditure invested for this project turns out to be the highest often so far precisely because of the delicacy of the urban and economic focal points it touches: the city has dedicated more than $400 million to the first phases of the BIG U, and the federal government has given $511 million (Figure 14).

Fig. 14 Helicopter survey of the Manhattan project area.

By systematizing the data obtained from the analysis of the winning projects, it is possible to develop a comparison matrix from which to extrapolate the general recurring criteria assumed to predominate one solution over another. The six general criteria define priority requirements to establish a system of actions for waterfront regeneration.

The first criterion, Eco-sustainable landscape with natural material, is based on the integration of virtuous solutions for the environmental protection of fauna and flora aimed at safeguarding the pre-existing environmental context of the site.

The second criterion, Comprehensive Strategy for low ecological impact, is based on a holistic approach that brings different actors together to recreate the missing links between the environment and its inhabitants.

The third criterion, Coastal Parks for a Productive City zone, is based on making infrastructure mitigation solutions capable of producing economic development. This implementation concerns the attractive capabilities of coastal regenerative actions to increase the site's market value and employment supply.

The fourth criterion, Adaptive protection of building system, is based on multi-scale defensive technological solutions.

The fifth criterion, Acceptability and Compatibility with the built environment pre-existence, is based on the approval of the transformation as a predisposition to change the image of the coastal built environment of established historical identity. Acceptability refers to the ability to have design solutions recognized not only by citizens and local governments but also by indirect and potential users of the coastal area. The term refers to the intangible effects of the transformation. Compatibility refers to the ability to avoid irreversible changes in the form of the site or its characteristic elements, proportions, and dimensional relationships between parts. It is the ability to prevent degradation or abandonment resulting from the design solutions. The term refers to the tangible effects of the transformation. This criterion, therefore, considers the combination of the impacts of the design solution in terms of alteration (or impairment) of the site's tangible and intangible values.

Finally, the last criterion, Recreational defensive technology, refers to blending multiple aspects within a single coastal modeling tool. On the one hand, the technological solution must protect human lives and the waterfront; on the other, in the absence of catastrophic weather events, it must represent valuable recreational equipment to both the user community and the testing site (Figure 15).

The matrix shows that within each criterion technological components coexist (in terms of innovative solutions formulated), social components (in terms of community participation, recreational uses, and stakeholder involvement), and environmental components (with attention to eco-friendly choices and nature-based design). Technological interventions transforming the coastline by creating complex ecosystems ensure that waterfronts represent the landscape as a mirror of the people who inhabit them and provide natural and mechanical services.

Projects	Main Data	Evaluation	Criteria
The Living Breakwaters	Eco docks made of oyster shells and low PH concrete and built to avoid coastal erosion regenerationg natural ecosystem	**Positive impact** Fusion of marine and terrestrial strategies with eco-friendly material connected to place history **Negative impact** Not contain tidal flow into innland	Eco-sustainable landscape with natural material
Rexist, Delay, Store, Discharge	Integration of infrastructural elements, such as vegetation terracs like protective walls and garden roofs like rainwater resistant tool. All supported by underground drainage system	**Positive impact** System exploits the absorbing capacity of the natural elements to filter the excess water **Negative impact** High costs due to the adaptation of the pre-existing buidings	Comprehensive strategy for low ecological impact
The New Meadowlands	Park system of embankments matched with mixed use of the area and the construction of road networks to the park, public spaces, recreational and residential areas	**Positive impact** Creation of new habitats and recreational places with solution to protect existing species on site **Negative impact** The population density increase which followed overbuilding center	Coastal Parks for a Productive City zone
The Living with the Bay	Greenway used for recreation spaces and a network of infrastructures for the protection	**Positive impact** Eco-sustainable materials for the construction of the protective barrier **Negative impact** The shape and size of the barrier which would thus become a visual limit affecting historical identity of the urban landscape	Adaptive protection of building system
The Hunts Point/Lifelines	Creation of a greenway that allows the transport of goods and the achievement of areas for leisure and the use of open places	**Positive impact** Fusion of marine and terrestrial strategies with aquatic plants and roads as recreation and social rebirth **Negative impact** Entire image of the site is distorted by the project	Acceptability/ Compatibility with built environment pre-existence
The Dry Line / BIG U	Walkways and raised platforms and creative absorption basins with friction and containment during disasters	**Positive impact** Design area can be divided into three compartmentalized areas that communicate with each other but work independently, precisely of the site in case of damage to one of them **Negative impact** High material-constructive impact, due to the disaster wich affecting systems such as macro tanks and immersion pumps, in disagreement with the will of the community	Recreational defensive technology

Fig. 15 Criteria matrix of winning projects analysis.

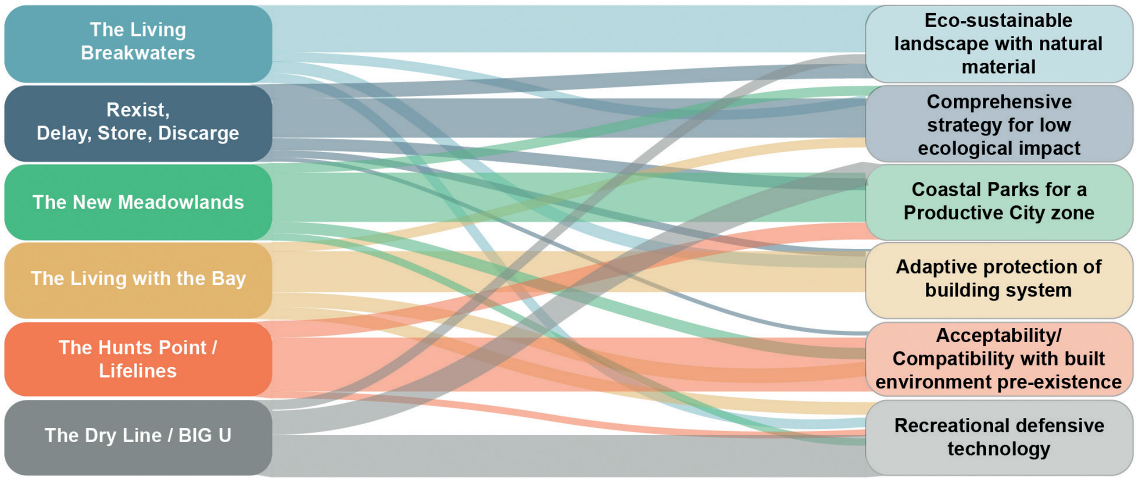

Fig. 16 The matching matrix.

By relating the case studies examined to the different criteria that emerged (right), it is possible to construct the matrix highlighting the fit and matching of these criteria through their correspondence with the other projects examined (Figure 16).

Although each project corresponds to a direct dominant criterion whose linkage is weighted with a greater thickness, other secondary criteria belonging to the other projects in the matrix, whose connection is weighted with a lesser thickness, can be indirectly linked. Compared together the matrix indicates that the South Bronx and Manhattan's Lower East Side can allow experimenting with the most interesting integrated solutions. The timeliness of the identified criteria is matched by the action directions provided in the recent U.S. guidelines for a resilient strategy to address critical climate issues expressed in Resilience 21 [154]. The latter document, published in 2021, was reflected in the latest sector tool New York City's Green New Deal [129], which aligns U.S. goals with European ones to enhance the transferability of experiments to different continents (Figures 17).

2.4 Technological innovation of New York City: The South Bronx and Manhattan's Lower East Side

During the different periods (2017-2018-2019) spent at the Graduate School of Architecture, Planning and Preservation (GSAPP) at Columbia University in New York, it was possible to conduct research activities within the labs as research-change intervention hybrids. In these labs, the study of the appropriateness of evolutionary tools for the built environment is explored. These are change-oriented experiments to discover research models to be replicated in other contexts. The experience

Fig. 17 The American actions fit the European Goals.

Criteria	Actions	Goals	
		New York City's Green New Deal (One NYC 2050, 2021)	
Waterfront ecosystem criteria	Resilience 21 building a nation of resilient communities (The Resilience 21 Coalition, 2021)	Agenda 2030 SDGs (United Nations, 2015)	European Green Deal (European Commission, 2019)
Eco - sustainable landscape with natural material	**ACTION 10.** Fundamental research on future hazards, risks and vulnerabilities informed by best in class science.	**SDG 14: Life Below Water**	**(§2.2.2)** Greening national budgets and sending the right price signals **(§2.1.8)** A zero pollution ambition for a toxic-free environment
Comprehensive strategy for low ecological impact	**ACTION 1.** Create leadership positions and estabilish the organizational structure necessary to advance change throughout the federal government. **ACTION 2.** Estabilish a National Resilience Task Force to bring a community of experts into the process of designing and adressing climate risk and multihazards. **ACTION 6.** Develop a contemporary decision-making framework for federal investments and further update NEPA environmental review processes.	**SDG 9: Industry, Innovation and Infrastructure**	**(§3)** The EU as a Global Leader **(§2.1.1)** Increasing the EU's climate ambition for 2030 and 2050 **(§2.1.8)** A zero pollution ambition for a toxic-free environment
Coastal Parks for a Productive City zone	**ACTION 4.** Research and prepare critical infrastructure, services and stockpiles for climate change and stresses related to climate risk and public health. **ACTION 8.** Create a Resilience Finance Committee to develop and support innovative financing and investment tools, funds and incentives for a range of funders and investors by drawing upon private and public investment to support and accelerate programmatic, technical and physical upgrades.	**SDG 12: Responsible Consumption and Production**	**(§2.1)** Designing a set of deeply transformative policies **(§2.1.1)** Pact increasing the EU's climate ambition for 2030 and 2050
Adaptive protection of building system	**ACTION 5.** Buildings and infrastructure that advance resilience, sustainability and social and climate justice. **ACTION 9.** Expan and align successful federal programs to accelerate holistic mitigation and adaptation improvements in homes, buildings and infrastructure.	**SDG 13: Climate Action**	**(§2.1.4)** Building and renovationg in an energy and resourche efficient way **(§2.1.5)** Accelerating the shift to sustainable and smart mobility **(§2.2.3)** Mobilising research and fostering innovation
Acceptability/ Compatibility with built environment pre-existence	**ACTION 3.** National recovery and Build Back Better initiative through environmental innovation in clean energy and advanced technologies.	**SDG 11: Sustainable Cities and Communities**	**(§2.1.7)** Preserving and restoring ecosystems and biodiversity **(§2.2.1)** Pursing green finance and investment and ensuring a just transition
Recreational defensive technology	**ACTION 7.** Create a "Future Visioning" Task Force to adress communities thretened by climate and human-caused displacement including sea level rise, wildfire, riverine and coastal flooding, environmental degradation and pollution, civil unrest, etc. This task force must support free will and mobility of communities to determine their own futures and have enough funding for support and proactive action. Considerations must include local, regional and global-reaching influences on American communities broadly: identify and provide technical and funding support to receiving communities to help them prepare for significant population and demographic changes, to ensure housing stock, infrastructure and community services are in place in addition to support networks and services. When affordable housing is to be relocated after consultation, build the receiving properties before demolishing the old and ensure that the total amount of affordable housing available to a population remains stable or increases.	**SDG 8: Decent Work and Economic Growth**	**(§2.1.3)** Mobilising industry for a clean and circular economy **(§4)** Time to Act - Together: A European Climate

gained has the dual ambition of generating complementary knowledge to foster processes of regeneration and transition and, at the same time, enriching their understanding. Research becomes a space for reinterpreting the existing through an inclusive vision of its diversity and the central mechanism to pursue actions to balance transformation and conservation of the built environment (Figures 18; 19; 20; 21).

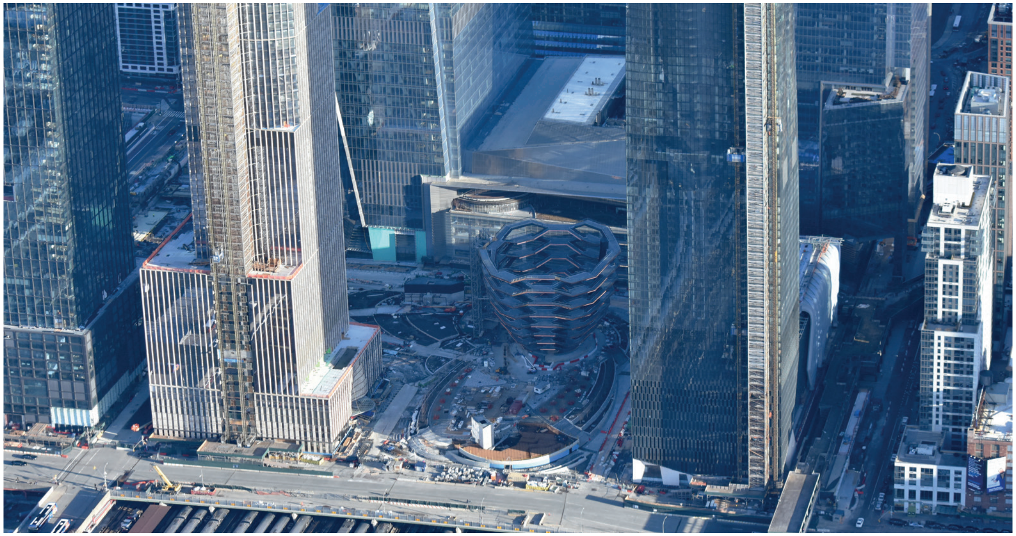

Fig. 18 Hudson Yards, one of the innovative architectural sites of New York City.

Fig. 19 Midtown Manhattan, one of the most consolidated architectural sites of New York City.

Fig. 20 Central Park, one of the most significant park infrastructures of New York City.

Fig. 21 Lower Manhattan, one of the most flooding vulnerable sites in New York City.

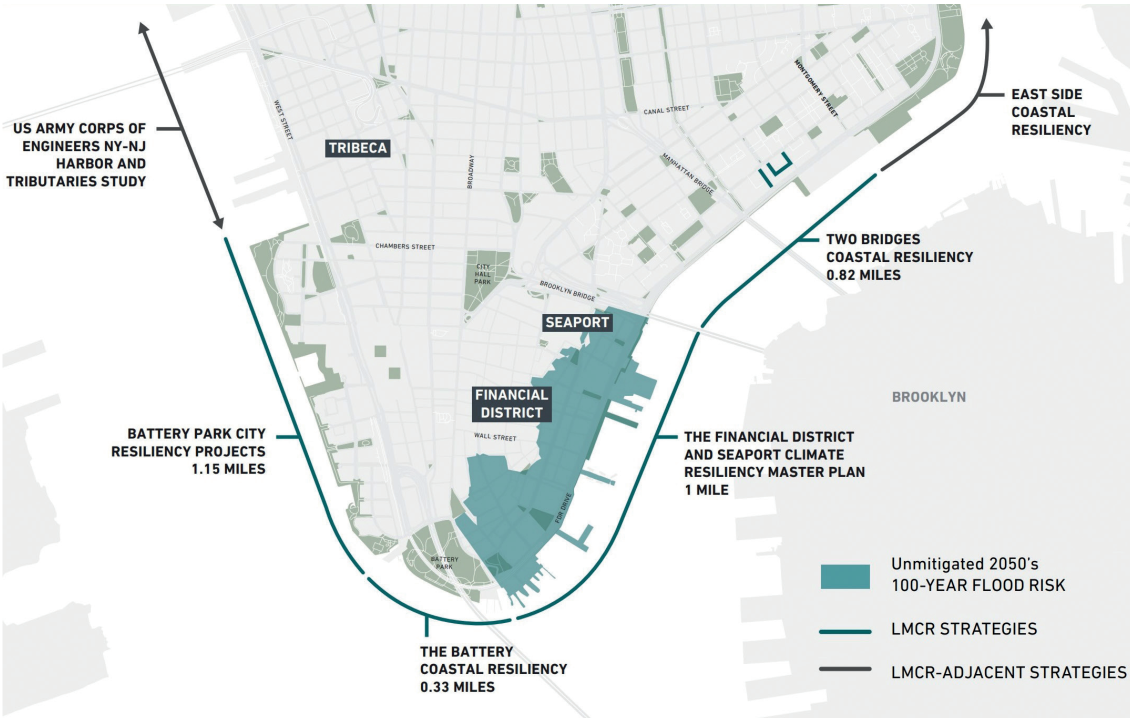

Fig. 22 New York City is advancing multiple projects to protect Lower Manhattan from flooding. A Livable Climate section of OneNYC2050, page 22. Excerpts from OneNYC 2050 Report, used with permission of the City of New York OneNYC 2050.
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The experimentation focused on regenerating the South Bronx and Manhattan's Lower East Side waterfront, exemplary case studies for integrating innovative technological systems into the vulnerable built environment. Empirical feedback that is not generalizable per se becomes so by being showcases characterized by advanced technological solutions tested in systems with high economic potential and verifiable climate impacts.

Flooding at the two sites occurs more frequently than at the other waterfronts previously analyzed. This fragility is related to the topography of the long river and ocean shorelines descending toward the edges and the inverted U-shaped concave orography of the site [155]. The South Bronx and Manhattan's Lower East Side (LES), located in the climatically most incisive annual flood belt, will face a sea level rise of 190.5 cm within the next 100 years [156]. Both sites have an economic and social vulnerability rate greater than 99% (Figure 22). They are subject to dense urban development patterns that accommodate 400,000 New Yorkers, 71,500 buildings, 49 million sq. m., and the most significant amount of critical infrastructure in the entire city [157].

According to the National Flood Insurance Program (NFIP), flooding impacts the coastal built environment, the hospital, industrial, and affordable housing infrastructure systems that characterize these places, and the wealthier and more influential New York State settlement systems adjacent to them [140]. The protagonist of the regeneration process is an innovative technology, which has been integrated into private surfaces for public use with very high economic potential [140].

Actions to transform the built environment have leveraged state funds dedicated to environmental protection, and respectively, the development of Manhattan East Side Park on the Brooklyn skyline side and the South Bronx on the Manhattan skyline side. Associated with the economic interests are several fragilities related to conservation actions in the built environment, such as claiming the preservation of sites known for their marine habitat and historical-identity value. In the case of Manhattan's Lower East Side, the area is developed on Sea Port City, the principal landing place in the U.S. for ethnic groups that migrated from the Old Continent and where the first established settlements on nationality (Chinatown, Little Italy, etc.) arise [158].

In the case of The South Bronx, the waterfront has as its only shoreline boundary the first street of the borough's urban layout, East 134th Street, which corresponds to the extension of Manhattan's urban grid infrastructure. This area affects the district's first founding site by Morris, which counted among its ranks two signers of the Declaration of Independence (Lewis, Robert) and the so-called "Penman of the Constitution" (Governor). In 1790, referred to as Morrisania, the area was among the candidates to be chosen by the federal government as the national capital because of the quality of the existing built environment [159].

Both areas, subject to gentrification phenomena related to rezoning practices [160] represent settlement systems that drive regeneration processes to maximum expression in response to the flooding emergency and the participation of expert knowledge, along with the opportunity to develop field research. In the case studies under consideration, the concept of stakeholder participation is guaranteed to such an extent that the community is not only elevated to an actor at the deliberative table along with institutions, investors, and technicians but is itself the holder of decision-making power capable of modifying and influencing design and technological choices. Stakeholder common knowledge has dictated, with the support of the local government, the preference of one defensive technological system over another to be integrated into its vulnerable built environment [161]. This potential stems from the stakeholder common knowledge that these technologies engage at the functional level and reshape social and economic dynamics at different scales in New York City.

The experimentation offers an opportunity to act on the interdependencies between infrastructure systems and climate change by examining the risks to energy distribution, transportation, telecommunications, water, waste, and sewage downstream of flooding.

According to the Climate Resiliency Design Waterfront Revitalization Plan [162], in the context of individual risk, the most severe effect is death from drowning, electrocution, falling trees, or blunt trauma aggravated by old age. Nearly half of the fatal accidents occur among adults with an average age of 65 years or older (20.47%), of which about 34.79% of them disappeared in the waves during coastal flooding phenomena [158]. The remaining people will likely lose their lives while trying to evacuate their residences. On the other, those who do not leave their homes before a storm and remain sheltered in their place have a threefold increased chance of dying from acute myocardial infarction related to emotional stress [160]. Furthermore, if floods cause power outages [160], they can generate carbon monoxide poisoning CO [159]. In addition, exposure to sewage-contaminated wastewater and limited access to drinking water and sanitation produce risky conditions related to mildew and mold [160]. Finally, all these factors contribute to increased levels of Post-Traumatic Stress Disorder (PTSD) from 18 months to five years after the event [161]. All these factors induce the search for flooding mitigation solutions that, in an inter-scale manner, ensure the performance realignment of the Technology Units in the shortest possible time and the resolution of existing failures and degradations [162]. These vulnerabilities are closely related to several variables that include the height of the building, the type of construction, the materials of which it is composed, and the age of construction. In general, low buildings (one to two stories) are more vulnerable to structural damage than buildings of medium height (three to six stories) and tall (seven stories or more) [163].

This concatenation of individual and building risks is further exacerbated by infrastructural and environmental hazards. For example, during intense flooding, the Metropolitan Transit Authority's (MTA) subway and rail systems, the Staten Island Ferry, and some of the city's tunnels may be forced to shut down completely. Much of the transportation infrastructure is located in the geographic area of annual flooding (i.e., experiencing periodic flooding at least every 12 months).

Within this area, 12% consists of major roads such as Belt Parkway and Franklin D. Roosevelt East River Drive (FDR Drive); three major tunnels; three helipads; and dozens of subway entrances and ventilation structures [163]. In addition, flooding exacerbates the natural phenomenon of bridge deterioration through scouring, that is, the erosion of the foundation or sediment on which the action of water anchors the bridge. All this limits urban flows, and consequently, the city's food supply system, as about 95% is transported in trucks based on liquid fuel. Most of the city's major food distribution facilities, wholesale warehouses, and public markets are located in the Hunt's Point neighborhood in the South Bronx. Nearly 13,000 trucks travel to and from the island's center daily, bounded by the

East River on two sides and the Bronx River on the third [164].

In the study areas, flooding determines transport isolation and vulnerability of power supply systems. Especially power plants, which generate slightly more than half of the power generation capacity of the entire city, fall within the test sites as well as 88% of the steam generating capacity used for heating. Similarly, more than 300 healthcare facilities in New York City, including hospitals, nursing homes, hospices, and senior care centers, are in the abovementioned areas.

One more risk involves the environment, whereby flooding can extensively damage the natural resources of these areas that have remained the last in the city to retain their flora and fauna [165]. Flooding can submerge for extended periods and cause shrinkage, barrier splitting, or inundation of inland vegetation with salt water, eroding the shoreline edge and damaging trees and shrubs.

It is, therefore, interesting to analyze the integrated approach to flood risk management adopted for the South Bronx and Manhattan's Lower East Side, which recognizes flooding as a natural process, but at the same time, experiments with effective strategies to cope with it. The approach focuses on increasing public awareness of risks, particularly among people living in flood zones, by reducing the vulnerability of individuals, communities, buildings, and infrastructure exposition. This approach aims to employ the collaboration of many actors from both the public and private sectors to strengthen the city's overall capacity to respond to periodic flooding. Strategies range from short-term to long-term, tangible to intangible transformations, and construction to policy.

The success of these projects has been verified over time. In this wake, the government has decided to rework what it has learned from the transformations, proposing a new way to redevelop waterfronts.

The two projects address a field of variables by introducing solutions for both the environmental system (configuration, sizing, distribution) and the technological system (structures, envelopes, systems, equipment). Mitigation technology tests the condition of flexibility [138] of the built environment from the compatibility of transformations related to the integration of innovation [53]. This compatibility, according to Di Battista, can be verified when it meets the requirements of:

- dislocation of environmental units, downsizing the geometry of used spaces;
- technical and material reconfiguration of innovation and mitigation elements;
- repositioning of infrastructure and plant networks in the built environment;
- framing of variables of new conditions of users' mental and physical well-being [138].

The compliance of both projects with the requirements above allows for comparing the compatible performance experienced in coastal built environment regeneration actions.

Manhattan's Lower East Side is part of the larger vision called Humanhattan 2050[1], based on the desire to create a hybridization in which advanced technological experimen-

[1] It is a visionary idea by Bjarke Ingels Group (BIG), on display at the Venice Architecture Biennale in 2018.

Fig. 23 Helicopter survey of Manhattan's Lower East Side on Two Bridges space.

tation is integrated with the pre-existing settlement system to mitigate its vulnerabilities related to climate change. The Humanhattan project looks at the experimental coast as the first site to test innovative systems to protect cities from sea level rise and future storms, placing social, technological, and environmental needs on the same level. According to this vision, the design for Manhattan's Lower East Side proposes new, technologically advanced infrastructure to safeguard the waterfront for the next hundred years. In addition, it makes these spaces more accessible to the community. This is done by designing a site where technology is integrated into the settlement system from the needs of human beings (hence Humanhattan). This design vision expands from BIG's successful idea for the boundaries of Lower Manhattan by strengthening existing sites and developing new physical shoreline extensions. This is part of a larger vision that has been referred to as "MOMA", a contraction of the expression "MOre MAnhattan" (Figure 23).

Technology becomes the driver of the project, guided by the need for active user involve-

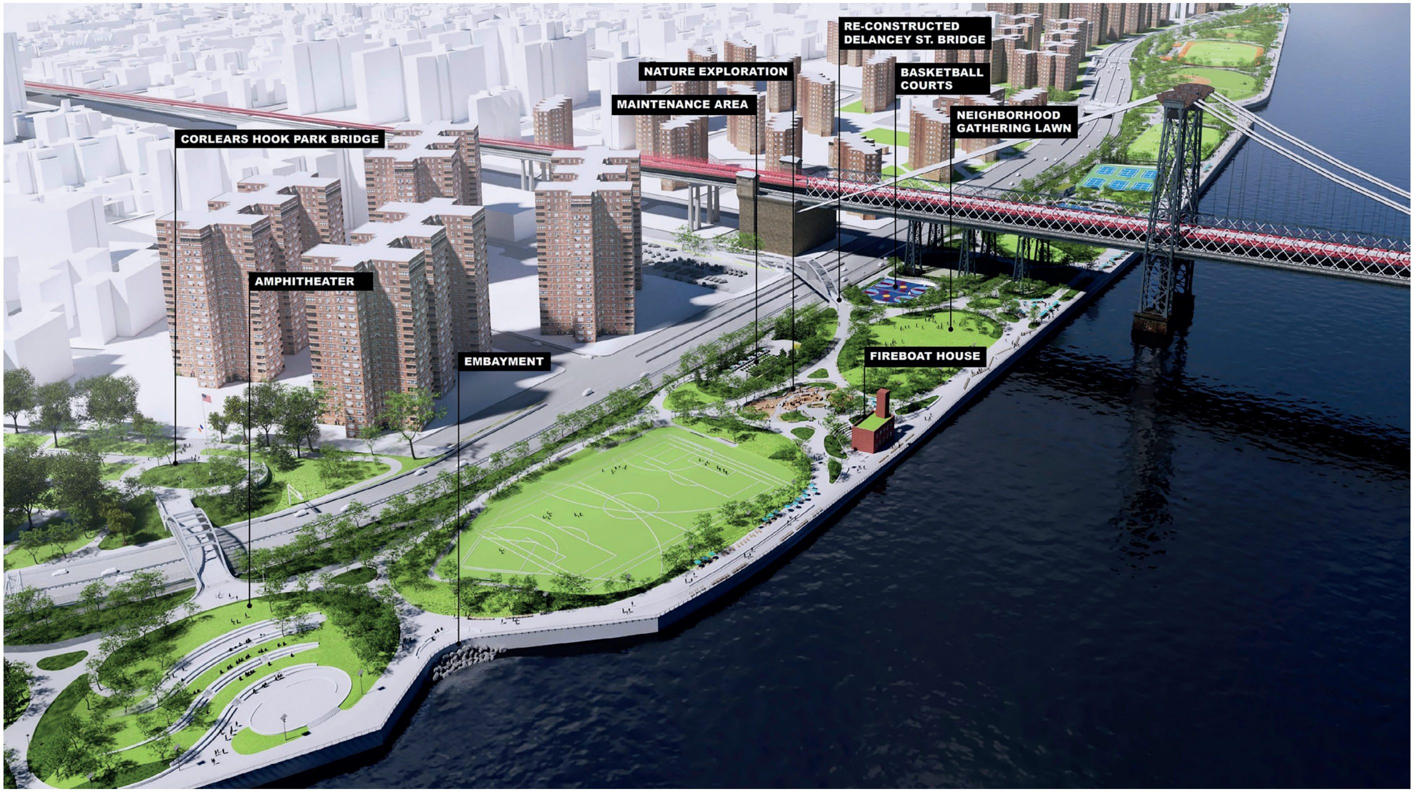


Fig. 24 East Side Coastal Resiliency (ESCR). Excerpts from East Side Coastal Resiliency SANDRESM1 Final Review Presentation, used with permission of the City of New York. East Side Coastal Resiliency SANDRESM1 Final Review Presentation' ©2019 City of New York. All rights reserved.

ment and the in-depth study of the vulnerabilities of the site [141]. As outlined by the forecast document Building the Knowledge Base for Climate Resiliency, prepared by the New York Panel on Climate Change (NPCC) [126], the transformations planned for the case study are part of a larger plan called East Side Coastal Resiliency (ESCR) [127] (Figure 24).

The ESCR project aims to be an integrated coastal protection system to reduce flood risk and facilitate waterfront access by creating enhanced public spaces and natural areas. Extending from Montgomery Street to East 25th Street, the ESCR project seeks to strengthen 3.9 miles of coastline while providing social and environmental benefits. Precisely, the project consists of two main parts involving the redevelopment of the East Side shoreline (extended along the East River from East 25th Street to Montgomery Street) and the implementation of the Lower Manhattan Resiliency Project (from Montgomery Street to Battery Park City), covering a total area of 100,000 square meters [127] (Figures 25; 26; 27; 28; 29;30).

Fig. 25 One of the flooding technological solutions of ESCR.

Fig. 26 One of the recreational facilities of ESCR which could work as flooding mitigation solution.

Fig. 27 Waterfront of ESCR, downtown perspective.

Fig. 28 Waterfront of ESCR, uptown perspective.

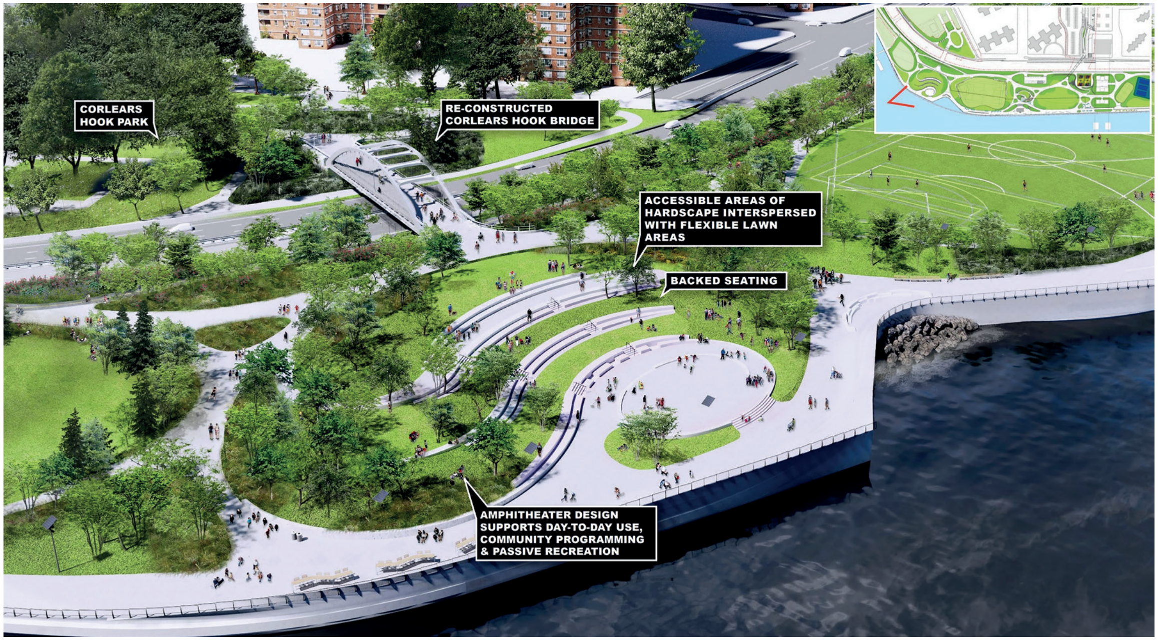
Fig. 29 Waterfront esplanade of ESCR.

Fig. 30 New facilities of ESCR, which could support absorbing and mitigating flooding.

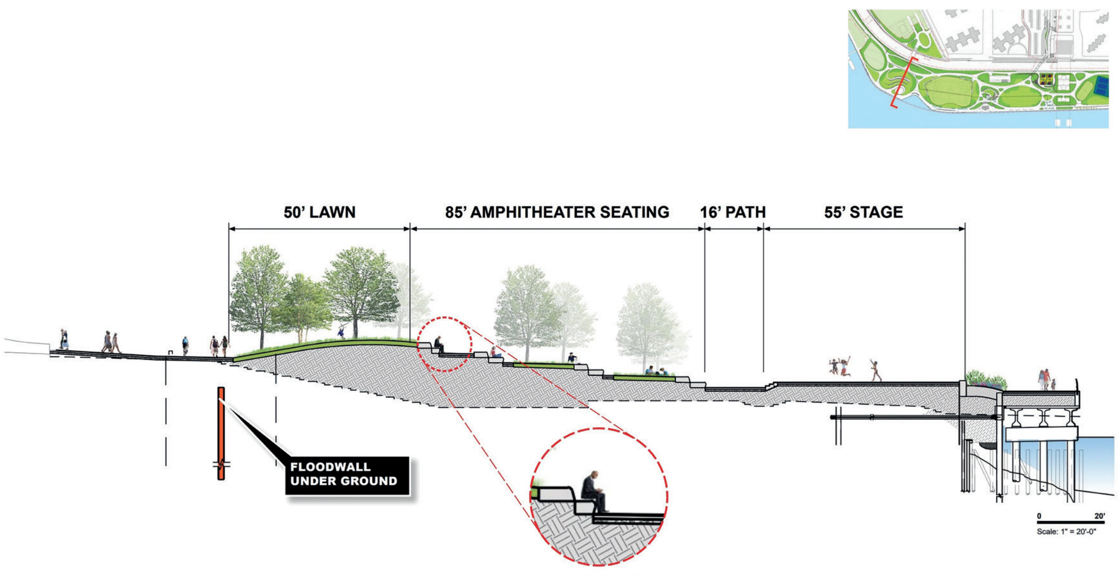
The latter part of the project has been realized, while the former started in spring 2020 and will be completed in 2024. This delay is due to the need to adapt the design drawings to the requirements of Manhattan's Community Board, which requested the modification of the shoreline protection strategy, no longer in extent but in elevation. It happens to safeguard Sea Port City's historic port identity and the interests of the local community from developers [143]. This request stems from the possibility of reusing part of the existing coastal area, currently used as a park (East River Park), and from the futility of increasing the surface extension of a site projected to be entirely below sea level within the next 100 years. Moreover, among all the proposed solutions, the community preferred retractable barriers to avoid altering the coastal landscape established over time. The peculiarity is that the main technology is integrated purely with the built environment's ground rather than the ocean floor (Figures 31; 32; 33; 34).

In particular, the community has demanded soil modeling to shift flood protection closer to the inner coastline, expanding the choice of buried coastal defense measures. This design approach's advantages include reducing lead times and ensuring the possibility of using this solution by the 2023 hurricane season. This would ensure less transit disruption for residents during construction, as work can be done more quickly and during the day across the East River. The coastal flooding solution and the resulting downtime reduction after storm events would work to support the inclusion of extensible connections to East River Park as direct waterfront access (breaking down existing physical fencing barriers between the park and the community). In the Lower East Side area of Stuyvesant Cove Park, elevated open spaces have been designed to include ferry docking points, the construction of cultural facilities, and enhanced kayaking facilities.

Overall, the ESCR project develops physical, social, and economic resilience by strengthening the city's waterfront while regenerating public space. Specifically, the opportunity to increase social cohesion comes from making the waterfront open and accessible. Defensive solutions are transformed into attractive amenities to prevent flooding in Manhattan's low-lying areas and revitalize the existing park space along the East River. The different jurisdictions involved within such a complex infrastructure as the urban coastal park are the Department of Transportation (DOT) for the roadway interruption during the site enhancement, the Department of Parks (DOP) with its regulations, and finally, the Department of Environmental Protection (DEP) protecting coastal land and water uses. In addition, the design of this new park for New York City, like those already built, has unique features contended between the needs of the resident community and the interests of developers imposed as performance requirements on the design. This balance varies concerning the public-private investment partnership for project implementation, the integration of coastal protective technology solutions, and the maintenance strategy that the large urban seaside park requires. To avoid pri-



Figg. 31-32 Design details of East Side Coastal Resiliency (ESCR). Excerpts from East Side Coastal Resiliency SANDRESM1 Final Review Presentation, used with permission of the City of New York. East Side Coastal Resiliency SANDRESM1 Final Review Presentation'



Figg. 33-34 Flood-proof design of East Side Coastal Resiliency (ESCR). Excerpts from East Side Coastal Resiliency SANDRESM1 Final Review Presentation, used with permission of the City of New York. East Side Coastal Resiliency SANDRESM1 Final Review Presentation' ©2019 City of New York. All rights reserved.

vate economic pressure, the park's design aims to use only federal, state, and district funds, seeking to create a recreational facility, unlike the intended uses of the Highline or Brooklyn Bridge Park. This has affected experimentation with innovative defense solutions such as flip-up gates, i.e., retractable gates, which are flexible and preferred over more technologies credited by FEMA (entailing an additional $350 million for site protection).

Innovative technologies have been integrated to make protective capabilities coincident with federal standards and design visions. The project technology consists of an experimental combination of several defensive solutions, active and passive, that keep the human factor tied to their operation. Most of the defensive technologies are designed to be operated by human management, except for underground hydraulic pumping machines and automatic tidal barriers (firewalls equipped with pop-up gates). These advanced technological defense elements absorb, reduce and forfeit flood waves with complementary operations to other integrated solutions. The choice also stems from the needs of the resident community regarding the use of advanced technologies that aim to reduce operational requirements and maintenance costs. Among the current changes is replacing retractable barrier technology with pressure barriers, which can be placed in the Two Bridges Project area. This innovative solution allows water to fill the caissons, pushing its constitutive technological bodies to flank each other on the surface, thus generating a continuous sluice gate to block subsequent inflows. The electronic devices, which are tied to the barrier and can also be manually operated, can detect flood about 18 hours before it occurs, based on wave motion and weather conditions [166].

The described technology may be a good solution for the park but not for the defense of the road section, as the solution may activate by not distinguishing flooding from heavy rain, leading to a risk to vehicles and people. In this sense, the defensive technology should fulfill an additional task, namely to reconnect through new access points and bridges the settlement system to the coast by integrating Franklin D. Roosevelt East River Drive (FDR Drive) into the project (Figures 35; 36; 37; 38; 39; 40).

The typological and morphological invention of the technological solutions adopted concurs with ensuring continuous connections between the neighborhood and its waterfront while enhancing the park's view from Domino Park and Williamsburg. The reconnection between the housing dimension and the park was one of the community's main demands, followed by creating play spaces for children and areas where families could gather. The park envisioned by The East Side Coastal Resiliency is not a Homestead [88] or Vox Park [88], it is not a modern park [88], it is not a historic park [88], but it has a very close neighborhood identity; the project site corresponds to the original green area designed in the mid-20th century. In this regard, the project team requested active community involvement to cushion the social impact that the population would suffer upon completion

Fig. 35 Technological solution of East Side Coastal Resiliency (ESCR). Excerpts from East Side Coastal Resiliency SANDRESM1 Final Review Presentation, used with permission of the City of New York. East Side Coastal Resiliency SANDRESM1 Final Review Presentation' ©2019 City of New York. All rights reserved.

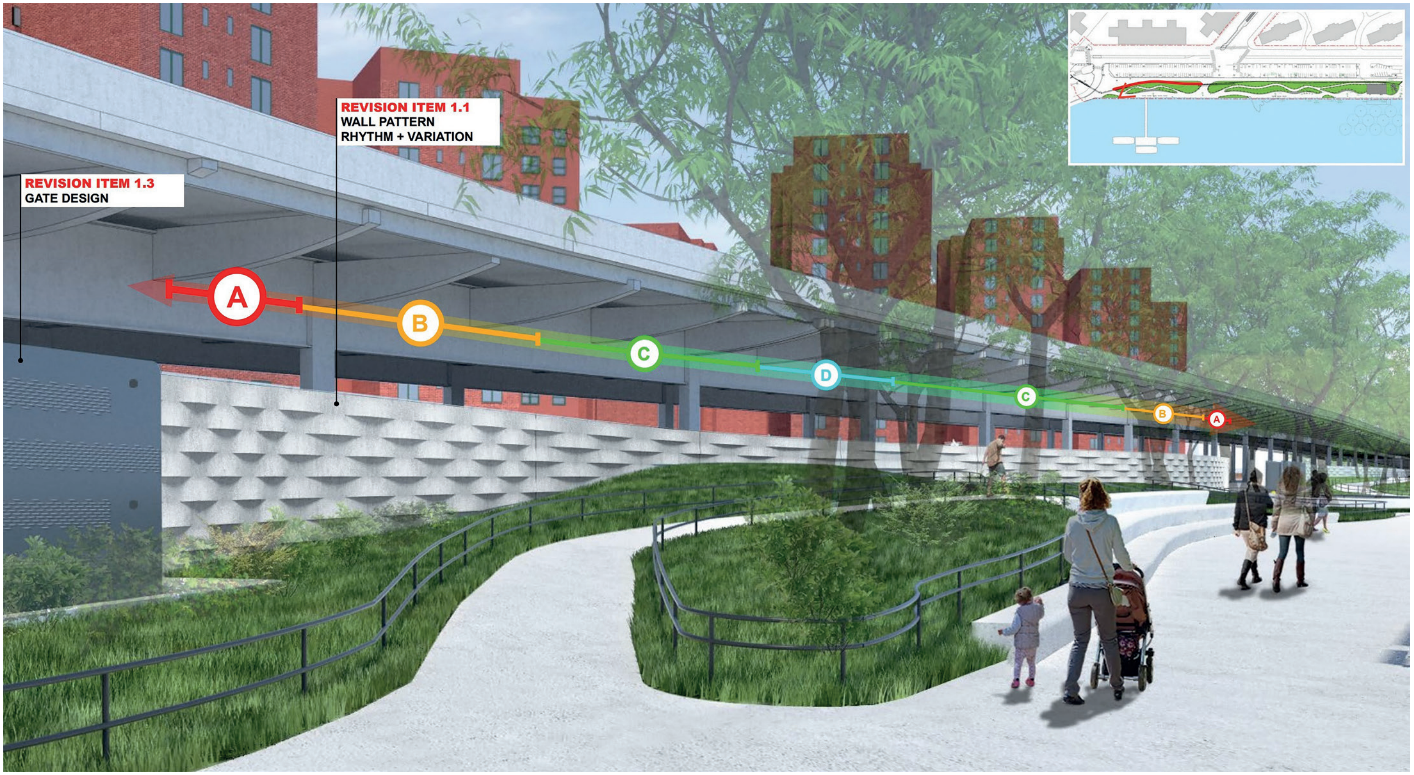


Fig. 36 Flood-proof solution of East Side Coastal Resiliency (ESCR). Excerpts from East Side Coastal Resiliency SANDRESM1 Final Review Presentation, used with permission of the City of New York. East Side Coastal Resiliency SANDRESM1 Final Review Presentation' ©2019 City of New York. All rights reserved.

Fig. 37 Operation of the technological solution without flooding in East Side Coastal Resiliency (ESCR). Excerpts from East Side Coastal Resiliency SANDRESM1 Final Review Presentation, used with permission of the City of New York. East Side Coastal Resiliency SANDRESM1 Final Review Presentation' ©2019 City of New York. All rights reserved.

Fig. 38 Operation of the technological solution with flooding in East Side Coastal Resiliency (ESCR). Excerpts from East Side Coastal Resiliency SANDRESM1 Final Review Presentation, used with permission of the City of New York. East Side Coastal Resiliency SANDRESM1 Final Review Presentation' ©2019 City of New York. All rights reserved.

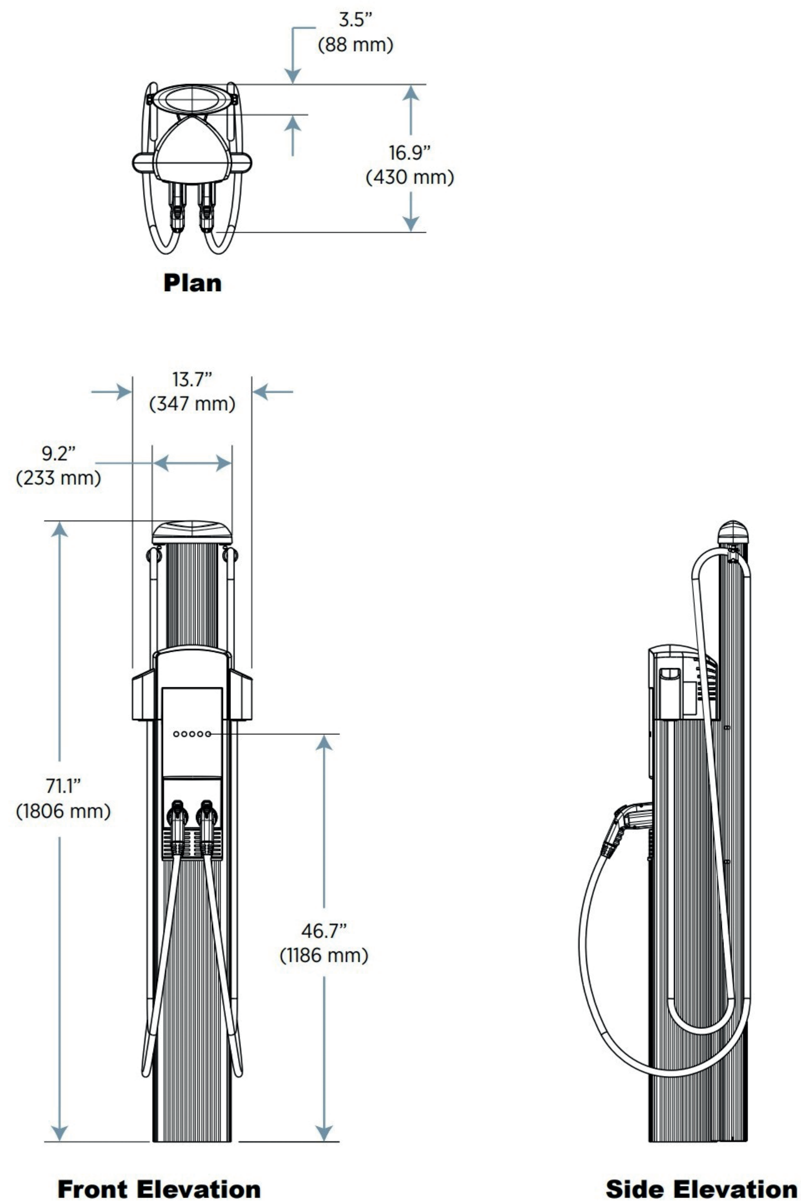


Fig. 39 Technological solution details of East Side Coastal Resiliency (ESCR). Excerpts from East Side Coastal Resiliency SANDRESM1 Final Review Presentation, used with permission of the City of New York. East Side Coastal Resiliency SANDRESM1 Final Review Presentation' ©2019 City of New York. All rights reserved.

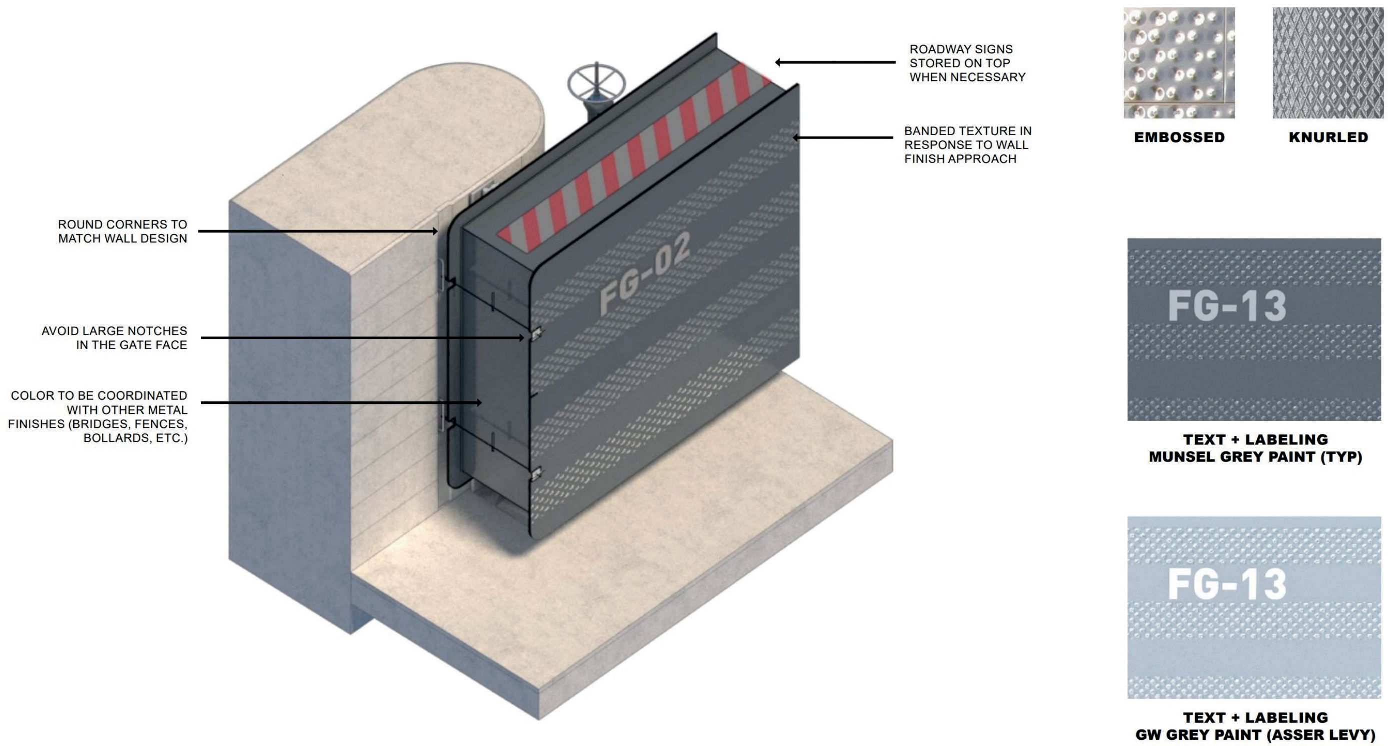


Fig. 40 Operation of technological solution of East Side Coastal Resiliency (ESCR). Excerpts from East Side Coastal Resiliency SANDRESM1 Final Review Presentation, used with permission of the City of New York. East Side Coastal Resiliency SANDRESM1 Final Review Presentation' ©2019 City of New York. All rights reserved.

of the project. During the feasibility study, numerous consultation sessions were held to educate the community on understanding climate change and the need to keep the dimensions of protection and social integration together. Looking at the project as an opportunity to build a stronger and more conscious form of cohesion, the community has influenced the design of the system of paths and bridges that connect the park with the city. This dialogue occurs through connecting structures characterized by the technological solutions of the barriers of varying heights according to the shoreline elevations (from three feet to eight feet high – 90 to 240 cm). The urban context is extended by employing a system of promenades elevated above sea level. Exploiting a vegetation system, allowing users to enjoy a redeveloped landscape system while being protected from the weather.

Between Manhattan Bridge and Montgomery Street, walls have been installed at the bottom of the FDR unit to protect the area from flooding. These panels will be decorated by local artists and highlighted by a built-in lighting system to transform the threatening area into a safe and secure destination. The plan also calls for a series of levees and docks to strengthen the barriers and prevent water from overflowing, especially in those bordering inlets to the East and West from which Hurricane Sandy had easy access to the coast. Should the new floodwall fail to repel the waters, 11 green areas have been provided to absorb and dampen storm and coastal water. Architecturally, several buildings have been designed that integrate innovative technologies into their structural system. In August 2018, construction began for a building in the East River area, which will provide free solar energy to park users 24/7, especially in case of another major storm like Sandy. This building will integrate different intended use: galleries, cafés, a kayak area, offices, and conference rooms.

Enriching the coastline is the planned regeneration of the coast guard office and its reuse as a maritime museum and environmental education facility. The latter, due to its building form, represents both a safety container in case of flooding and a “reverse aquarium”, allowing visitors to observe tidal changes by positioning themselves below sea level.

Combining general strategies with coastal modeling practices has also been strongly supported in the South Bronx, where coastal regeneration projects are in the Harlem River, Mott Haven, and Port Morris areas. A large number of associations related to the project expressed their needs through entities grouped of the South Bronx River Watershed Alliance (Mothers on the Move, Youth Ministries for Peace and Justice, Tri-state Transportation Campaign, The Point CDC, The Pratt Center, We Stay/Nos Quedamos). The regeneration project, and the different forms of technological integration, are called upon simultaneously to intervene in the degree of social vulnerability that depends strictly on the type of minority groups settled (Figures 41; 42; 43; 44; 45).

The latter leads to an aggregate lifestyle that influences the compatibility of new uses

Fig. 41 The South Bronx social vulnerability.

Fig. 42 The South Bronx built environment.

Fig. 43 The South Bronx waterfront.

Fig. 44 Recreational facility of The South Bronx waterfront.

Fig. 45 The South Bronx waterfront infrastructure.

and the appropriateness of technological integration.

During the months of experimentation, the research associates plan to transform the South Bronx's coastal built environment with a soil modeling approach identifiable with the concept of "wave landscape design". Interpreting the latter as the development of new walkability through a sinuous land pattern determined by an organically shaped path system that precisely grafts onto the pre-existing historic layout. The fluidity of the pathway system drawn in the plan takes the orographic reconfiguration of the land as its motif. The soil profile has been modeled through lowering and raising operations to create a play of dunes and basins protecting the coastal built environment.

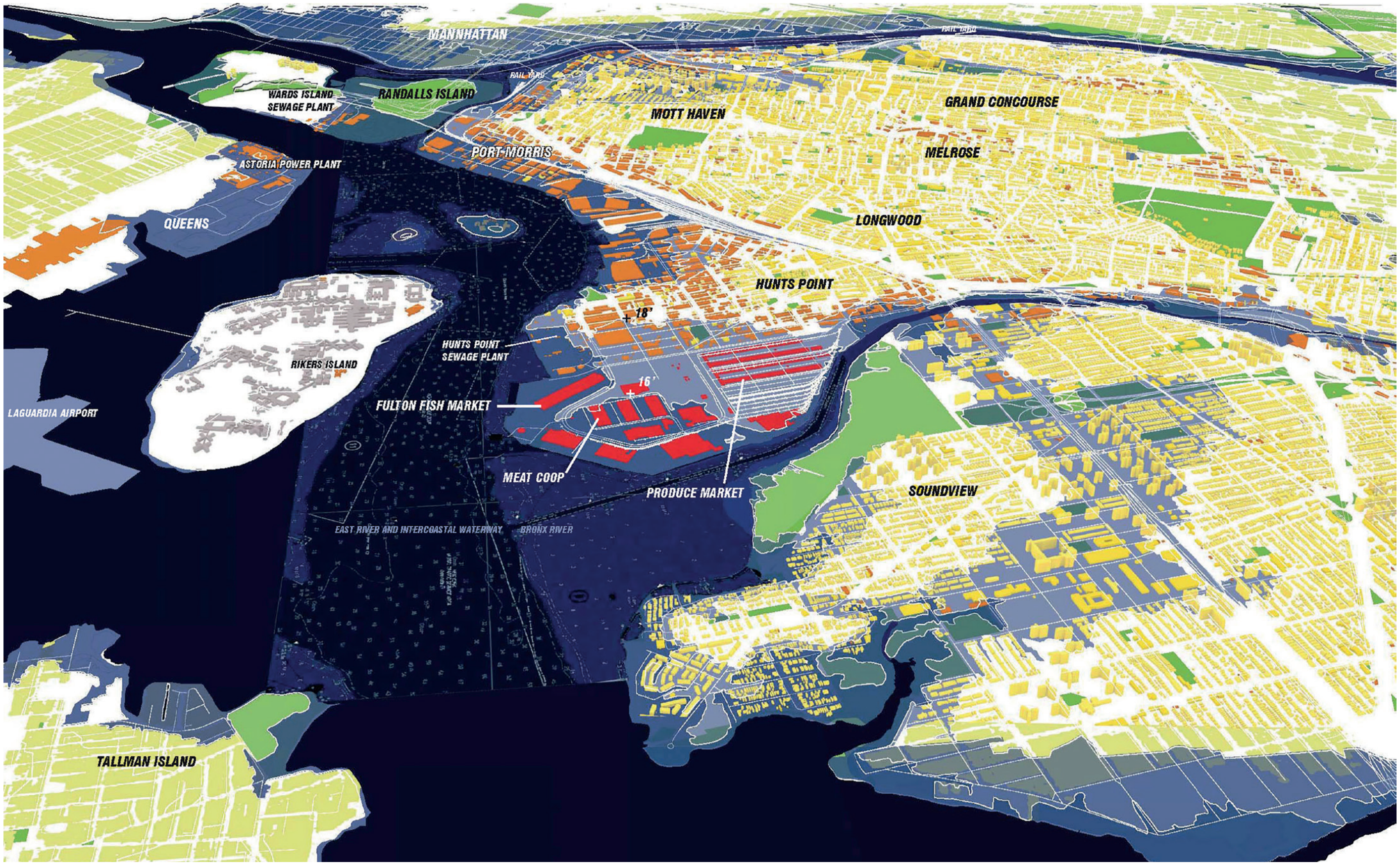
The Harlem River experimentation consists of 9 operational compartments, whose uses are combined with as many flood mitigation technology systems.

In the first compartment, technologies adapt to the introduction of commercial, residential, and entertainment uses (theater complexes, galleries, indoor sports, restaurants, clothing stores, children's products, and toy stores). In addition, the new intended use of this section of the coastline as a public square serving the community influences the environmental impact attributed to the scale and extent of the technological proposal for infrastructure such as flood containment basins. Specifically, the system involves installing 64 sensors within the city sewage infrastructure. Their function is to detect hypothetical increases in the water level. If the predetermined limit is exceeded, the sensors automatically increase the power of pumping and draining excess water to be disposed of into the sewer.

In the second and third compartments, technologies adapt to the introduction of uses based on the community's necessities, focusing on primary needs (supermarkets, pharmacies, laundries, community facilities, institutional, educational, and medical offices). The new intended uses of these shoreline subdivisions result in the search for technological solutions with a low degree of physical transformation through experimentation with equipment responsive to stakeholder acceptability.

In the fourth, fifth, and sixth compartments, technologies adapt to introducing social uses (nursing homes for the elderly, private health offices, and social service offices). The new intended uses in these compartments result in the search for technological solutions with high-performance reliability through experimentation with neighborhood equipment serving building systems.

In the seventh, eighth, and ninth compartments, technologies are adapted to introduce environmentally oriented uses (nature reserves, reclaimed spaces, transportation lines). The new intended uses of these coastal compartments require technologies with high constructive modifiability for all the mitigation elements throughout the overall reclaimed area. The technology consists of a system of plates fixed to the perimeter



of the building, camouflaged with the pavement on the site. A series of steel pillars are bolted to it; aluminum panels are connected to them. The entire frame is completely removable following the storm, so it is not a visually impactful element. The temporary barrier will be erected by a team of specialized workers, starting with the warning issued by the government about 10 hours before the hurricane's arrival. This structure protects the basement floor of buildings, where the electrical systems of buildings are usually placed (Figures 46; 47; 48).

The Mott Haven and Port Morris experimentation consists of 7 operational compartments, whose uses are configured with the same number of flood mitigation technology systems.

Fig. 46 Overview of flood risk and adjacent land use in the South Bronx, with industry shown in orange the FDC in red, and residential in yellow. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

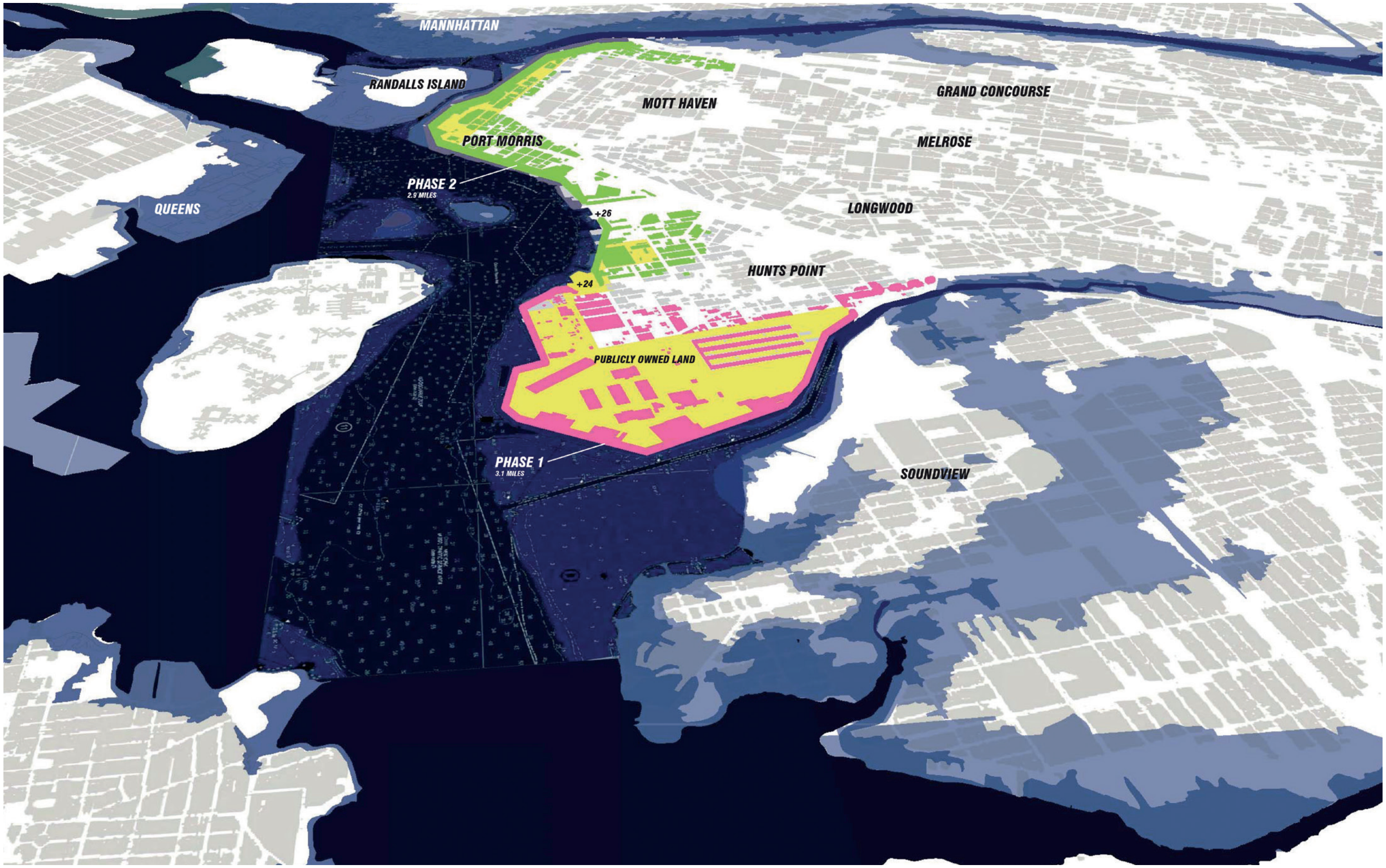
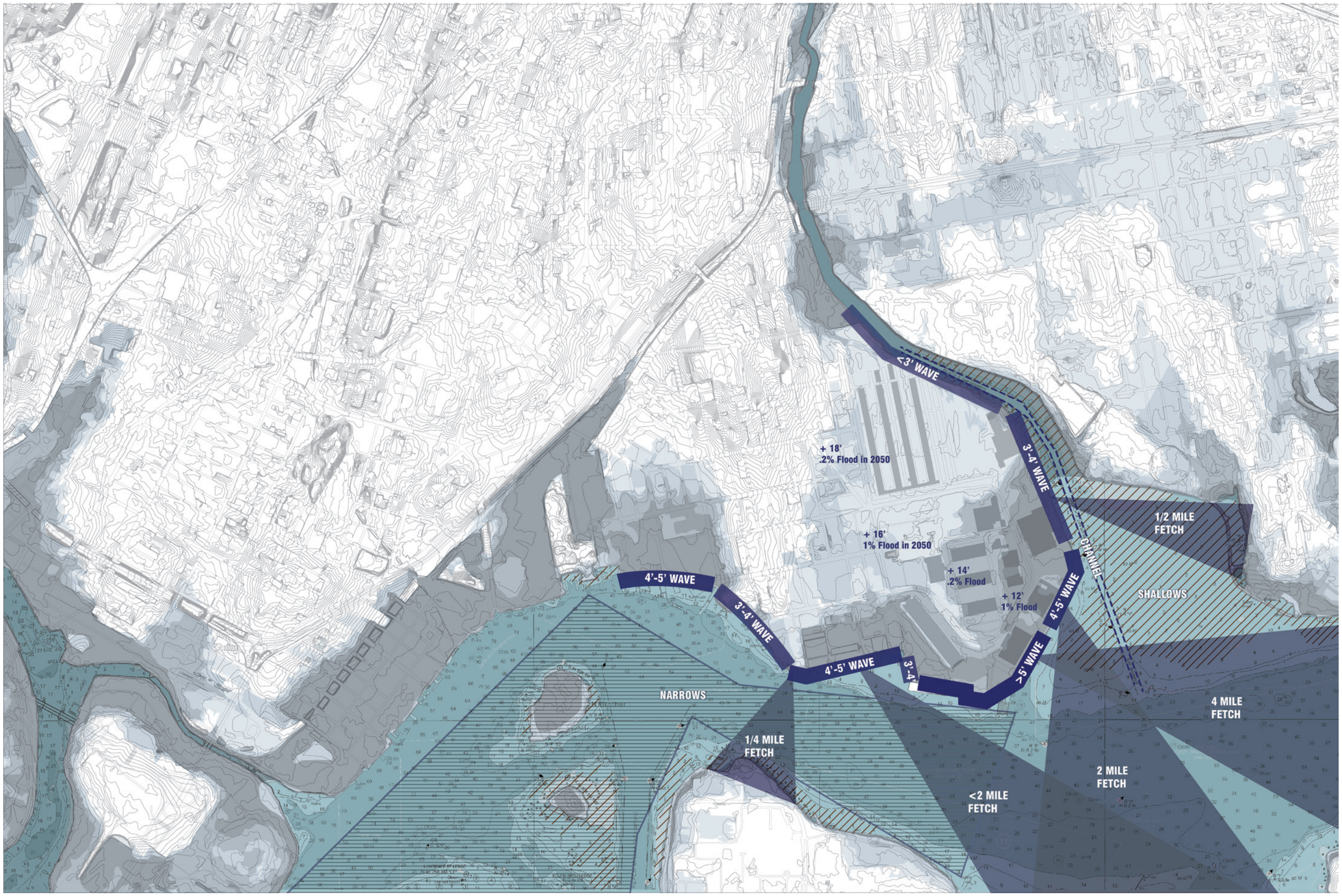


Fig. 47 Overview of flood risk and adjacent land use in the South Bronx, with project phase 1 shown in pink, and the project phase 2 in green. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

The first compartment, the Bronx Kill Waterfront Park, is a former Native American settlement designated for the burial of indigenous peoples. Hence, the use of nature-based strategies is envisioned regarding technologies since it is the last remaining green space in the area.

In the second and third compartments, Park Avenue Waterfront Park and Lincoln Avenue Waterfront Park, respectively, sport fishing and diving areas were redeveloped. Mitigation technologies followed the principle of fragmentation [57], taking on an integrative conformation determined by the relationship between the development of the built environment and the technological surface area required to intervene in sewage filtration. The park area has been virtually divided



into layers, each serving a technological function that cooperates with the flood mitigation strategy. During a hypothetical storm, water permeates within the area: the vegetation absorbs part of it, and the remaining amount is channeled into the system of paths deeper than the normal ones (80 cm), which are thus transformed into rivulets or small rivers that direct the flows to the basins. Each basin has a filtration and piping system connected to the government sewage system. In this way, when the tide floods the site, the water that fills the basin has two destinations: the first, as well as the most immediate, is to flow into the city's

Fig. 48 Most flooding vulnerable point of South Bronx waterfront. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

sewer disposal system, which through the aforementioned 64-sensor system, boosts the filtration maneuver. The second involves the reuse of the water channeled into the basins, from which filtered water can be reused at the end of the emergency for irrigation or sewage disposal of the site (Figures 49; 50; 51; 52; 53; 54; 55; 56; 57).

Fig. 49 Overview of the South Bronx project to mitigate the flooding. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

Fig. 50 Overview of the South Bronx waterfront infrastructures. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

Fig. 51 The South Bronx waterfront facilities. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

Fig. 52 Overview of the South Bronx harbour esplanade. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

Fig. 53 Overview of the South Bronx harbour. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

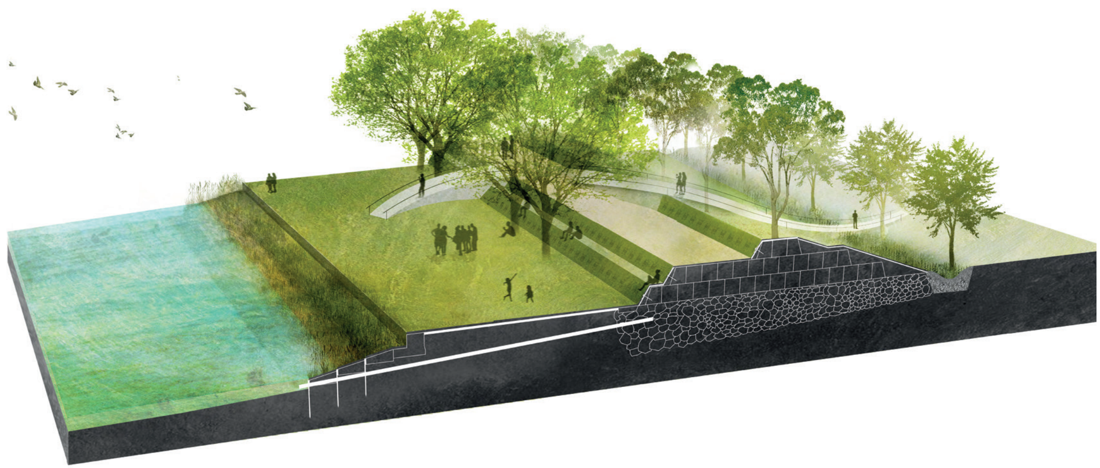


Fig. 54 Green technological details of South Bronx project solution to mitigate the flooding issue. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

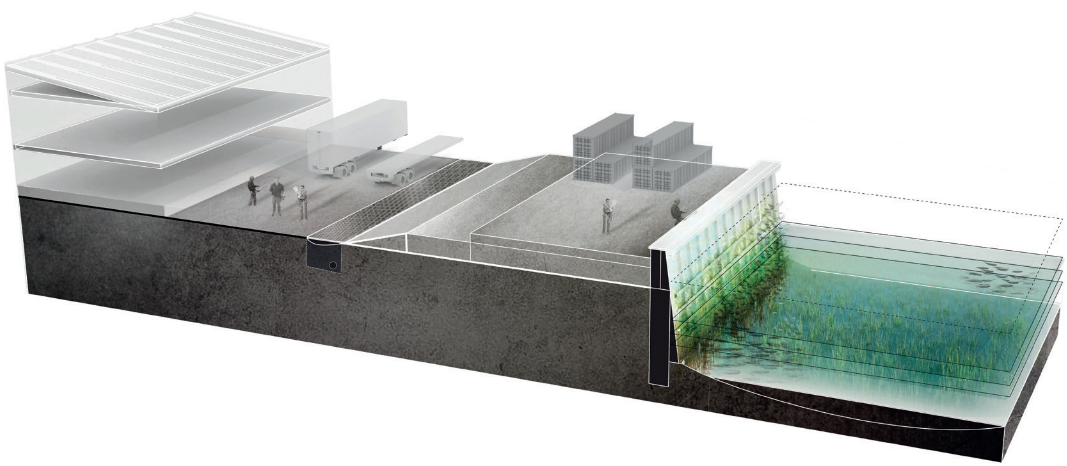


Fig. 55 Section of technological solution of South Bronx buildings. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

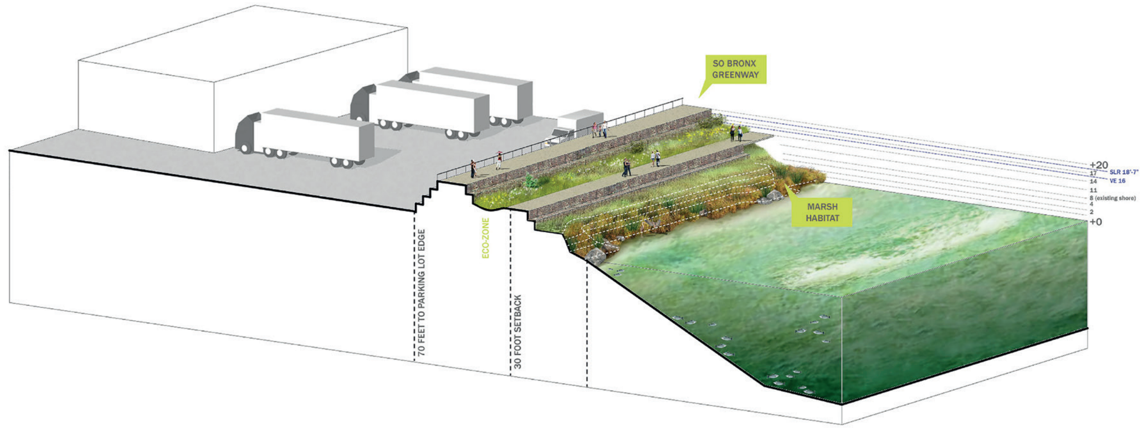


Fig. 56 The South Bronx greenway and marsh habitat to mitigate the flooding issue. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

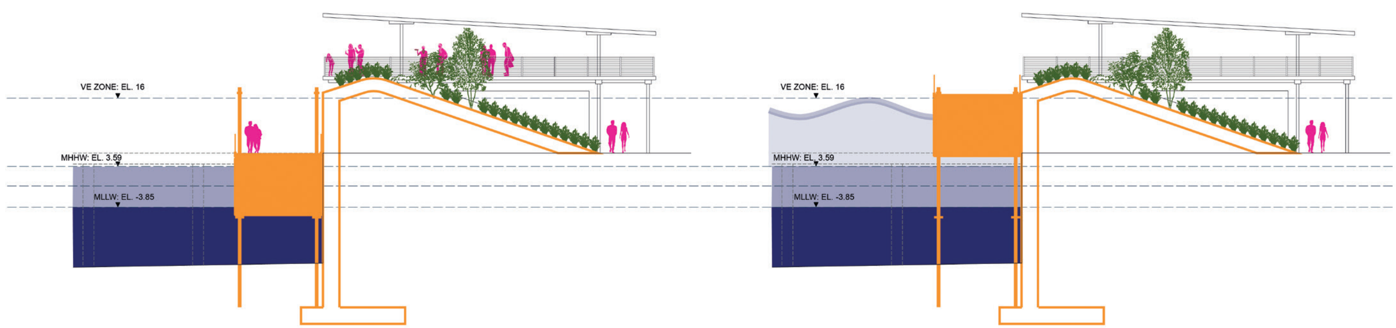


Fig. 57 Double floodbank to protect the South Bronx waterfront. By courtesy of the PennDesign, OLIN, HR&A Advisors, eDesign Dynamics, Level Infrastructure, McLaren Engineering Group, Barretto Bay Strategies, Philip Habib & Associates, Buro Happold.

3. A Reticular and Integrated Model for the regeneration of the built environment

3.1 Processes and approaches for an appropriate coastal integration of cutting-edge technologies

The analyzed technological solutions open new frontiers of the regeneration processes of the coastal built environment, representing the set of innovative ways by which to adapt it to the challenges of our time. This attributes a threefold meaning to technology, which according to Ciribini [54] identifies it with being normative (for the system of contents, rules, and, procedures to which it is called to respond and which it redesigns); intentional (for its ability to influence social behavior) and operational (for the system of material entities it generates in integrating with the natural environment). According to Architectural Technology [12,19-23,54], science and technology are inseparable, so the derived knowledge from information about the built environment coincides with its value system [166].

This interpretation surpasses the traditional scientific theory, which was determined by an evolution of the sciences based on the dichotomous relationship between nature and culture [167], promoting the compartmentalization of knowledge that defines reality. The sectorisation of information and the severing of links between different scientific fields has generated, over time, the proliferation of hybrid [168] makeup in various research fields. The above is the Actor-Network Theory (ANT) [169] by Bruno Latour, which aims to stitch together the sciences as relative systems in open communication [170]. Moving beyond classifications by intrinsic qualities or predefined correspondences, the built environment is no longer composed of separate entities awaiting reconnection, but rather has value and is identified within the relationships it establishes. In particular, the research reveals an interpretation of the built environment as an assembly [171] that is composed of a heterogeneous network of entities that, with multiple interests, constitute evolving alliances [89].

The ANT shares with STS (Science, Technology, Society) [172] the principle that technology is composed of individuals assembled in intellectual communities that, by producing instruments and interpreting experimental measurements, consider technical elements as active participants in scientific studies, together with social and environmental ones. It is in this key of interpretation that the instrumental and anthropological concept of technology is merely a tool in the service of human activity [173]; overcoming this principle of cause-and-effect [174]. Considering technology embedded in cultures, and therefore mutable according to context, the components of the human-nature-technology triad are placed on the same plane, conditioning each other according to a principle of inseparability between humans and non-humans [175]. This occurs because it is not enough for an entity to exist, but it must perform an action within the process in order for it to be defined as such.

Because an action occurs when the relationships, or network assemblies in which the entity can move [176] are changed, even non-human things become a substantive part of the actor networks of the regeneration process. These ties are therefore endowed with a material makeup, not inherent in the idea of the action but in the physicality of the production of the action itself. For example, in the case of coastal processes, it is not enough for the natural element of water to be involved, but it must manifest itself through an action of inundation in order to participate in the regeneration process and be placed on par with human actors. The inclusion of non-humans determines that, regardless of being animate or not, they share with equal weight in the dynamics and the behaviors of humans [86]. So, ignoring the dualisms typical of essentialist thinking, humans and non-humans are integrated with each other in the form of "actants" [177] as the result of the relationships in which they are involved. The "actant" (i.e., the human or non-human actor) conditions the dimensions of the regeneration process of the coastal built environment.

From a time point of view, the actant affects the speed of the connections of the links it develops over time due to the mixing of elements until now considered subordinate. This imparts an acceleration in the transformation processes of the built environment as opposed to the inertia of integrating innovative solutions. The actants, while belonging to different temporalities (for example, the duration of human life, the natural environment or machine performance) can connect with each other by realigning the temporal asynchrony of processes. Time exists as a link between them, a flow of autopoietic and iterative relations [178].

From a spatial point of view, the actant takes the form of arrow-directions [179], known as the potential of the conditions of the actions of which it is the promoter, as they are distributed throughout the network.

This reasoning highlights the existence of two axioms: relational materiality and performativity [179]. The former stems from the idea that actants are the result of connections; the latter looks at them as elements that acquire their form as the result of the relationships in which they are spatially immersed.

This gives the process characteristics of being both heterogeneous, in terms of the quality of assemblies, and hybrid, in terms of the quality of actants in concert [180].

Within the aforementioned combined mechanism [6], assemblies must take into account the coincidence of multiple trajectories [181], that is, multiple subsystem (social, cultural, economic, technological, environmental, and design) that may relate to each other according to different orders [114]. The systemic analysis of the built environment refers to the one introduced by Di Battista according to a breakdown into a natural physical sub-system, anthropized physical sub-system, and economic sub-system [53]; but the adopted methodology evolves this vision by specifically distinguishing between social and cultural sub-systems and recognizing the technological sub-system as equal in level to the other ones.

There are, therefore, points of contact called 'nodes', which represent the product in/from/through which the relationships that make up the network are distributed in temporary, and therefore, unstable forms [182]. Since no actant is autonomous, but it is in its action that it contributes to the creation of the networks that enable it to exist [183], stabilizing a network requires that the links between the different actants strengthen the relationships while also developing new ones. Thus, the assembly of the different networks generates a connective network, interpreted as a spherical pattern of multidirectional, horizontal and vertical processes and relationships [184] (Figure 58).

For example, when flooding hits the coast it modifies the relationship between communities, natural phenomena, technological tools, and governance processes. Similarly, the climate event redesigns new relationships through the resulting infusion of innovative technological solutions called upon to address both past challenges and controversial outcomes arising from its integration [185]. Technologies abandon their characteristic saving trait and thus prove to be strictly dependent on how they integrate with the built environment. Taking the definition of integrability [139] as the set of conditions relating to the aptitude of units and elements of the system to connect functionally with each other [186], appropriate, and therefore, skillfully integrated technologies reconnect systems that are no longer in communication. In this sense, their ability to integrate evolves from a design requirement to a process paradigm, representing the guide toward innovation that is not only material but also attentive to the evolutionary values of the time [187]. Promoting the ability to integrate with innovative technologies in the built environment foreshadows 'thresholds' within which transformative action can be called appropriate [188]. Appropriate integration must optimize existing resources and enhance the multiplicity and dynamic nature of relation-

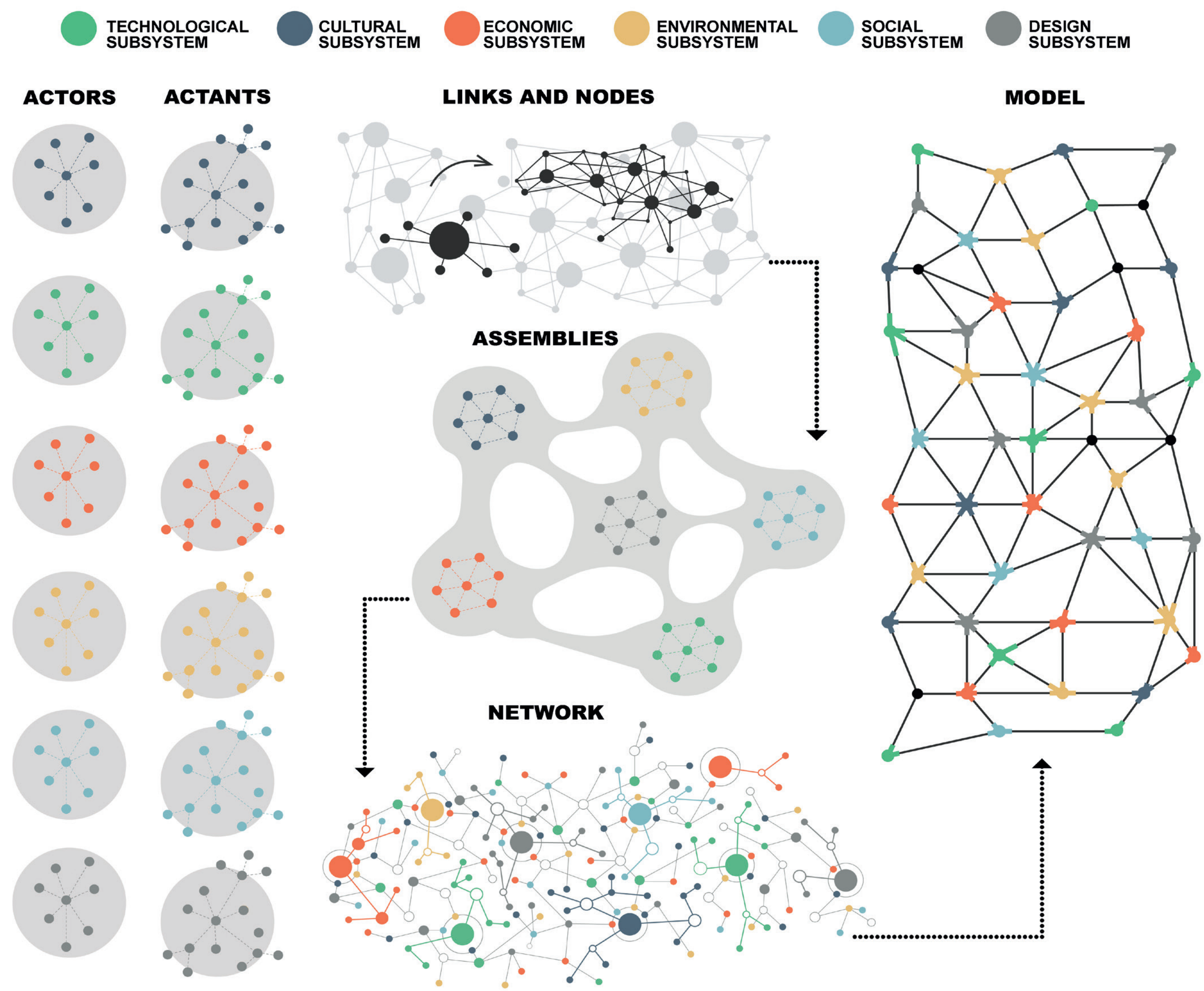


Fig. 58 Actor-Network Theory in Architectural Technology: how are actants connected?

ships in the built environment through actions of care and active participation of all actors in the regeneration process [189].

3.2 Engagement strategies and participation methods for waterfront stakeholders and decision makers

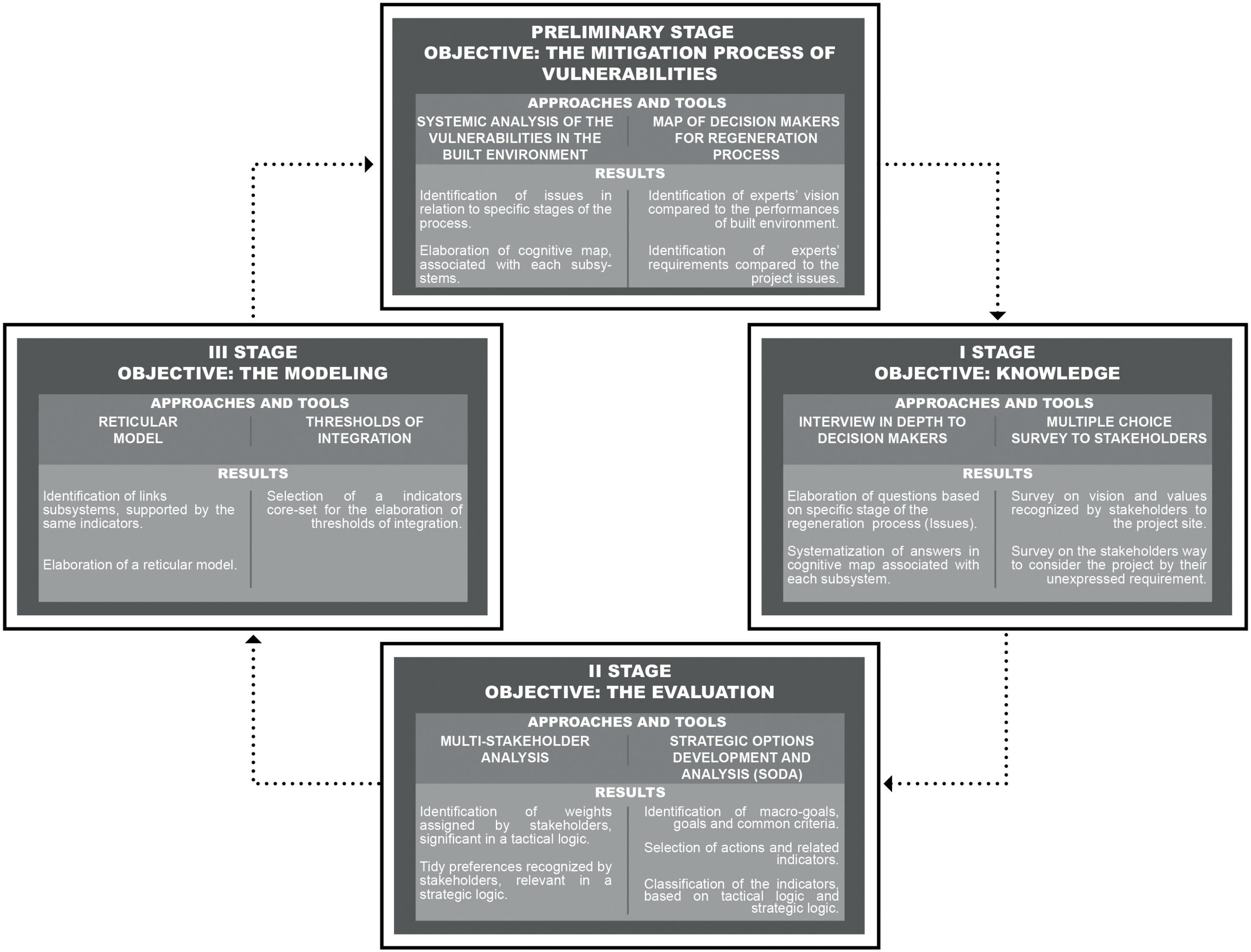
The research tests the theoretical approaches of the previous section through the construct of a circular, reiterative, and replicable methodological path. The methodology is dynamically structured, combining systemic concepts with participatory approaches supported by integrated assessment strategies for technological innovation.

The research outlines a decision-making process that combines stakeholders, decision makers, technological solutions, and specifications of the built environment through performance analysis of the context, the dynamics of acting pressures, and the definition of an intervention strategy. The advancement of the methodological process is linked to the ability to combine the needs of the users with the performance of the system; therefore, by the possibility of implementing participatory strategies attentive to conflict management and the sharing of the design proposal. The data derived from this methodological process represents the base of complex indicators, deciding factors of the construct of the thresholds of integration between innovative technological solutions and the vulnerable built environment. The methodological path consists of four main stages, eight intermediate steps, and sixteen actions (Figure 59).

The objective of the preliminary stage of the methodological process is to construct the systemic analysis of the vulnerabilities in the built environment, in order to identify decision makers and associate them with the relevant subsystems. The cross-scale articulation [190], whereby from the system it was possible to identify its subsystems, is based on the combination of quantitative desk data (research data collected through *in situ* experience, site surveys, and multidisciplinary collaborations, which are described in the second chapter of this book).

According to Turner, vulnerability is both a condition of exposure and a capacity to cope with dynamic processes, developed with reference to the experience that individuals and communities have in dealing with hazards and disturbances [190]. Having identified in the character of vulnerability the likelihood of a system to suffer damage, either in its entirety or in its components [191], links the built environment to the resistance of disturbance [192] – that is, the speed with which it returns to a condition of equilibrium [193]. It is not simply what is observed at the time of its occurrence, but the vulnerability represents the set of processes that generate it in relation to the capacity of the disturbances, in the presence of calamitous events, of multiplying impacts [194]. Since the built environment is a dynamic, connected, and adaptive system that evolves in many different ways through internal interactions and external influences [195], vulnerability is

Fig. 59 The research methodological path.



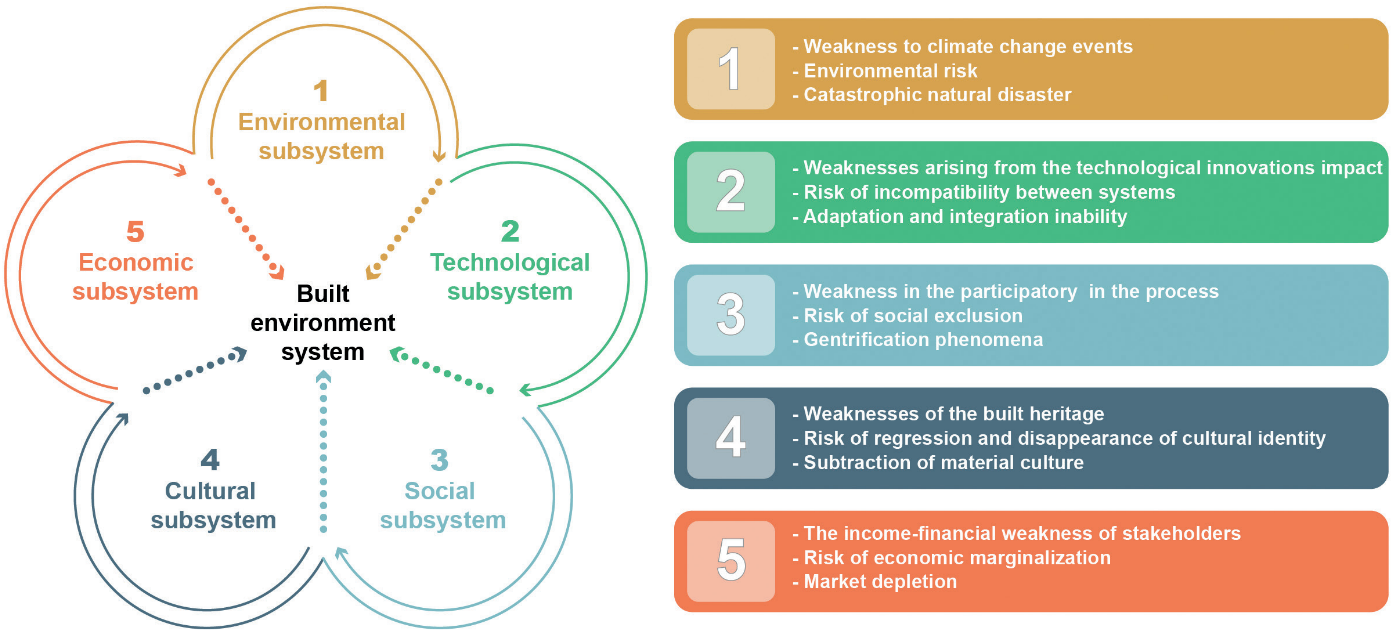


Fig. 60 Systemic analysis of vulnerabilities in the built environment.

the binder of its subsystems [196]. Therefore, a systemic analysis of the built environment was conducted in which vulnerabilities were broken down into weaknesses, risks, and phenomena [197]; associated with the different subsystems in which they occur. The environmental subsystem (SEn) is characterized by weakness to climate change events, environmental risk, and resulting phenomena of catastrophic natural disasters. The technological subsystem (ST) is characterized by the weaknesses arising from the impact that technological innovations bring about in the context, the consequent risks of incompatibility between the two systems, and finally, the mutual capacity for adaptation and integration. The social subsystem (SS) is characterized by the participatory weakness in the process dynamics manifested by the stakeholders involved and the related risk of social exclusion, often the cause of the gentrification phenomena. The cultural subsystem (SC) addresses the weaknesses connoting the built heritage by the risks of the regression and disappearance of the cultural identity that result in the phenomena of the subtraction of material culture. The economic subsystem (SE) confronts the income-financial weakness of stakeholders, who under the stress of economic marginalization generate market depletion at both local and global scales (Figure 60).

The vulnerabilities of each subsystem, which in turn reverberate onto one another

[198], determine the choice of decision makers to be involved in the regeneration process through the responsiveness of its level of influence coated in the weaknesses, risks, and phenomena of the different subsystems. Such responsiveness lays the foundation for the realignment between the needs of actants (requirements) [199] and the integrability of solutions into the system (performance) [200]. The decision makers identified were involved as part of the relationships activated in the course of the experiment of this book and refer to key actors in the dynamics of U.S. vulnerability mitigation. They include experts from academia and research, policy, finance, environmental protection, innovative technology, engineering, the housing market, institutions, communities, and advocacy organizations. Their initials and role of reference mention stakeholders involved in the process (Figure 61).

In this way, it is possible to associate each decision maker with specific weaknesses, risks, or phenomena in each subsystem. The environmental subsystem (SEn) is characterized by the experts of P.M. for climate weakness, R.L. for environmental hazards, and K.B. for the resulting catastrophic natural phenomena. For the technological subsystem (ST), the following were considered: P.O. as an expert for the weaknesses arising from the impact that technological innovations determine on the urban context; R.C. for the consequent risks of incompatibility between the two systems; and finally, W.C. to investigate the adaptive capacity and technological integrability. In the social subsystem (SS), T.H. stands out for the participatory weakness manifested by the actors involved and the related risk of social exclusion, often the cause of the gentrification phenomena. The latter is supported by 1,000 multiple-choice questionnaires administered to the local population. For the cultural subsystem (SC), R.B. addresses the weaknesses connoting the built heritage,

E.S. the risks of involution and loss of cultural identity, and M.M. the phenomena of loss of material culture. For the economic subsystem (SE), the following were considered: D.S. for the income weakness of stakeholders, B.J. for the stresses of marginalization and economic investment and V.G. for market depletion in environmental response. Finally, D.F. was involved to examine the settlement system from the perspective of transformations brought about by experimentation with new technological design (Figure 62).

It is important to specify that the research considers the design subsystem as the policies and strategies deployed by the projects analyzed for the New York City case studies. This attribute nurtures a conscious and shared exchange among various knowledgeable experts. On the one hand, it is possible to grasp the concrete incidence of the transformations expressed in the demand for the use of the built environment; on the other, to disarticulate the aprioristic compartmentalization of the disciplines that govern the stages of the built environment's regeneration process. Promoting participation means that identified decision makers seek to accommo-

PT — Professor of Geography, Hunter College, City University of NY
Director of the CUNY Institute for Sustainable Cities (CISC)
Member in the Earth and Environmentale Sciences Program at CUNY Graduate Center

RL — President and CEO of Metropolitan Waterfront Alliance

KB — Director of resilience of Metropolitan Waterfront Alliance

PO — Research Assistant Professor of Ocean Engineering of Stevens Institute of Technology, New Jersey

RC — Structural Engineer at Mueser Rutledge Consulting Engineers

WC — Structural Engineer at AmerCom Corporation

TH — Lawyer and Founder of Tenants United Fighting for Lower East Side and TUFF-LES Chief of Two Bridges Community

RB — Professor of Urban Planning at Graduate School of Architecture, Planning and Preservation of Columbia University of New York City

MM — Director of Waterfront and Open Space Planning of New York City, Department of City Planning of NY State

ES — Mayor's Representative in the Public Design Commission and Adjunt Professor in the Urban Planning Program at Graduate School of Architecture, Planning and Preservation at Columbia University of New York City

DS — Adjunt Professor and Assistent Director of Urban Design Program at Columbia University of New York City

BJ — President and Chief Executive Officer of Battery Park City Authority

VG — Special Research Scientist at GISS/Center for Climate System Research (CCSR) and Director of Earth Institute at Columbia University and Science Collaborator at NASA Goddard Institute for Space Studies

DF — Senior Technical Director of AKRF, INC as Environmental, Planning and Engineering Consultation for BIG U and LES

Fig. 61 Roles and identities of decision makers.

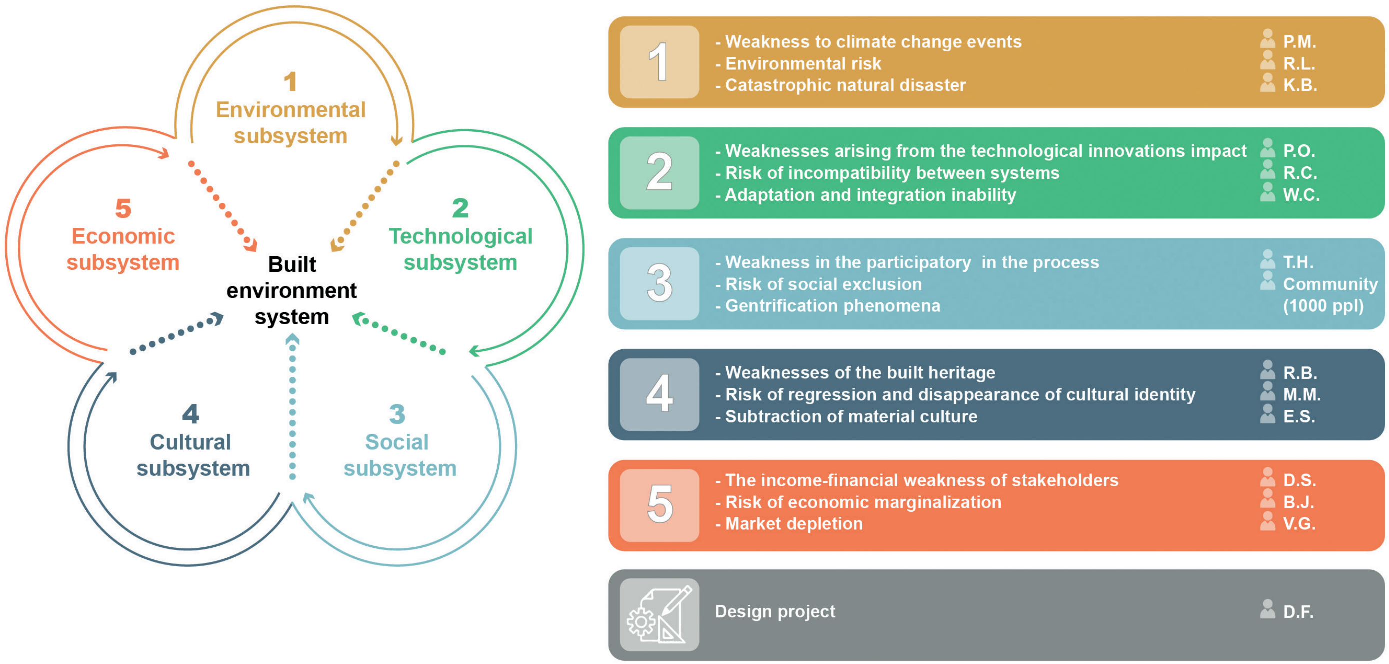


Fig. 62 Attribution and correspondence between decision makers and subsystems.

date requests and observations in order to turn them into governance directions. Each decision maker, being the bearer of different demands and guarantor of operational links, makes the process less rigid but more complex and evolved by exploiting participation as an interconnection between people, places, and activities [201].

The knowledge stage of the methodological process aims to identify the positioning of decision makers within the built environment's regeneration process and to structure the decision problem. This provides insight into the extent to which the role and participation can impact within the stages of process to which they are linked, establishing relationships with each other and with the specific scope.

The Knowledge stage was structured according to types of data collected, selected, and classified by:

- a desk research of the scientific literature, with attention to relevant data compiled from research on the topic;
- a field research (experiment), oriented toward the collection of meaningful data that can make explicit the characteristics of the observed practice;
- a survey, carried out through questionnaires, to find out the preferences of different

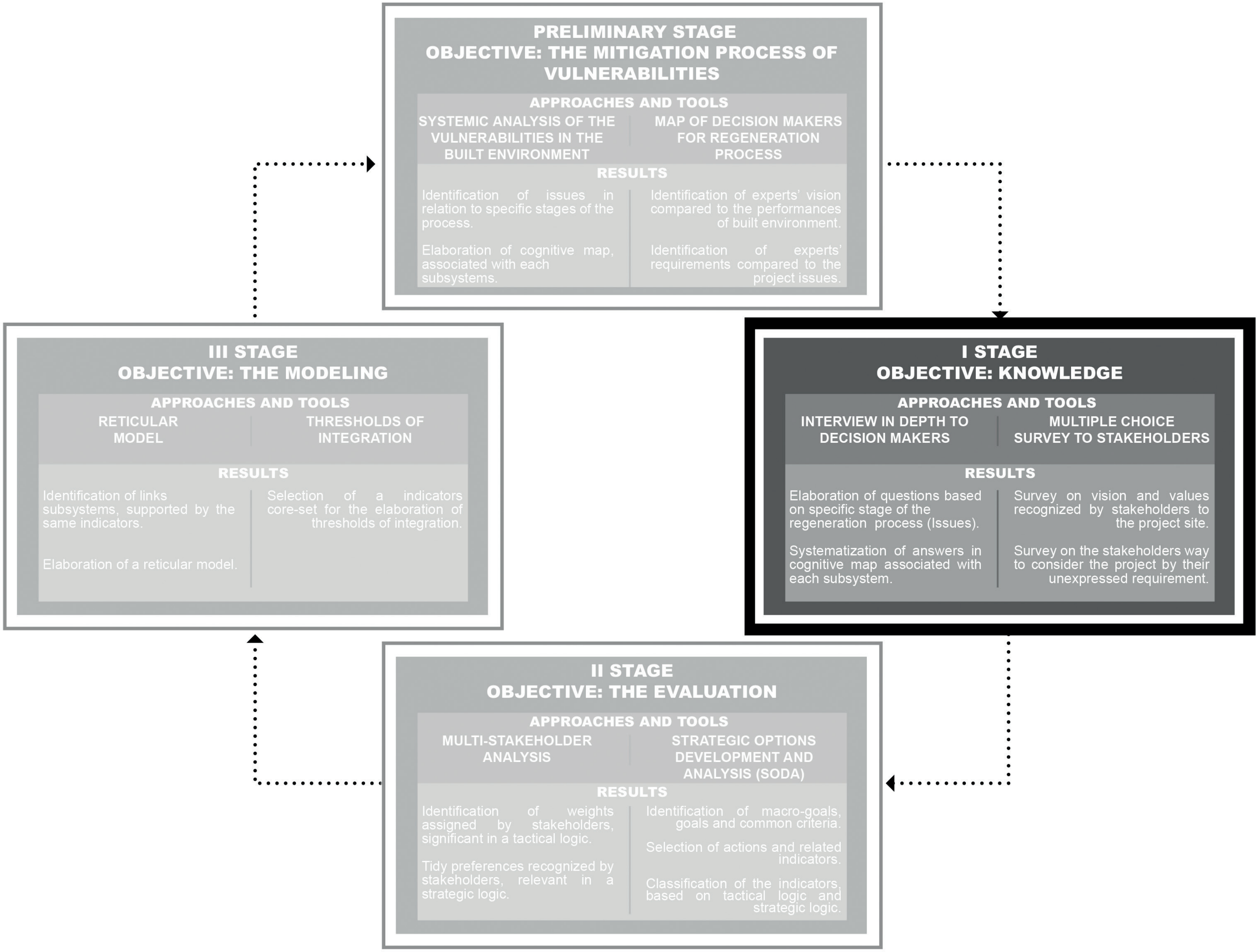


Fig. 63 The knowledge stage of the research methodological path.

stakeholders affected by the transformations activated in the built environment of study areas;

- a system of interviews, carried out through verbal protocols with the selected decision maker (Figure 63).

The documents, studies, and insights made from explicit significant data, identifies the

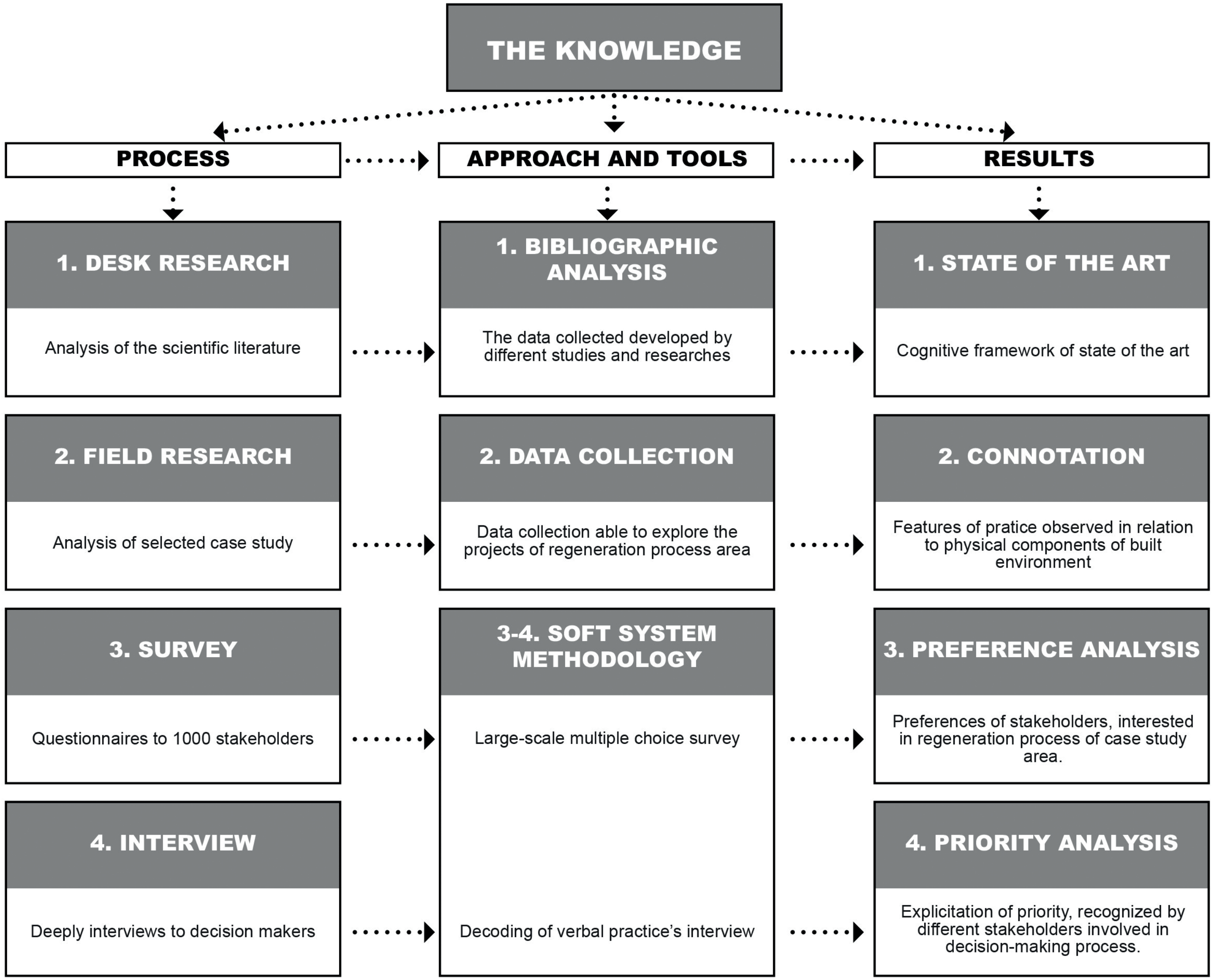


Fig. 64 The articulation of the methodological path in the knowledge stage.

specifics of the issue and its international relevance. At the same time, the results of the survey and interviews, returned data, from which the preferences of stakeholders (local communities) and decision makers (experts) were deduced, identifying those issues deemed priorities. The analysis of the data enables the identification of significant evaluation components and the weight given to them. In particular, the Soft System Methodology approach [202], using Strategic Options Development and Analysis (SODA) techniques [202], allows the verbal protocols of the interviews to be decoded and make explicit the priorities recognized by the experts involved in the decision-making process (Figure 64).

In the quality of experts identified in the preliminary phase, the decision makers [203] are placed in consultation [204]. This step then allows considering them in the organizational design of the regeneration process of the built environment. With reference to the UNI 10838:1999 standard, the process consists of an organized sequence of phases that include and accompany the process from the detection of needs to their satisfaction, through actions of knowledge, planning, programming, design, and management of a built asset [205]. Transposing this logic to an urban scale, such as the settlement scale, the configuration of the process can change according to the relationships that are created among different decision makers and repeatedly affect certain stages. The complexity of the process follows the importance of the roles and different activities they perform with respect to the objective, to make the process effective and replicable according to a need-performance approach [206]. The sequence of the process evolves following an analysis of the possible configurations considering each stage no longer preparatory to the next but articulated according to the concurrence of different scenarios. From knowledge to management, the stages can be influenced by the modes of action, different roles, and relationships among decision makers. The latter determines not only the proper discretization of the stages but also influences the entire process (Figure 65).

Within the first phase of the regeneration process, the knowledge phase, the decision maker P.M., R.C., and E.S. are called to respond regarding the analysis of the affected area and the type of vulnerability. Especially, all of these interlocutors are able to return coherent indications through their responses from the environmental point of view, as a professor of geography at New York University (P.M.), from the technological point of view for the territorial orography in which to graft the solutions (R.C.), and from the cultural point of view, constituting part of the institutional representation of the city (E.S.). The analysis of the area's potential and criticality is addressed from an environmental point of view through the figure of the president of the Metropolitan Waterfronts Area (R.L.) and from an economic point of view based on the past experience of the president of an already implemented, as well as neighboring, park such as Battery Park (B.J). Finally, the analysis of the area's emergence is defined both from an environmental

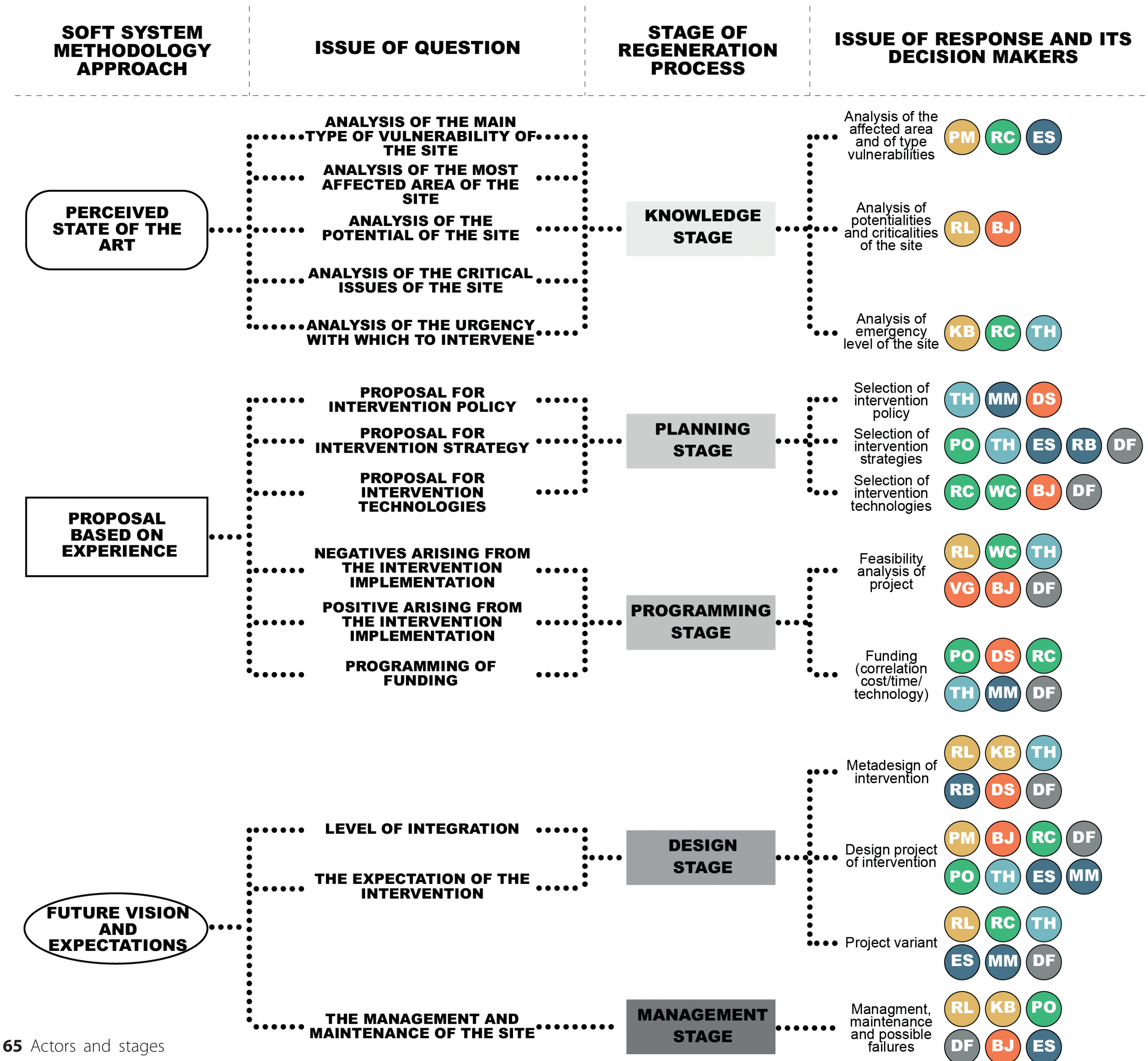


Fig. 65 Actors and stages in the regeneration process.

perspective through the expertise of the metropolitan area waterfronts resilience director (K.B.), from a technological perspective through the expertise of engineering consultation Mueser Rutledge (R.C.), and from a social perspective through the advocate and founder of the East Side of Two Bridges Community Association (T.H.).

Within the second phase, the planning phase, new experts are called to respond, adding to those previously involved such as M.M., D.S., P.O., R.B., E.S., D.F, B.J., and W.C. The director of the city's waterfronts and open spaces department (M.M.) participates from a cultural point of view, from an economic point of view, the university knowledge involved in urban design programs (D.S.), and from a social point of view, the representative of the community residing between the Brooklyn and Manhattan bridges (T.H.). The latter also recurs in the definition of the intervention strategy supported both from the design point of view by the engineer who coordinates the modeling of the project's experimental technology (D.F.), from the cultural point of view, through the academic knowledge in Urban Design (R.B., E.S.), and from the technological point of view, with the knowledge related to the technological instrumentation for responding to oceanic problems (P.O). Finally, the choice of technologies is returned from the design point of view, through the project engineer (D.F), from the economic point of view, through the CEO of Battery Park (B.J.), and from the technological point of view, with the two engineers involved with their consulting companies outside the project (R.C., W.C.).

Within the third phase of design, that of mitigation, the experts inherent to the environmental sphere assigned to the coordination of actions along the coast (R.L.), the technological experts of engineering consultation (W.C., R.C., P.O.), the representative of the social experts to protect the inhabitants (T.H.), the project actors for the programmatic definition of the project (M.M.) and the economic experts with specific reference to the executive head of the neighboring park (B.J., V.G., D.S.) and the director of the Institute of Earth Science in the field of environmental costs (P.O). From the funding point of view, all those experts capable of co-participating in the technology/cost/time relationship are involved, namely the technology experts in technical and environmental consultation (W.C., R.C., P.O., P.M., K.B., R.L.), economic study experts (D.S., V.G., B.J.), project coordination experts (R.B., E.F., M.M.), social representation experts (T.H.) and administrative representation experts (D.F.).

Within the fourth phase, the design phase, the coordinating experts of the waterfront transformation (R.L., K.B.), the community consultation experts (T.H.), the economic implementation experts (D.S.), and the accompanying design experts of the technological (D.F.) and urban development (R.B.) contribute for the meta-design part. For the design part, the largest number of experts concur with the complexity of the whole representation of the different subsystems. Differently for the variant in progress, the environmental experts of waterfront management (R.L.), departmental and metropolitan regulatory coordination experts (M.M., E.S.), executive design experts, already involved in reviewing the problems of the social representation experts (D.F., T.H.) and the technological response experts (R.C.) all intervene.

Within the fifth and final phase, the management phase, environmental experts related to waterfront management (R.L., K.B.), cultural experts related to the city's administrative and urban planning sphere (E.S.), economic experts of neighboring and inspirational park expenditure forecasts (B.J.), design experts (D.F.), and technological experts related to the oceanic environment in which they fall (P.O.) are involved in operation and maintenance.

What has been experienced shows how the process takes the form of a collaborative space [207] by means of the relationships that different decision makers forge among themselves; therefore, also among their respective different subsystems. The dense mesh of ties returns the level of integration of information, needs, skills, and innovations. The complexity of the process, determined precisely by the many interconnections between its stages, pushes research to overcome a linear vision in favor of a dynamic one; elaborating a new organizational form in which relationships simplify, simultaneously, and at different scales, the resolution of conflicts.

Therefore, the process acquires the dimensional space of a cycle of operations characterized by iterative motions [208] and autopoietic [209], in which part of the output is deferred as input for its progressive and incremental improvement (Figure 66).

Within the process, the stages undergo continuous evolutions over time, individually predictable, but not cumulative of the overall links. This happens because the process changes continuously, relying on its dynamism to develop the relationships related to it. It has, therefore, the non-linear characteristic that is associated with the discontinuous transformations of the built environment; of dynamism in that it changes without ever assuming a defined state or retracing the previous one; of reversibility in that it constantly evolves by its changes over time.

3.3 Complex tools for constructing thresholds of integration between technological innovation and vulnerable built environment

The evaluation stage of the methodological process (Figure 67) aims to test cutting-edge participatory techniques by structuring cognitive maps [210] through which priority themes and issues can be identified.

As outlined in the previous paragraph, the different stages of the process, and with them the different steps that characterize them individually, guided the structuring of the 14 questions submitted to the decision makers in the interviews based on the same questions. The data results of decoding the responses, which were processed through the Strategic Options

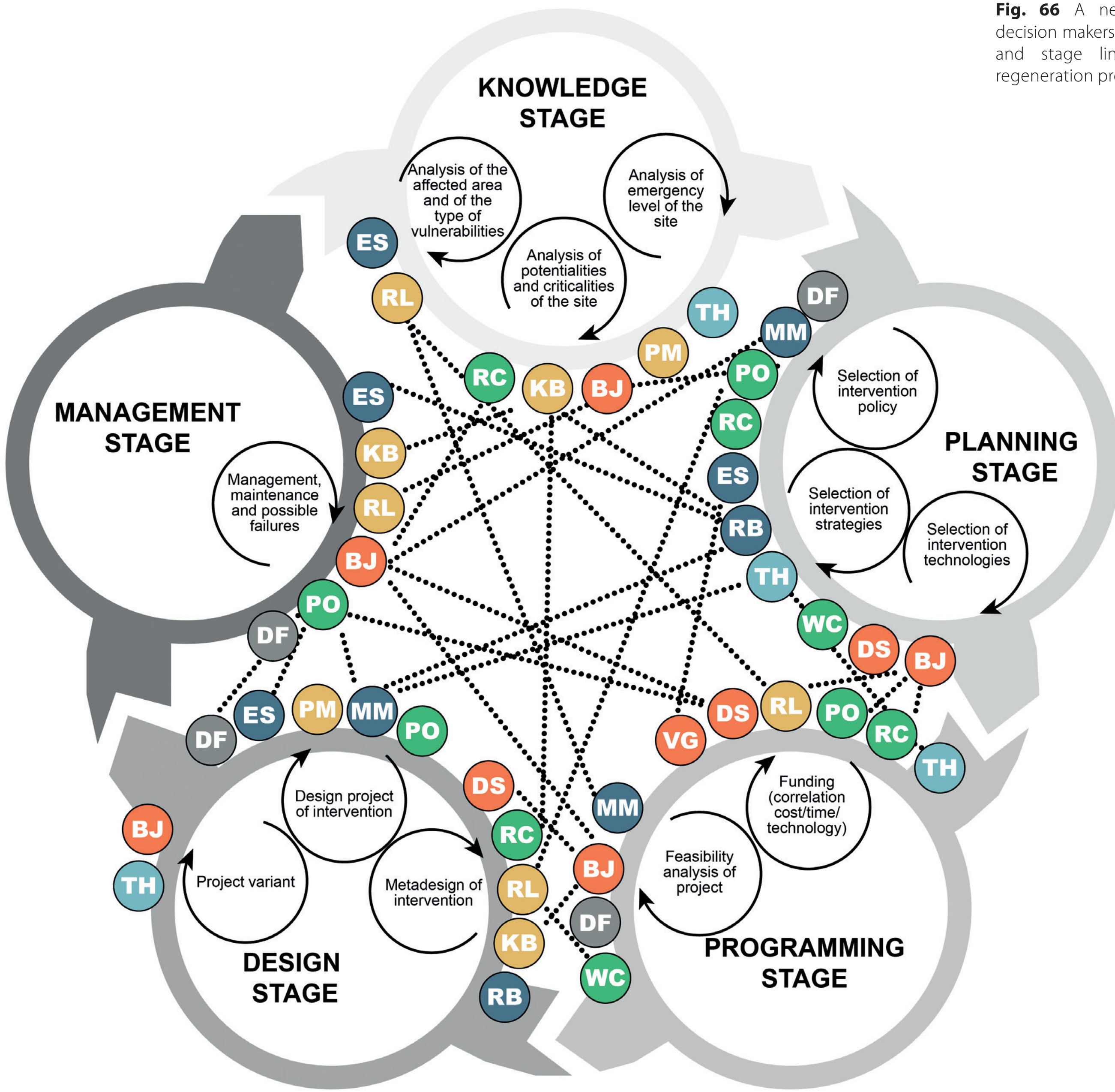


Fig. 66 A new idea of decision makers distribution and stage links in the regeneration process.

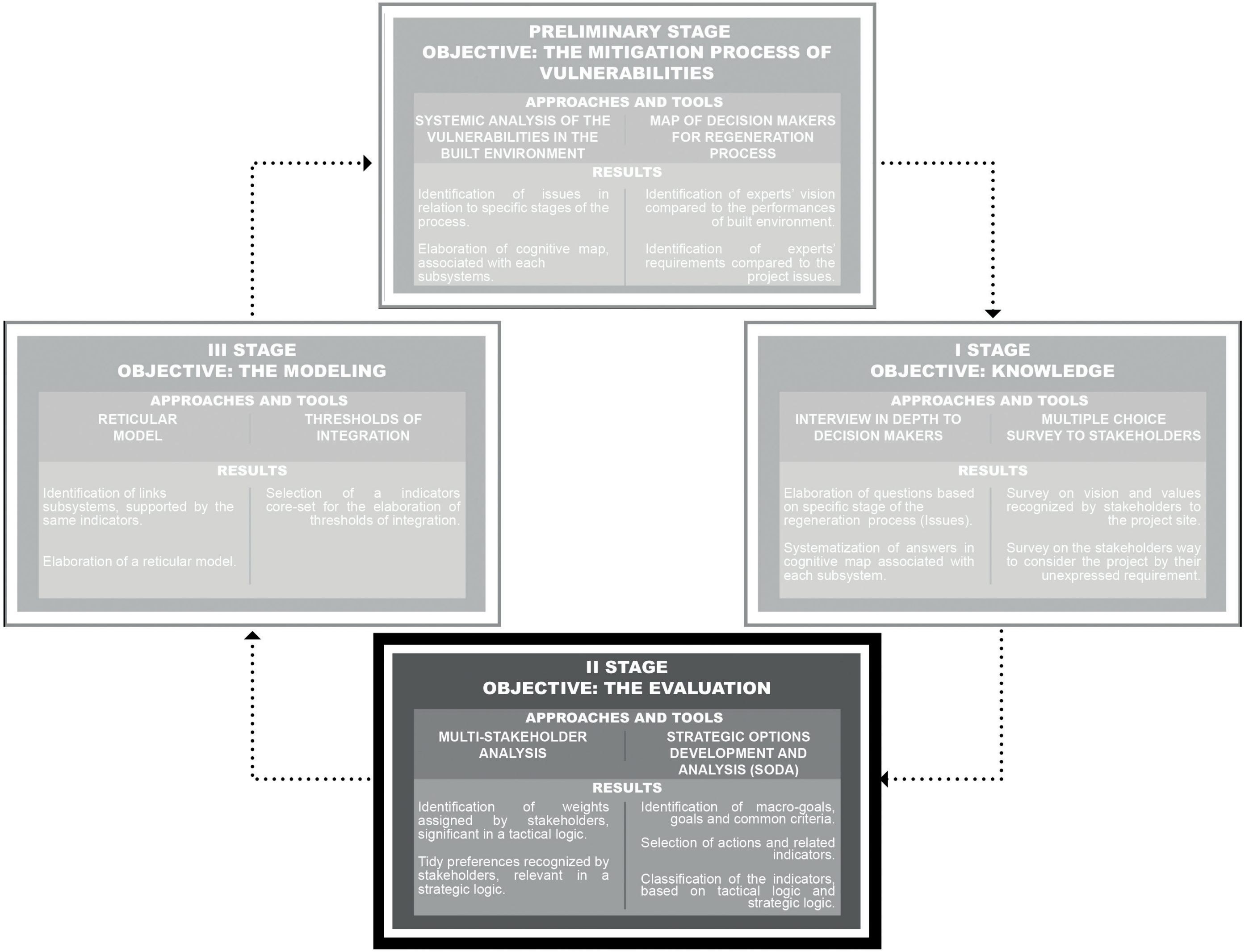


Fig. 67 The evaluation stage of the research methodological path.

Development and Analysis (SODA) approach [211] in order to be transferred into cognitive maps, one for each category of decision makers. Each cognitive map was constructed for each person downstream of the conceptualization of the responses that emerged from the interview. This process served to compose a “view”, which can be grouped into “windows”, i.e., overall maps referring to the set of decision makers belonging to the same subsystem of the built environment (environmental, cultural, social, economic, technological, and design project). For example, the environmental window is composed of the views of decision makers (P.M., R.L., and K.B.), as many windows as there are subsystems have been similarly developed. Specifically, each view consists of the same number of “cards” that have different shapes referring to the perceived state of affairs (boxes with rounded corners), the proposal (defined boxes) and the future vision (ovals). Since the cards are the explication of concepts of the interview responses, they are divided according to the subject matter of the 14 questions, respectively concerning as follows:

- the main type of vulnerability of the site;
- the most affected area of the site;
- the potential of the site;
- the critical issues of the site;
- the urgency with which to intervene;
- the intervention policy;
- the intervention strategy;
- the intervention technologies;
- negatives arising from the intervention implementation;
- positives arising from the intervention implementation;
- the programming of funding;
- levels of integration;
- the expectations of the intervention
- the management and maintenance of the implemented site.

Finally, the cards are related to each other by means of directional vectors (arrows) afferent to three types: causal (negative or positive) when the relationship is that according to which one concept can determine another; connotative when the relationship is that according to which one concept cannot disregard another; temporal when the concept is temporally related to another (Figure 68).

Using the Banxia Decision Explorer program [212] the qualitative data from the individual windows were processed by the software by applying Domain and Central analyses [213]. The two analyses yield a hierarchical order of concepts in which the dominant ones (i.e., repeated and recalled several times within the interviews on a given issue), and the central ones (i.e., able to establish the largest number of links with other concepts within the same issue) are identified, respectively. The processing yields numerous pages of data, arranging that data according to subsystems, the research considers subsystems including environmental, economic, technological, social, cultural and design. The richness of the number of links between one concept and another determines the value of the individual point of view within the process and the impact of one subsystem on a given issue versus another [214]. In

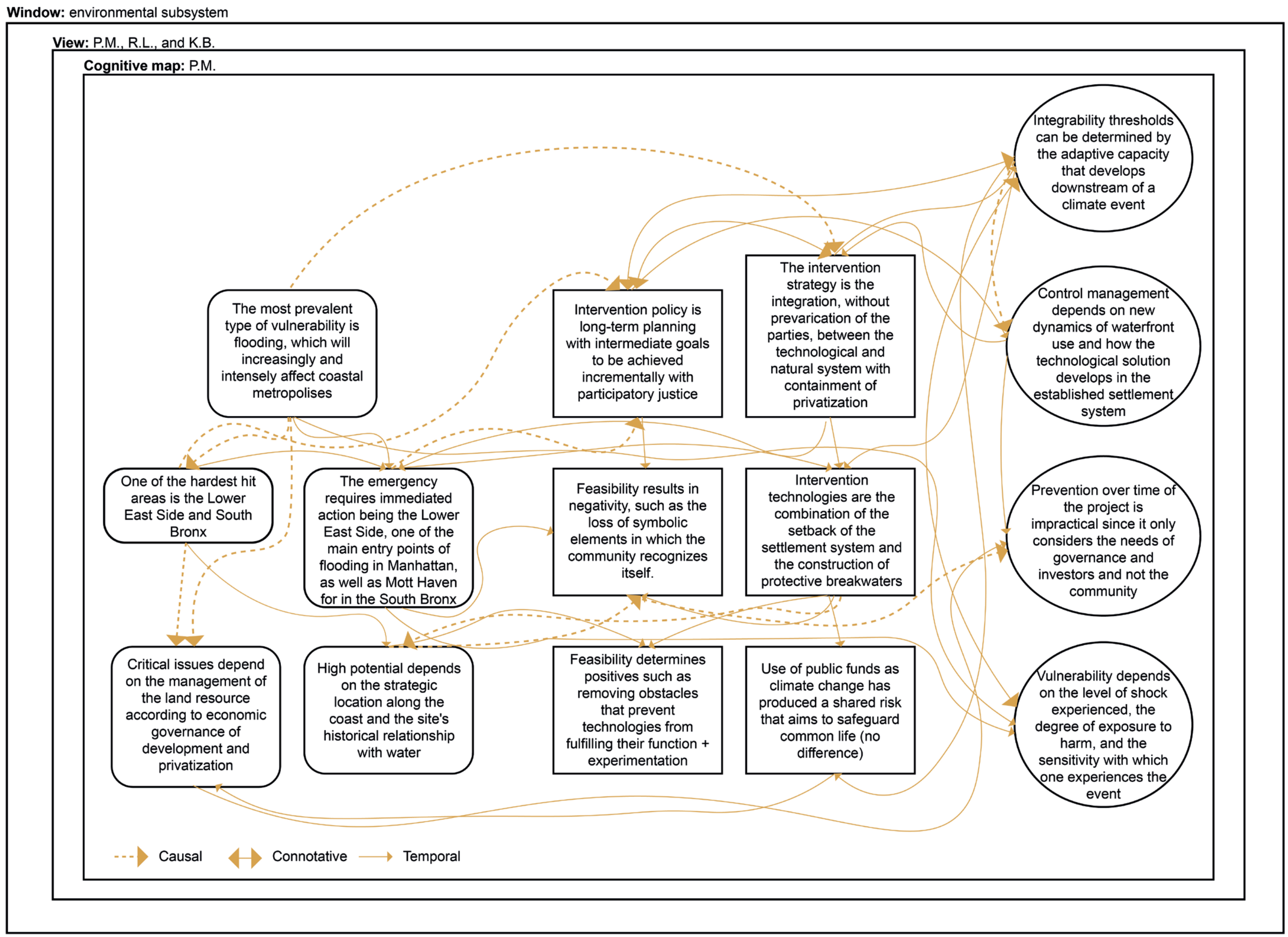


Fig. 68 Example of cognitive map of an individual decision maker in Baxia Decision Explorer software.

order to process the complex amount of data received, a matrix of priority responses was constructed [215] by placing the six tables from the windows, one for each subsystem, containing in turn the results of the respective Domain and Central analyses in the order output from the software. The purpose of the priority response matrix is to identify relevant concepts, eliminating in each subsystem table those that match only one of the two columns of Domain

ENVIRONMENTAL SUBSYSTEM	TECHNOLOGICAL SUBSYSTEM	SOCIAL SUBSYSTEM	CULTURAL SUBSYSTEM	ECONOMIC SUBSYSTEM	DESIGN SUBSYSTEM
central/domain matching					
The **intervention policy** is long-term planning with intermediate goals to be achieved incremen-tally with participatory justice approaches	The most prevalent type of vulnerability is flooding, which will increasingly and intensely affect coastal metropolises	The **intervention policy** aims to empower the community role at consultation tables with government agencies and developers	The **intervention policy** is based on a holistic approach involving the mayor, the federal government, environ-mental regulatory agencies, and community	The potential depends on the strategic economic investment location that could increase the political power of the site and protect the community	The **intervention policy** aims at more conscious planning of land use redesign that has direct impacts on community activities
The phenomenon requires acting in urgency through immediate intervention being the site project one of the main entry points of flooding in Manhattan and The Bronx	One of the hardest hit areas is the project site, the most vulnerable section of Manahattan and The Bronx	Control management depends on the use of funds calibrated not on investment in the short term but in caring for operation in the long term	The **intervention strategy** aims to protect what remains of the historic coastal heritage preserving the cultural identity of the place and community	The intervention policy aims to include a socially and politically thought-out technology according to the idea of integration as mediation and involvement between different parties	The **intervention strategy** aims to elevate the ground by including new itinerant routes that actively involve the social sphere
The hypothetical negatives arising from the feasibility of the intervention manifest themselves in the possible loss of symbolic elements in which the community recognizes themselves	**Management of** public and private **funds** for maintenance plans based on investment and safeguard forecasts	**Management of** public **funds** ($1.4 billion) for the design and construction of a new lower east side exploiting the east river park in terms of elevation	The hypothetical negatives arising from feasibility concern the very high risk of distorting the historical image of the place by widening and/or expanding the coastline	Technological solutions involve the simultaneous operation of passive (such as the wall) and active instrumentation (such as water-activa-ted barriers and slats)	**Management of** federal, state, and municipal **funds** attentive to collateral costs for roads, materials, and technological complexity overhead

Fig. 69 Excerpt from the priority response matrix.

or Central results. Once the concepts common to both analyses have been selected, they can be associated, taking care to respect the order obtained from the analysis. This step is critical since the order in which the concept is produced further defines its value (Figure 69).

With respect to the possibility of making a further association between the issues that emerged having the same order; therefore, the same value within the restitution process, the concepts were divided into two logics: one strategic and the other tactical. Strategic logic [216] works on touchpoints that are able to resolve conflicts and reactivate connections; that is, on those that identify a more complex scenario to enable its simplification. In contrast, Tactical logic [216] works on the specific and infrequent operations, but connoting a particular system to which they bind.

Downstream of this discretization, it was possible to trace the path of identifying the complex indicators, both strategic and tactical, aimed at constructing the thresholds of integration between vulnerable settlement systems and innovative technological systems.

Each response was placed within a macro-question associated with the breakdown of the questions asked in relation to the perceived state of affairs, the proposal, and the forecast of the future vision.

Each macro-issue was correlated to an issue related to a stage in the process of transformation of the built environment described above.

Each question, in turn, was correlated to a macro-objective concerning the elaboration of the concepts entered within the computational program as well as the synthesis of the responses from the decision makers' interviews. These are associated with different systems (environmental, social, economic, technological, design, and cultural) depending on the affiliation of the decision maker who gave that answer.

Several objectives have been associated with each of the individual issues that represent directions to the transformations to be carried out; grouped into macro-criteria and criteria. The criteria respond to avoidance actions, protection actions, promotion actions, and triggering actions. From the study of the established criteria, it was possible to draw the potential of an integrated approach, considering the interaction of multiple facets creating a base knowledge for the construction of transformation actions.

Associated with the different criteria are the different actions to be pursued in order for the developed response to occur or not. Specifically, the proposed actions are existing, and therefore feasible, as well as borrowed from the quantitative study of data collected during the experience and desk research. As the actions are exercisable and provided for by existing regulations, it is possible to return the concreteness of the order of feasibility to which the research refers, exploiting the existing resources through the reworking of their role in the process of regeneration of the built environment (Figure 70).

Once actions have been determined, it is necessary to identify indicators that can measure them.

The choice of the indicator starts from the characteristics of the case study, cross-referenced with sources of indicators already in the literature. The indicators were discretized according to their scientific name in order to be able to ensure both their recognition within codified studies and traceability for technicians who intend to rely on them. In addition, a description of the indicator was included in order to yield the appropriateness of its use and especially its applicability in different contexts. The unit of measurement is calculated through the direction; which must be maximized or minimized depending on the intended goal and the source (Figure 71).

The research used sources for the construction of complex indicators that refer to research and studies conducted in the past three years. Although the bibliography is vast and varied, the innovation of the methodological

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Action
State of the art	Criticalities of the site	Affected area and type of vulnerability	Knowledge stage	Increased risk of distorting the historical image of the place by widening the coastline	Cultural system	- Protect the morphology of the coast - Protect the historical image of the place	Cultural governance	Planning and coordination of the 2050 urban plan	- Gentrification census status agenda - Mapping of active communities on the site - Agenda of guidelines to the preservation of historic sites
The proposal	The intervention policy	Proposal based on experience	Planning stage	Long-term planning with intermediate objectives to be achieved incrementally and based on the principle of participatory justice	Environmental system	- Activate long-term planning processes - Identify objective to be achieved incrementally	Environmental governance	Agenda of plans and processes in both in short and long term	- Drafting of Climate Change Panels for periodic review of urban plan objectives
Future vision	Level of integration	Expectation	Design stage	Integrability is based on rezoning policies referred to the needs of the community (not investors) to the goal of avoiding gentrification with bottom-up approaches	Social system	- Activate rezoning operations based on community needs - Promote bottom-up planning	Social governance	Scheduling of rezoning operations based on approaches to protect the resident community	- Social vulnerability mapping of the site - Discussion calendars to inform the population of risks and shared strategies - Training of consumer education courses - Review of zoning laws - Planning of land uses - Mapping of active site associations - Analysis of the population's perception of the site - Analysis of the population's preferences for action - Programming of district awards and grants - Programming of costs of projects implemented by call for proposals

Fig. 70 Excerpt from the first section of the strategic logic indicators table.

Action	Name of indicator	Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source
- Gentrification census status agenda - Mapping of active communities on the site - Agenda of guidelines to the preserva-tion of historic sites	**15.3.1.** Soil sealing from artificial land cover	By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	%	Proportion of land that is degraded over total land area	min	Available at: https://www.i-stat.it/storage/-SDGs/SD-G_15_Italy.pdf
- Drafting of Climate Change Panels for periodic review of urban plan objectives	**11.b.2.** Proportion of local governments adopting and implementing risk reduction strategies in line with national legislation	By 2020, substantially increase the number of cities and human settlements adopting and implementig integrated policies and plans towards inclusion, resource to disasters, and develop and implement, in line with the Sendal Framework for Disaster Risk Reduction 2015 - 2030, holistic disaster risk management at all levels	%	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies/proportion of total local governments	max	Available at: https://unsta-ts.un.org/sdgs/-metadata?Tex-t=&Go-al=11&Tar-get=11.b
- Social vulnerability mapping of the site - Discussion calendars to inform the population of risks and shared strategies - Training of consumer education courses - Review of zoning laws - Planning of land uses - Mapping of active site associations - Analysis of the population's perception of the site - Analysis of the population's preferences for action - Programming of district awards and grants - Programming of costs of projects implemented by call for proposals	**CNC** Networks of citizens organized into active communities in the area	Training increases awareness and preparedness. It can be extensively carried out in schools, hospitals and the workplace.	%	Percentage of population that has received training on first-aid and emergency response skills in past two years	max	Figueiredo, L.; Honiden, T.; Schumant, A. (2022). Indicators for resilient cities. OECD regional development working papers 2018/22

Fig. 71 Excerpt the second section of the strategic logic indicators table.

process is in the way indicators are selected. In particular, in order to cover the dimension of the research field, the majority of indicators are derived from the OECD studies [217] and the SDGs [218]. These documents were analyzed paying special attention to the issues of combating climate change, poverty, supporting health and well-being, education for environmental advocacy, flooding services and infrastructure, economic growth, energy resources, innovation and business, reducing inequality, responsible consumption and production, marine and terrestrial protection, building sustainable cities and communities, and public-private partnerships for the implementation of environmental and settlement transformations (Figure 72).

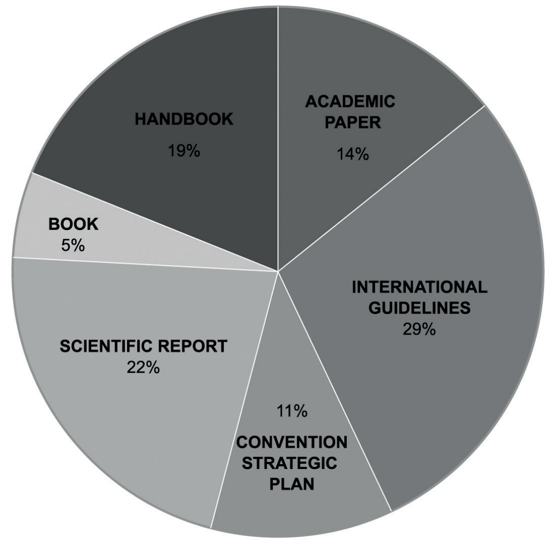


Fig. 72 The sources of the indicators.

The modeling stage of the methodological process (Figure 73) integrates the results of data analysis, placing the shared knowledge of stakeholders together with the expert knowledge of decision makers. The interaction between different forms of knowledge and roles in decision-making allowed the structuring of a hybrid approach, combining theoretical background, field studies and participatory approaches.

The identification of the relevant thematic issues shared by different stakeholders in the decision-making process, it was necessary to consider what emerged from the decoding of the views expressed by common knowledge. Consulting and engaging the community from what is defined by expert knowledge and field study allowing for the selection of complex indicators that constituting thresholds of integration between innovative technological systems and the vulnerable settlement system.

Community participation acts in order to re-appropriate the common built heritage, aiming at the transmission of the representative values of local culture. In this key, the community finds its strength in connecting the synergies established among individuals. In a consulting role, the community is able to exert a more resonant impact, inserting itself on par with decision makers in the dynamics of the regeneration process of the built environment. The participatory approach used within the research defines new user needs in response to instances of transformation, activating a process of social innovation both in terms of the expression of latent needs and

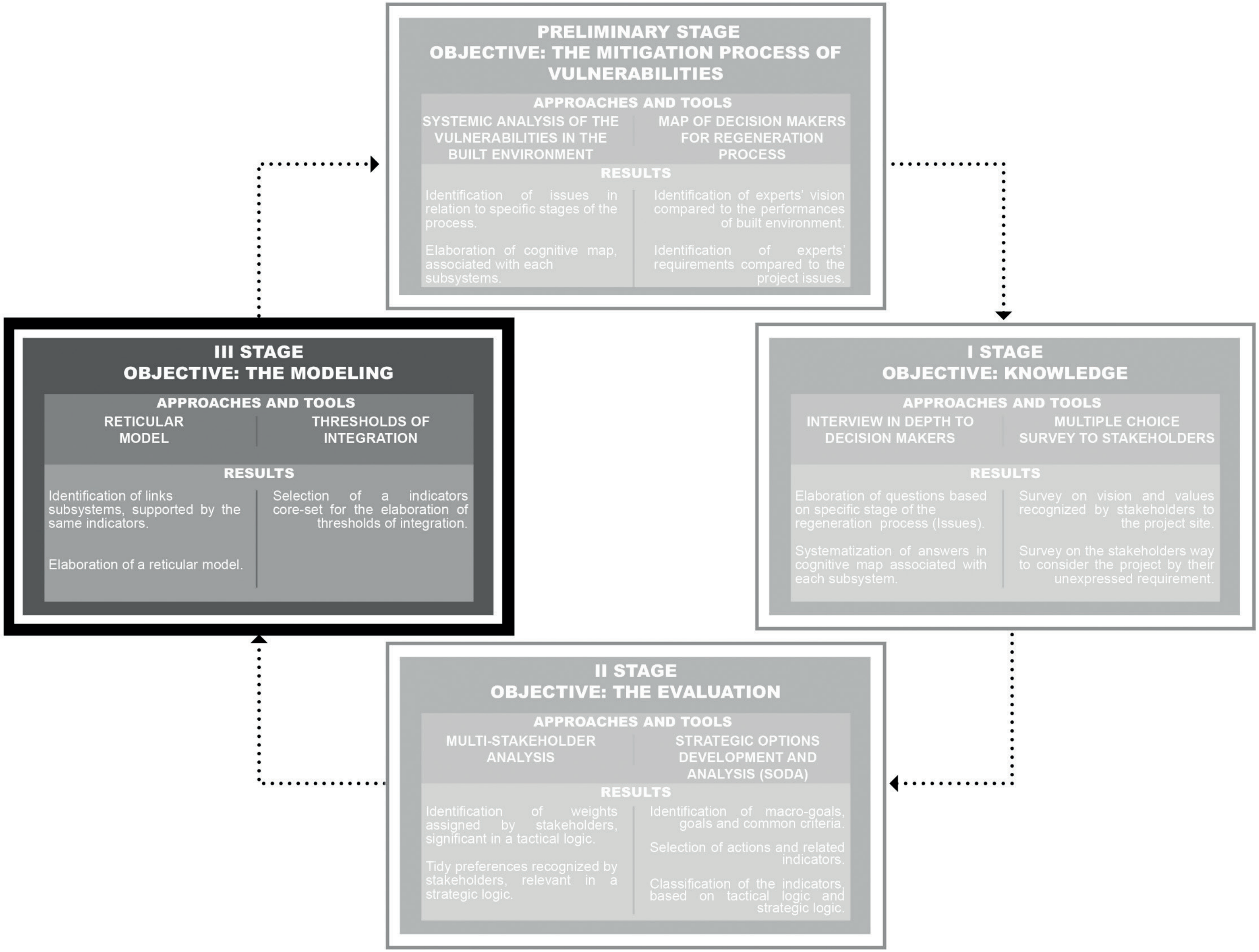


Fig. 73 The modeling stage of the research methodological path.

in relation to design choices. The involvement of the community, distant and reluctant to this type of often gentrifying transformation, required a path of interlocution attentive to the dynamics that push the built environment toward changes beyond which there is a loss of the recognizable characteristics; therefore of the sense of belonging of the site. The active participation of the stakeholders within the process discussed is essential as it completes the objective of the experiment to compare the different weights, which decision makers (expert knowledge) and the stakeholders (common knowledge), point to the different indicators. The concurrence of decision makers and stakeholders leans towards the same indicator, which determines a priority role to issues demand more relevant than others within the decision-making process. Therefore, two types of large-scale questionnaires with multiple responses were administered to the same sample of 1,000 people from the local community. The first type of questionnaire was crafted to infer the respondent's characteristics, economic, cultural, social, environmental, and with an infrastructure perspective of the site and the values that the stakeholder recognizes in it; by expressing their latent needs (Figure 74).

The questionnaires were constructed using Likert scale [219] structures by giving a response margin according to four options (very satisfied, satisfied, dissatisfied, and very dissatisfied). The Likert scale allows for a psychometric technique of attitude measurement distinguished mainly by the possibility of applying item analysis methods based on the statistical properties of interval or ratio scales. This technique consists primarily of developing a number of satisfaction ratings – called items – that express positive and negative attitudes toward a specific object. Very satisfied indicates that over the past 10 years, the item exceeds both the normative standard and the expectations found 8/10 on a subjective value scale. Satisfied indicates that over the past 10 years, the item matches both the normative standard level and the expectations found 6/10 on a subjective value scale. Unsatisfied indicates that over the past 10 years, the item does not meet both the normative standard and the expectations found 4/10 on a subjective value scale. Very dissatisfied indicates that in the last 10 years, the item is much lower than both the minimum level of normative standard and the observable expectations 2/10 on a subjective value scale. The sum of these judgments will tend to delineate reasonably accurately the subject's attitude toward the object. For each item, an agreement/disagreement scale, generally a 4-mode scale, is presented. Respondents are asked to indicate on them their degree of agreement or disagreement with what the statement expresses. This method is applicable for both unidimensional and multidimensional attitudes (for which statistical techniques such as factor analysis or principal component analysis are required). To assess the expected performance of the community, an approach was chosen to decode the expressed needs and scenari-

RATE THE NEIGHBORHOOD WITH RESPECT TO:	VERY SATISFIED	SATISFIED	UNSATISFIED	VERY UNSATISFIED
safety	X			
presence of crime			X	
state of disrepair of the buildings		X		
functional facilities		X		
parks, playgrounds, ball fields		X		
areas equipped for the elderly			X	
management of urban traffic			X	
management of pedestrian traffic		X		
state of the architectural heritage		X		
municipal waste management		X		
open space and green areas			X	
parking			X	
municipal waste management		X		
presence of institutions		X		
wheelchair accessibility		X		

HOW WOULD YOU CLASSIFY THE STANDARD OF LIVING OF THE DISTRICT:	
VERY SATISFIED	
SATISFIED	X
UNSATISFIED	
VERY UNSATISFIED	
I would like to live elsewhere	X

DO YOU THINK THELOWER EAST SIDE IS A SAFE BOROUGHT?	
very safe	X
safe enough	
unsafe	

Please mark your choise with a X.

First Name (s): Tom
Last Name (s): Cole
Age: 58
Position: security services
(if student, please indicate school, grade/level and field of study)

HOW SATISFIED ARE YOU WITH:	VERY SATISFIED	SATISFIED	UNSATISFIED
quality of housing	X		
quality of the built			X
quantity and quality of open spaces		X	
quality of uban design and lighting system		X	
presence and quality social services		X	
presence and quality of health services		X	
presence and quality of cultural services			X
quality of schools			X
quality of public transportation			X
municipal waste management		X	
management of urban traffic		X	
available parking			X
opportunities to participate in the transformation processes			X
job opportunities	X		

Fig. 74 Example of the first type of completed questionnaire.

os that emerged from the survey through a ranking of alternatives. In this way, it was possible to compare the preferences with a higher frequency coming from the different responses as well as those for medium and low values, successively. This was done in order to identify the degree of incidence of the requirement to which the community response corresponds. This process resulted in the construction of a need ranking [220] related to the existing relationship between the stakeholders, the built environment and the characterizing dynamics (Figures 75; 76).

Similarly, identifying the most significant indicators for stakeholders, within the selection of those pertaining to the tactical logic, a second type of questionnaire was administered. The same sample of 1000 people was asked multiple-choice questions regarding their perceptions of the project and the tangi-

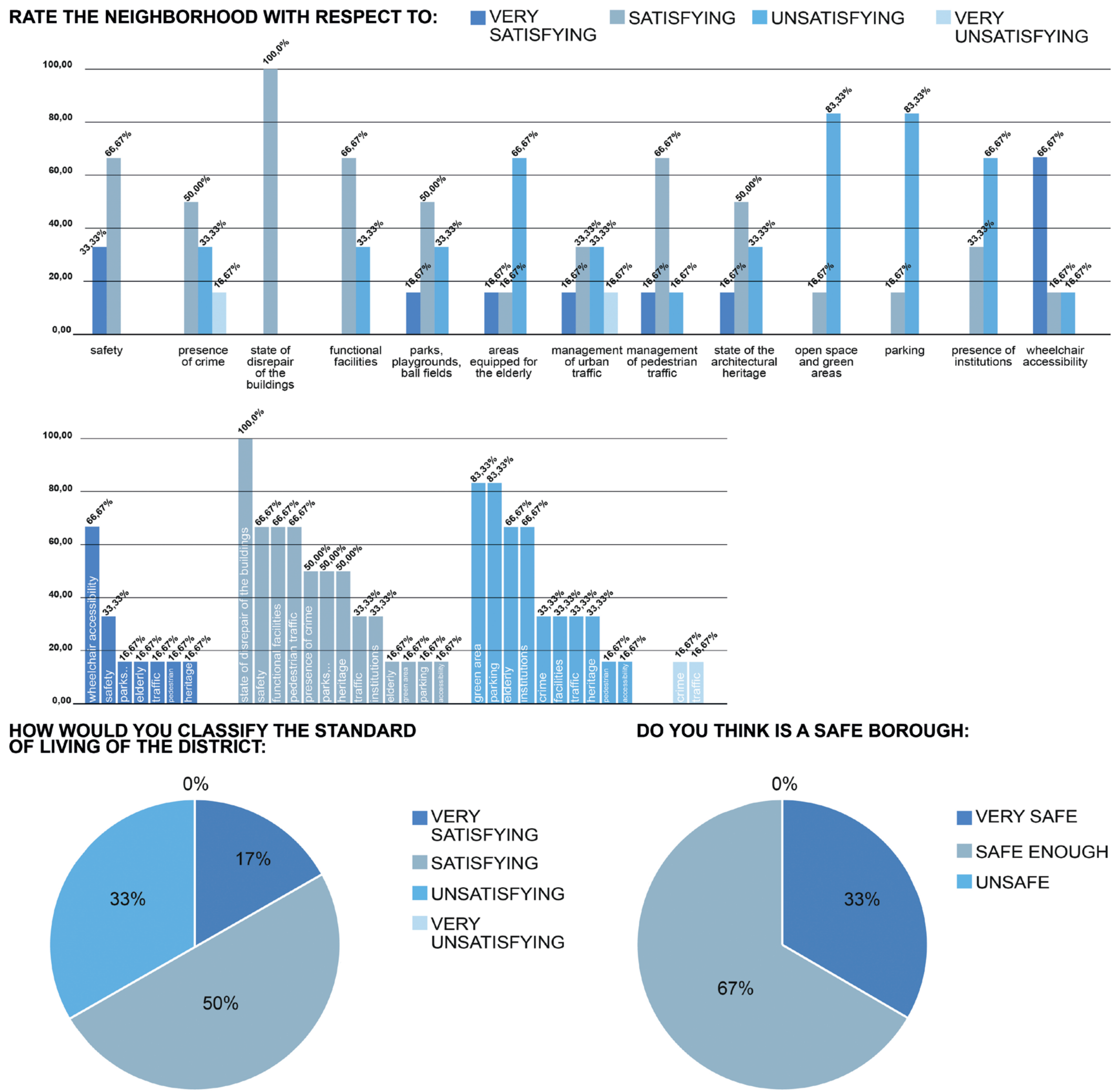


Fig. 75 Need ranking of stakeholders in relation to perception.

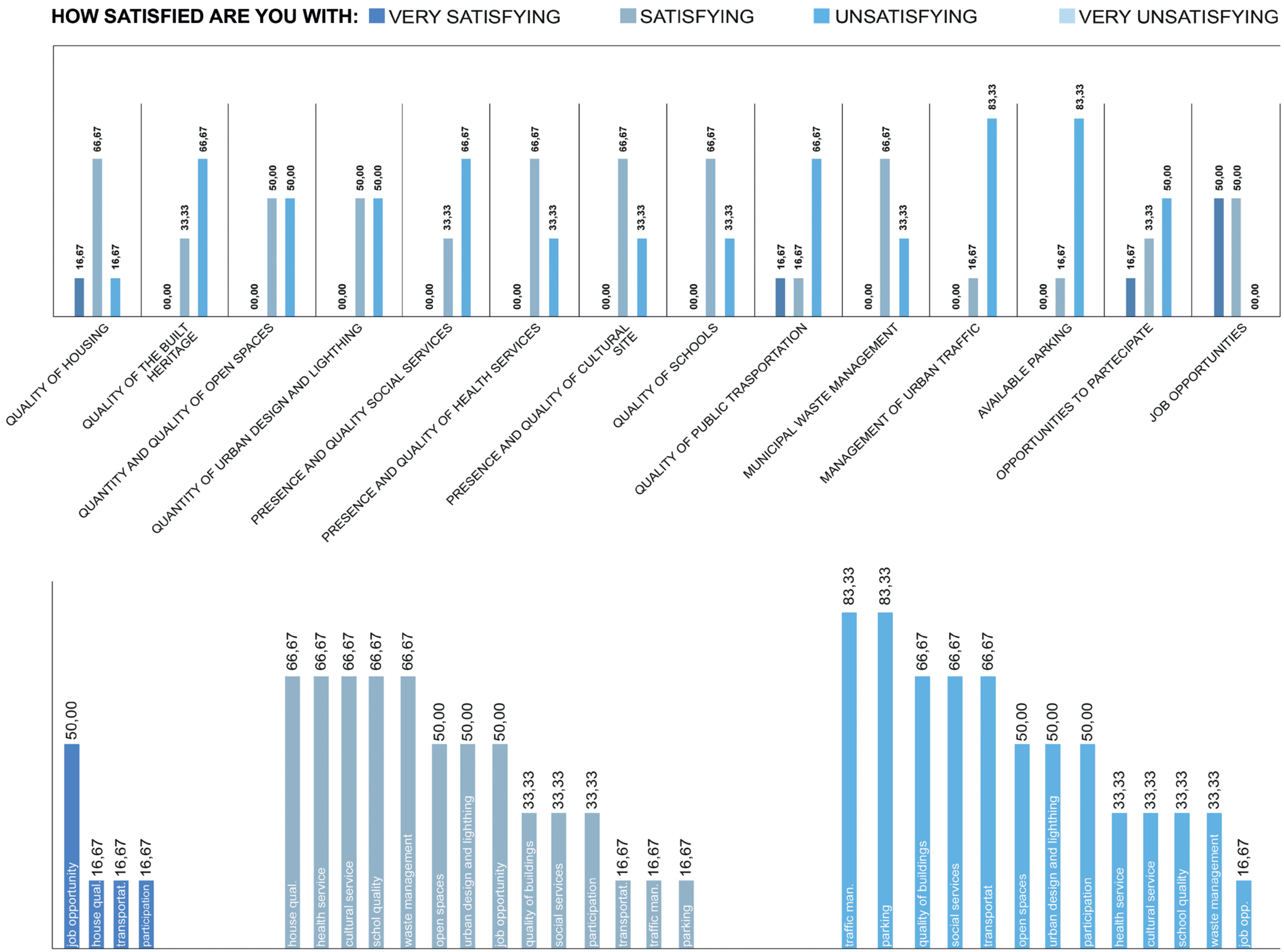


Fig. 76 Need ranking of stakeholders in relation to preferences and priorities.

ble and intangible transformations it evokes, affecting their lives. For the second type of questionnaire, the community's contribution lies in the possibility of discretizing the collective vision, indicating the perceived concerning certain directions of intervention aimed at adapting the site in response to the new uses. This type of questionnaire was submitted in order to understand stakeholders' perceptions of the project and their vision regarding the transformations brought about by the environmental, economic, and social demands that had manifested in the previous survey. The questions investigate the requirements of the population with respect to the integration of appropriate technologies, both to preserve the culture of the local tradition, reinforcing its identity, and transferring this teaching of appropriateness in the use of technological solutions as a good practice to be replicated (Figure 77).

In addition, investigating the perception of measures to be implemented orients the population toward an awareness of the need to follow the research and actively participate in the management of the built environment. This awareness stimulates the rediscovery of a sense of place and acts as a driver of local management processes within the perspective of inclusive approaches. The questions were formulated to analyze social, economic, cultural, environmental, and technological perceptions of actions and strategies falling on the built environment. The questions are structured in such a way as to yield the level of perception of the proposal; the level of openness to the transformations that will result from it; the propensity to be involved in the process dynamics; the level of expectation derived from the project actions; the level of benefit they think they will derive from the implementation of the project; their propensity to manage and 'take care' of the reclaimed built environment. The responses of the population were processed to construct an information matrix in which the different type of perception of the issues investigated is yielded by means of a master sheet of the surveyed sample distinguished by age group and type of work occupation (Figure 78).

By selecting dominant values, what emerges from community involvement is the constitutive basis for identifying weights. Ranking allows the potential and fragility expressed by the community in communicating its needs to be highlighted.

3.4. Proposal for the Reticular and Integrated Model of waterfront regeneration

Thresholds of integration consist of the set of indicators as one of the outcomes of the research. These help define the "threshold" within which integration between technological innovation and the built environment can be defined appropriate.

The indicators, based on the network they establish through the thresholds, can also be used individually with respect to the strategic or tactical logic, defining directions both in the broad view of the process and in the opera-

Name: Tom Surname: Coke Age: 58 Job: security service	√	X	Level of impacts
Do you believe technology innovation could be an effective tool to improve your city?	x		Level of openess
Would you like to be invoved in redevelopment projects that enhance your city?	x		Level of propensity to be involved
Based on previous experience, do you believe new defensive technological parks benefite the urban context?	x		Level of perception
Do you think this kind of project could have a positive impact on local community?		x	Level of perception
Do you think this kind of project could improve the business and economic context?	x		Level of perception
Do you think this kind of project could affect the heritage buildings and the place's cultural identity?		x	Level of perception
Would you suggest other projects like this to improve your city?	x		Level of expectation
Are you afraid of any negative impacts on you from the project?	x		Level of expectation
Do you think you could draw direct or indirect benefits form this project?		x	Level of benefit
Would you be willing to perform voluntary maintenance of the project space?		x	Level of propensity to care the site

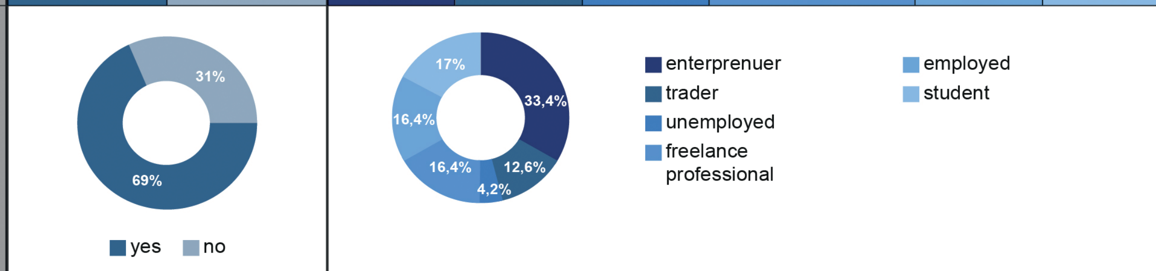
Fig. 77 Example of the second type of completed questionnaire.

tional view. Should the criticality be related to a specific area identified as a subsystem, since the indicators are relatively divided into them, it is possible to intervene on that specific part concerning all other areas. Complex indicators offer the flexibility of use as guiding tools that, starting with needs as a priority, relate to the entire built environment.

There are 8 indicators in the strategic logic, which belong to the social subsystem, which are referred to as follows: "extent of citizens' education in sustainable development addresses necessary for the nation's educational policies, educational experience, approach to teaching, and student learning (4.7.1)"; "proportion of local government units with established policies and operating procedures for community participation in water management (6.b.1)"; "public institutions adopting forms of social and/or environmental reporting (12.6.1); "no-profit voluntary organizations (including NGOs and sports associations and social organizations)

AGE POPULATION	LEVEL OF PROPENSION TO BE INVOLVED		JOB TYPE					
	yes	no	enterprenuer	trader	unemployed	freelance professional	employed	student
10-20	105	34	16	39	0	12	8	78
20-30	150	51	29	41	23	40	44	90
30-40	159	43	108	34	38	50	45	0
40-50	170	61	46	19	26	31	36	0
50 +	160	67	51	13	19	32	32	0
TOTAL	**744**	**256**	**250**	**146**	**106**	**165**	**165**	**168**

FREQUENCY



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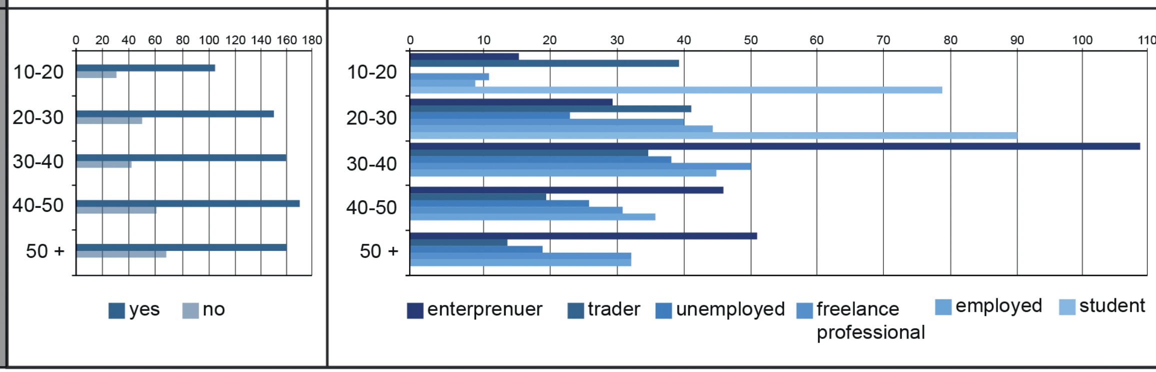


PROJECT PROPOSAL	PERCENTAGE		INDICATORS
	yes	no	
Level of openness to the project proposal	96%	4%	13.1.2 - 13.3.1
Level of propensity to be involved in the project proposal	68%	32%	13.1.1
Level of benefit from the project proposal	92%	8%	6.a.1 - 11.5.2
Level of propensity to care the realized proposal	58%	42%	13.b.1 - 12.b.1

Fig. 78 Processing of the results by information matrix matching community priority indicators.

registered in cities within a population of 10,000 (A69); "number of people killed or missing due to flood landslides (11.5.1)"; "percentage of loss of transformed coastal areas (CAL)"; "retrofitting or design of housing exposed to a level of environmental risk (RHE)"; "networks of citizens organized into active communities in the area (CNC)"; "organization of proportion of land consumption to the degree of population growth (13.1.1)."

There are five strategic logic indicators belonging to the technology subsystem which are referred to as follows: "resident population exposed to flood risk in medium flood risk zones (13.1.3)"; "proportion of national economic zones managed exclusively with ecosystem approaches for choice of uses (14.2.1)"; "countries adopting strategies for strengthening policy coherence to sustainable development (17.14.1)"; "countries adopting strategies for coordinated insurance across different levels of government (ECLG)"; "proportion of total government spending on essential services including health, education, and social and environmental protection (1.2.1)."

There are 8 strategic logic indicators belonging to the cultural subsystem which are referred to as follows: "economy directed toward innovation (ILPE)"; "proportion of the total budget devoted to research in the field of marine technologies (14.a.1)"; "number and types of agreements and programs between countries regarding research and technology cooperation (17.6.1); "controls and actions on trafficking in flora and fauna and their use for illegal material productions (15.7.1)"; "proportion of cities with direct participation in civil society structures engaged in urban planning and management with the purpose of democratization and site regulation (11.3.2)"; "the strengthening of protection and preservation of cultural and natural heritage (11.4.1)"; "risk of erosion of sites with a global coastal heritage (DER)"; "salinization of soils due to coastal land cover and extension (15.3.1)."

There are 7 strategic logic indicators belonging to the project subsystem which are referred to as follows: "total investment employed by countries to promote, transfer, disseminate and diffuse environmental and technological development (17.7.1)"; "coastal risk related to climate vulnerabilities (CRIMED)"; "statistical capacity to monitor sustainable development goals (17.18.1)"; "sustainable urban development of wetlands as flood absorption sites (SUD)"; "spatial development control (HA24)"; "ecological level (E)"; "amount of investment in public-private partnerships to build protective climate infrastructure (17.17.1)."

There are 8 strategic logic indicators belonging to the economic subsystem which are referred to as follows: "number of countries/regions that are progressing in ratification and economic implementation through legal agreements and institutional policies related to international flood jurisdiction (14.c.1)"; "amount of land consumption relative to population growth (11.3.1)"; "investment in research and development through defined capital funding (9.5.1)"; "insurance against natural disasters (IAD)"; "investments in mitigation of environmental impacts (IIM)"; "increased awareness and preparedness for climate events (ANA)"; "voluntary residents organized into local emergency groups to respond to environmental impacts and disasters (LEG)"; "incidence of green areas compared to urbanized areas in the city (11.7.1)."

There are 7 strategic logic indicators belonging to the environmental subsystem which are referred to as follows: "level of integration and management of water resources and fluxes (6.5.1)"; "proportion of local governments adopting and implementing risk reduction strategies in line with national legislation (11.b.2)"; "support for economic, social and environmental linkages between urban, periurban and rural areas for strengthening national and regional development (11.a.1)"; "level of investment in emergency response (IER)"; "land use policies developed based on environmental risk management (LPN)"; "expected needs (ESN)"; "number of countries that have national strategies for long-term economic support for community and environmental adaptation (13.2.1)."

Since strategic logic is apt to direct the construction of a general framework within which to move for the resolution of process conflicts and connections, it is interesting to note that some subsystems accommodate a greater number of indicators than others. In particular, the social, cultural, and economic subsystems accommodate a greater number of indicators than the environmental, technological, and planning subsystems, which are typically more pertinent to sector specificities and issues.

In contrast, there are 5 indicators of tactical logic that belong to the social subsystem and they are referred to as follows: "economic mobilization that from 2020 seeks to allocate $100 billion of funding to support communities (13.a.1)"; "international support for social infrastructure and development of economic and insurance flows (9.a.1)"; "direct economic loss caused by the disaster to communities in relation to critical baseline damage to services and infrastructure around the world (11.5.2)"; "extent of coastal land in relation to the inhabited coastal area (14.5.1)"; "number of countries with national and local risk reduction strategies (13.1.1)."

There are 3 indicators of the tactical logic that belong to the technology subsystem and they are referred to as follows: "number of countries that have reported institutional, systemic and individual strengthening of the capacity of their buildings to adapt, mitigate and transfer innovative technologies and actions (13.3.2)"; "researchers employed in the study of innovative technological solutions per million inhabitants (9.5.2)"; "permanence of rural coastal buildings (HA15)."

The indicator of tactical logic belonging to the cultural subsystem is only one and refers to "proportion of the average value of industries producing innovative technologies to the total value of industries present (9.b.1)."

There are 4 indicators of tactical logic that belong to the environmental subsystem and which are referred to as follows: "proportion between flood basin areas and water management cooperation operations (6.5.2)"; "number of deaths, missing and injured due to floods per 100,000 population (13.1.2)"; "number of countries that have integrated mitigation, adaptation and risk reduction strategies into their spatial policies in the first, second and third levels (13.3.1)"; "proportion of the area degraded by natural disaster to the total area considered (15.3.1)."

There are 3 indicators of tactical logic that belong to the project subsystem and which are referred to as follows: "the change in the extent of water-related ecosystems over time (6.6.1)"; "number of countries and islands that have received special funding for reconstruction, technological defense, building protection capacity related to climate effects with reference to fragile communities (13.b.1)"; "number of sustainable tourism strategies and policies for implementing monitoring operations and evaluation tools (12.b.1)."

The tactical logic indicator that belongs to the economic subsystem is only one and it refers to "amount of assistance developed in connection with flood management and sanitation policies related to government plans (6.a.1)."

Unlike strategic logic, the indicators of tactical logic are significant for specific operations, but rare, in that they connote the system to which they are linked. For this reason, the technological, planning, and environmental subsystems accommodate a larger number of indicators than the remaining ones.

In the description above, each indicator has a code in parentheses identifying the source. Descriptions containing alphabetic acronyms are derived from OECD, New Green Deal addresses and international documents. Otherwise, indicators with numeric and/or alphanumeric codes are directly associated with the addresses of the Agenda 2030 directives.

By associating the indicators obtained with the outcomes of the development of the first type of participatory approaches to which the community was subjected, it is possible to determine the weight they give to certain issues and the opportunities for action rather than others. This makes it possible to obtain an order of the most significant strategic actions. Thus, within the strategic logic the community can prioritize the need to implement the following: parks, green spaces and pedestrian paths (corresponding to the ecology indicators and the 11.7.1 indicator identified by expert knowledge); facilities for the elderly and parking (corresponding to the HA24 indicator identified by expert knowledge); associations and institutions active in situ that stimulate user participation (corresponding to the 11.3.2 indicator identified by expert knowledge); protection of the historical and architectural heritage (corresponding to the 11.4.1 indicator and dynamic erosion risk indicator identified by expert knowledge); quality of the existing built environment and waste disposal management (corresponding to the 13.2.1 indicator and retrofitting or designing houses exposure to a level of natural hazard indicator identified by expert knowledge); urban traffic, public transport and street lighting management (corresponding to the 17.17.1 indicator identified by expert knowledge); social services and health care (corresponding to the 1.2.1. indicator and citizens' networks in active communities indicator identified by expert knowledge); cultural services and quality of education (corresponding to the 4.7.1 indicator identified by expert knowledge).

In turn, the results of this processing, combined with those obtained from the decoding of expert knowledge views, yielded the results of the complex indicators related to strategic logic. These results outline the complexity of different interests and preferences, complemented by multidimensional and multidisciplinary connections [221] (Figure 79).

This analysis makes it possible to associate the response of the dominant sample with a particular complex indicator that is given a different priority, attentive to the developed specifications of the context and its inhabitants. Otherwise, through decoding the results collected from the information matrix, it is also possible to define the weight that the community places on the indicators of tactical logic. This makes it possible to associate the high level of openness attributed to the project proposal with indicators 13.1.2 and 13.3.1; the medium level of propensity with indicator 13.1.1; the high level of benefit derived from the proposal with indicator 6.a.1; the medium level of propensity to take care about the project and thus the level of fondness concerning indicator 13.b.1; to the medium level of positive perception of the project concerning indicator 11.5.2; to the medium level of expectation about project outcomes concerning indicator 12.b.1. Similar with what was performed for the strategic logic, it is possible to have in the first place a complete scenario of the complex indicators belonging to the tactical logic (Figure 80).

Comparing what emerges from the priorities that decision maker and stakeholders assign to the same issues; therefore, to specific complex indicators, it is possible to consider the weight given as a point of connection between the two logics. Within the reticular methodological vision, such indicators can be called real nodes of a spherical model. This selection of complex indicators is capable of both guiding relevant actions in the transformation process as a manifestation of the co-participation between stakeholders and decision makers. And also to bring further into the light those significant issues which are possible to critically reinterpret the reading of the project under consideration.

These indicators serve as anchor points between the different subsystems into which the built environment has been decomposed, allowing communication both between multiple domains of knowledge and between multiple agents/actants of the same process, overcoming all forms of compartmentalization. The dichotomy that could have resulted from the separation between stages, agents, knowledge, and actors, as discussed at the beginning of the chapter, is overcome here by the hybridization of the same and aimed at the functioning of the process as gears of a single mechanism. These indicators are given not only the role of connectors but also that of accelerators: they are, in fact, the crucial nodes that through their order of priority give speed/dynamics to the Reticular and Integrated Model. We will obtain, therefore, vertical

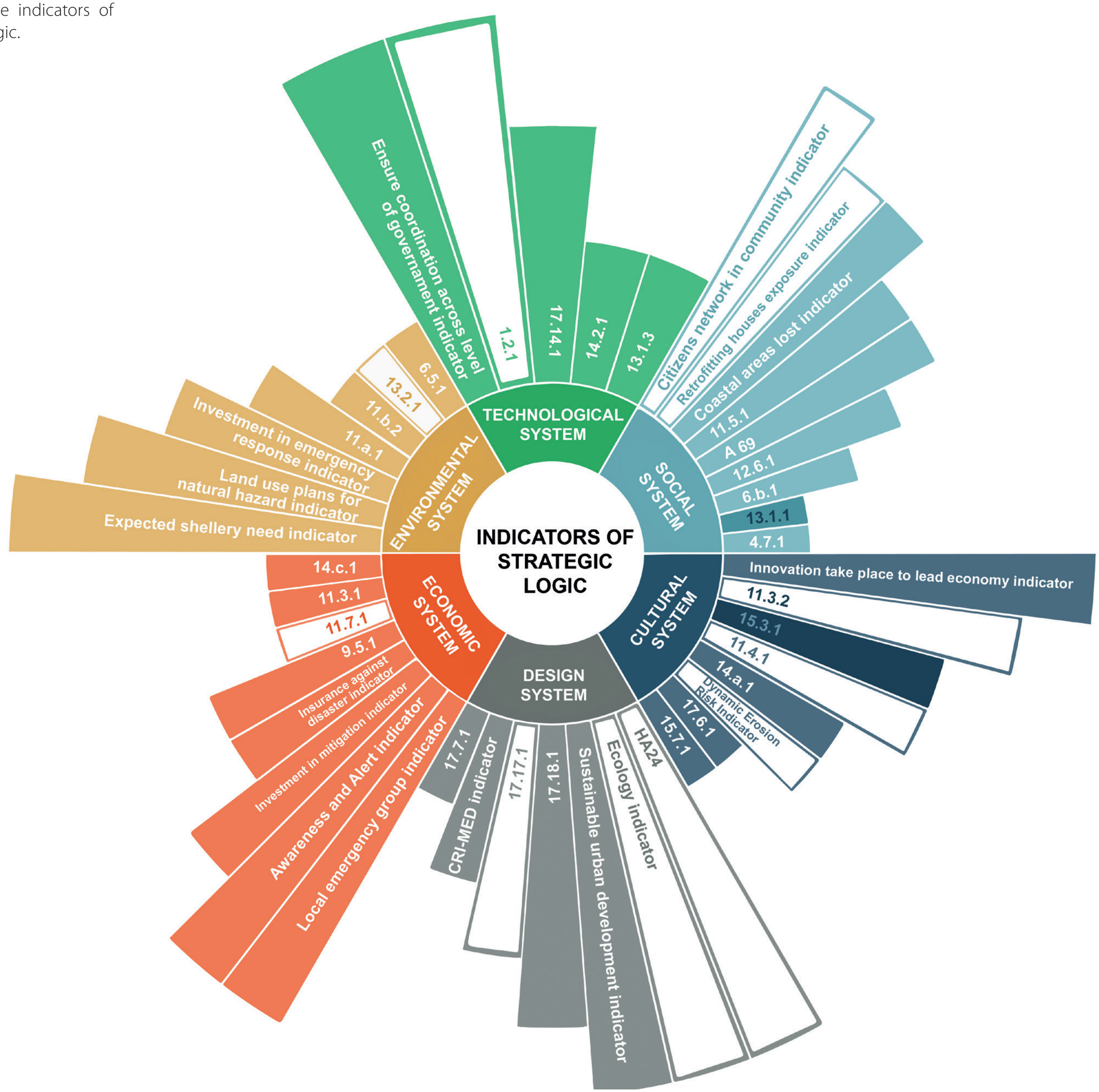


Fig. 79 The indicators of strategic logic.

CONTENT

- **nr.** Indicator of subsystem
- **nr.** Indicator of subsystem priority (vector)
- **nr.** Indicator of subsystem contact between the two logic

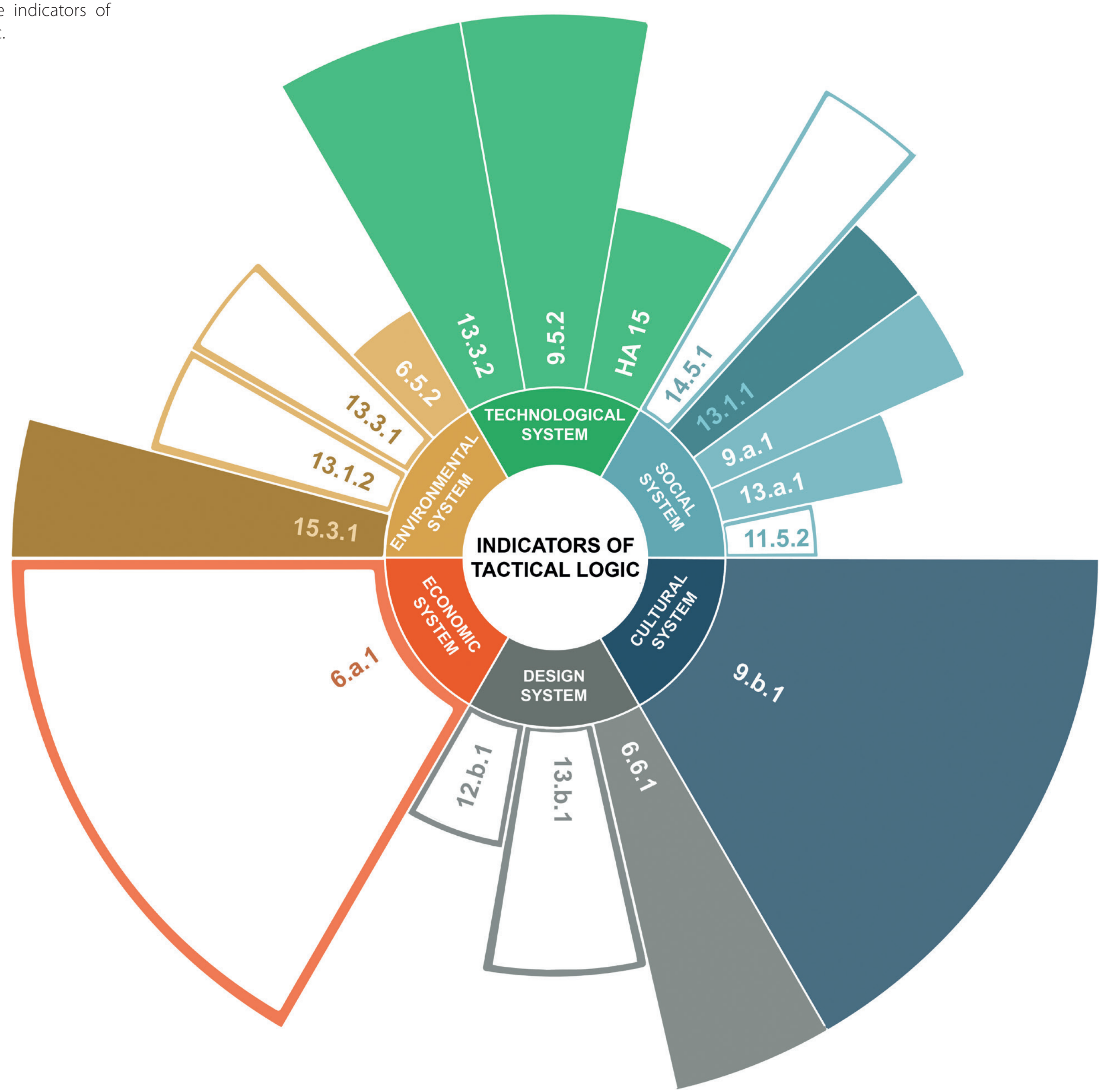
- **4.7.1** Extent of citizens' education in sustainable development addresses necessary for the nation's educational policies, educational experience, approach to teaching, and student learning
- **6.b.1** Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management
- **12.6.1** Public Institutions adopting forms of social and/or environmental reporting
- **A 69** No-profit voluntary organizations (including NGOs and sports associations and social organizations) registered in cities within a population of 10,000
- **11.5.1** Number of people killed or missing due to flood landslides
- **CAL** Percentage of loss of transformed coastal areas
- **RHE** Retrofitting or design of housing exposed to a level of environmental risk
- **CNC** Networks of citizens organized into active communities in the area
- **13.1.1** Organization of proportion of land consumption to the degree of population growth
- **13.1.3** Resident population exposed to flood risk in medium flood risk zones
- **14.2.1** Proportion of national economic zones managed exclusively with ecosystem approaches for choice of uses
- **17.14.1** Countries adopting strategies for strengthening policy coherence to sustainable development
- **ECLG** Countries adopting strategies for coordinated insurance across different levels of government
- **12.2.1** Proportion of total government spending on essential services including health, education, and social and environmental protection

- **ILPE** Economy directed toward innovation
- **14.a.1** Proportion of the total budget devoted to research in the field of marine technologies
- **17.6.1** Number and types of agreements and programs between countries regarding research and technology cooperation
- **15.7.1** Controls and actions on trafficking in flora and fauna and their use for illegal material productions
- **11.3.2** Proportion of cities with direct participation in civil society structures engaged in urban planning and management with the purpose of democratization and site regulation
- **11.4.1** The strengthening of protection and preservation of cultural and natural heritage
- **DER** Risk of erosion of sites with a global coastal heritage
- **15.3.1** Salinization of soils due to coastal land cover and extension
- **17.7.1** Total investment employed by countries to promote, transfer, disseminate and diffuse environmental and technological development
- **CRI MED** Coastal risk related to climate vulnerabilities
- **17.18.1** Statistical capacity to monitor sustainable development goals
- **SUD** Sustainable urban development of wetlands as flood absorption sites
- **HA 24** Spatial development control
- **E** Ecological level
- **17.17.1** Amount of investment in public-private partnerships to build protective climate infrastructure

- **14.c.1** Number of countries/regions that are progressing in ratification and economic implementation through legal agreements and institutional policies related to international flood jurisdiction
- **11.3.1** Amount of land consumption relative to population growth
- **9.5.1** Investment in research and development through defined capital funding
- **IAD** Insurance against natural disasters
- **IIM** Investments in mitigation of environmental impacts
- **ANA** Increased awareness and preparedness for climate events
- **LEG** Voluntary residents organized into local emergency groups to respond to environmental impacts and disasters
- **11.7.1** Incidence of green areas compared to urbanized areas in the city

- **6.5.1** Level of integration and management of water resources and fluxes
- **11.b.2** Proportion of local governments adopting and implementing risk reduction strategies in line with national legislation
- **11.a.1** Support for economic, social and environmental linkages between urban, peri-urban-periurban and rural areas for strengthening national and regional development
- **IER** Level of investment in emergency response
- **LPN** Land use policies developed based on environmental risk management
- **ESN** Expected needs
- **13.2.1** Number of countries that have national strategies for long-term economic support for community and environmental adaptation

Fig. 80 The indicators of tactical logic.



CONTENT

- **nr.** Indicator of subsystem
- **nr.** Indicator of subsystem priority (vector)
- **nr.** Indicator of subsystem contact between the two logic

- **13.a.1** Economic mobilization that from 2020 seeks to allocate $100 billion of funding to support communities
- **9.a.1** International support for social infrastructure and development of economic and insurance flows
- **11.5.2** Direct economic loss caused by the disaster to communities in relation to critical baseline damage to services and infrastructure around the world
- **14.5.1** Extent of coastal land in relation to the inhabited coastal area
- **13.1.1** Number of countries with national and local risk reduction strategies
- **13.3.2** Number of countries that have reported institutional, systemic and individual strengthening of the capacity of their buildings to adapt, mitigate and transfer innovative technologies and actions
- **9.5.2** Researchers employed in the study of innovative technological solutions per million inhabitants
- **HA 15** Permanence of rural coastal buildings
- **9.b.1** Proportion of the average value of industries producing innovative technologies to the total value of industries present

- **6.6.1** The change in the extent of water-related ecosystems over time
- **13.b.1** number of countries and islands that have received special funding for reconstruction, technological defense, building protection capacity related to climate effects with reference to fragile communities
- **12.b.1** Number of sustainable tourism strategies and policies for implementing monitoring operations and evaluation tools
- **6.a.1** Amount of assistance developed in connection with flood management and sanitation policies related to government plans
- **6.5.2** Proportion between flood basin areas and water management cooperation operations
- **13.1.2** Number of deaths, missing and injured due to floods per 100,000 population
- **13.3.1** Number of countries that have integrated mitigation, adaptation and risk reduction strategies into their spatial policies in the first, second and third levels
- **15.3.1** Proportion of the area degraded by natural disaster to the total area considered

connections determined by the contact indicators between the two logics, which confer not only the link between the tactical and strategic visions but also the revolutionary motion of the reticular model (Figure 81).

By critically reading what emerges from the described evaluative methodological process, it is possible to construct thresholds of integration focused on the issues that such transformations imprint on places. The resultant matching of these convergences yields a wealth of issues from the described methodological system that manages to hold together different dimensions. The indicators identified as priorities by expert and common knowledge constitute a vector that gives rotational motion to the Reticular and Integrated Model, assuming in itself, the temporal value of being corresponded with more urgency than the other indicators identified (Figure 82).

These observations bring us back to the premise of the research and develop the conceptual hypothesis of assembly by proposing a Reticular and Integrated Model, composed of layers of actants in open multidimensional communication. Each subsystem represents, in turn, an iterative circuit of two-dimensional inquiry, capable of developing incrementally through repeated cycles in which results (identified as outputs) are feedback as input to take advantage of the critical issues encountered. This results in an implementation of the initial process through iteration, in key steps of the circuit, in which the actants are able to modify and add new functional capabilities to the subsystem under consideration. The role of the actant evolves the two-dimensional circuit of a subsystem toward a multidimensional meaning. This results in an iterative thrust of the circuit that causes the actant to improve the process through cross-subsystem interaction. The actant becomes the connecting pole between subsystem circuits in the absence of communication, yielding a network-like overview. It is a gear in a perpetual circular motion in which the vulnerabilities of a subsystem, previously managed through closed interaction, can now be mitigated in relation to complex iterative processes. These affect all other subsystems and generate multiple solutions in different dimensions. To guide the iterative process, the actant by its definition establishes relationships between subsystems, determining the elements, and thus new functions, to be implemented to support areas of the redesigning of the existing solution.

The network is continually revised, regenerated, and adapted according to the vulnerabilities, tangible and intangible, that the spatial and temporal change in the built environment undergoes as it evolves. What distinguishes assemblies, from how networks are commonly conceived, is their materiality. Instead of an ontology that positions ideas as the basis of action, this view embraces the materialism of the idea itself, emphasizing the physicality of networked action production (Figure 83).

The Reticular and Integrated Model evolves from Latour's vision (of a connected world and reality made up of two-dimensional assemblies) toward the network as a "three-dimensional reticular". The proposed Reticular and Integrated Model takes on several meanings, the first among them being understanding the

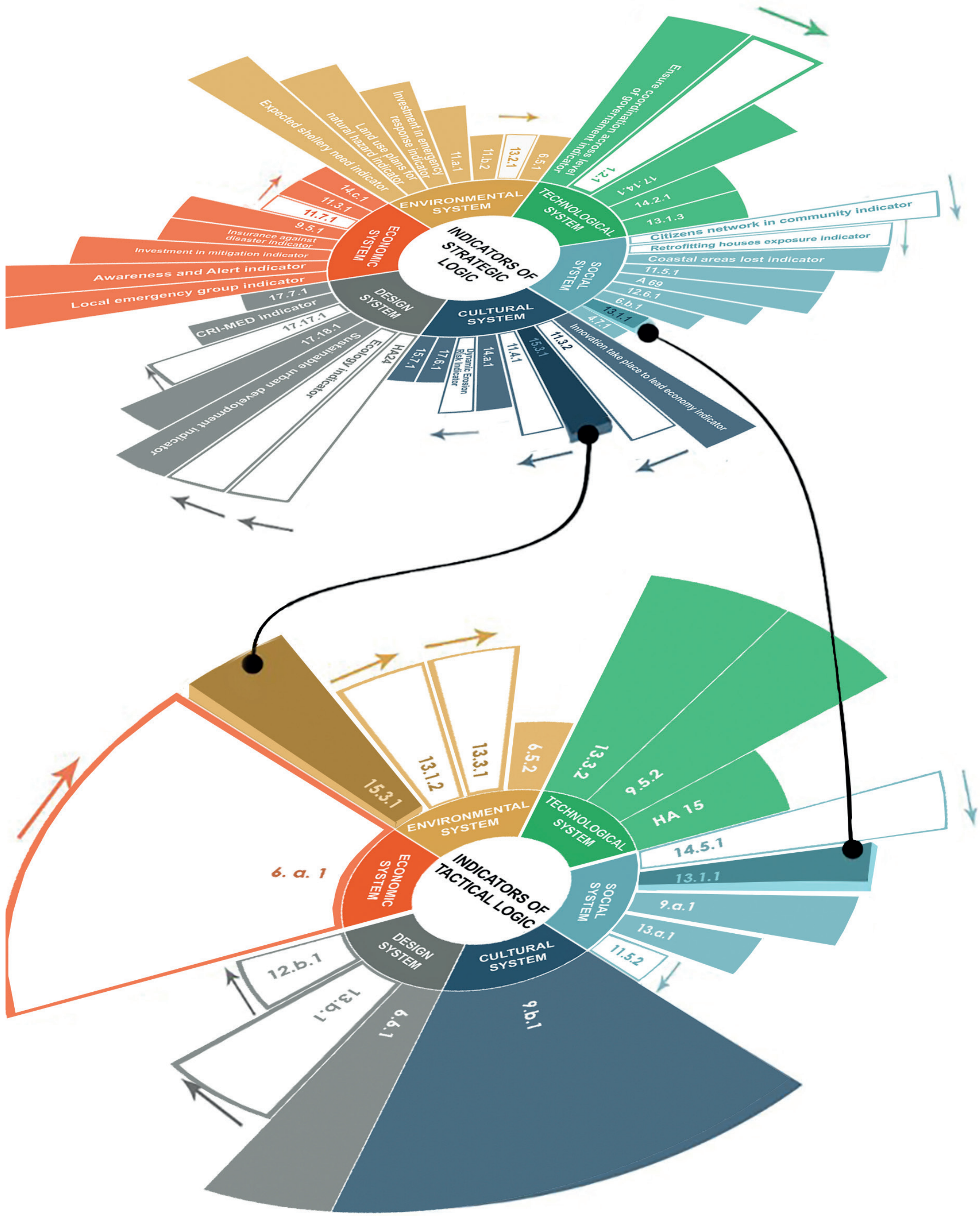
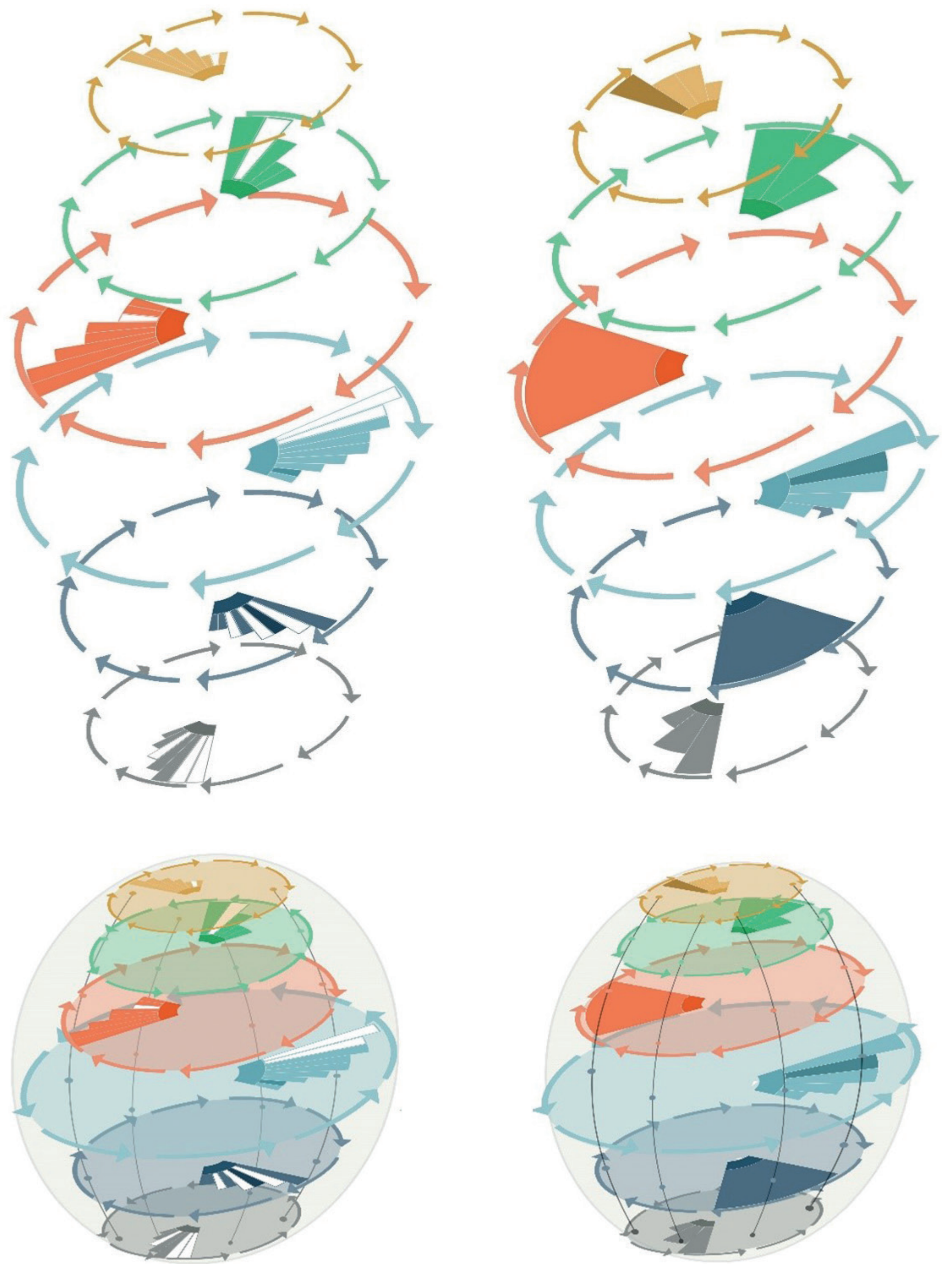


Fig. 81 Nodes of the Reticular and Integrated Model in the regeneration process of the built environment.

Fig. 82 The rotation vectors of the Reticular and Integrated Model (strategic logic on the left, tactical logic on the right).



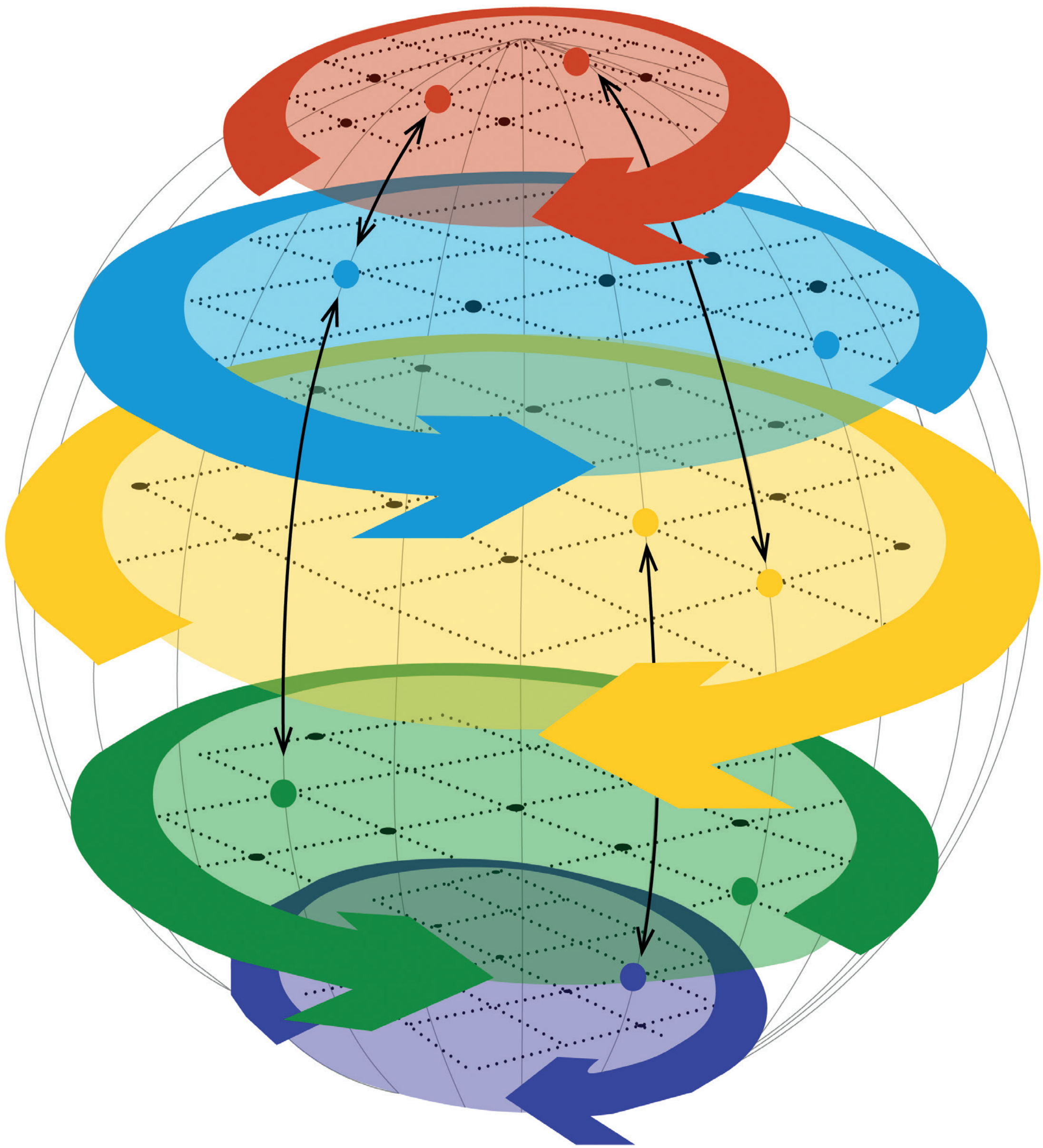


Fig. 83 The Reticular and Integrated Model.

adaptability of a system, as the ability of the system to assimilate itself to different realities characterized by relative state variations. Adaptability is associated with the characteristics of the iterative and repetitiveness of the information decision-making circuit, adjusted according to the so-called "trial and error" method and referring to the perturbative actions of internal or external events.

The model's ties acquire dynamism through an understanding of temporality expressed by the need to prioritize some addresses over others. The Reticular and Integrated Model is stationary at a given instant by interpreting the time variable as an absolute value. For the model to acquire a capacity for rotation and revolution, it must also bind itself to the temporal variable, which gives it a connotation of dynamism, understanding the process as a succession of states. The temporal priority is defined through understanding the specifications that characterize the context and making explicit the views of the experts and communities involved in the regeneration process. From this reasoning, it is possible to infer the importance of the identification of actants, those of which, read in a systemic key, mitigate the built environment by means of thresholds of integration.

4. Validation of method in the waterfront regeneration process

4.1 Replicability and innovation of the method

The development of the Reticular and Integrated Model characterizes an extended scope of application to both regeneration processes and tools for governing the dynamics of the built environment. This model traces mitigation actions in which thresholds of integration are made explicit by complex indicators capable of reducing or limiting vulnerability conditions with an appropriate technological integration.

Research comprises data expressed in quantitative terms and related to the impacts of decision-making actions as well as data expressed in qualitative terms related to the participatory approach. The structured connection between various knowledge facilitates the identification of requirements for innovative solutions attentive to the demands of time according to environmental, cultural, economic, social, and technological aspects. The model assumes an essential role in identifying the significant components of the decision-making process; while the thresholds made by complex indicators verify the impacts by guiding the transformation actions. The method, made by model and tools, developed by the research invests the built environment. This will provide the ability to apply the indicators to the formulation of new regeneration processes for the built environment, and by yielding the importance of learning from occurred practices, using the solution of emerging vulnerabilities to improve new performance. The multidimensional nature of the subsystem indicators can be activated at different scales and levels, considering the plurality of experimentation goals as a key to interpreting the specifications in order to guide replicable interventions (Figure 84).

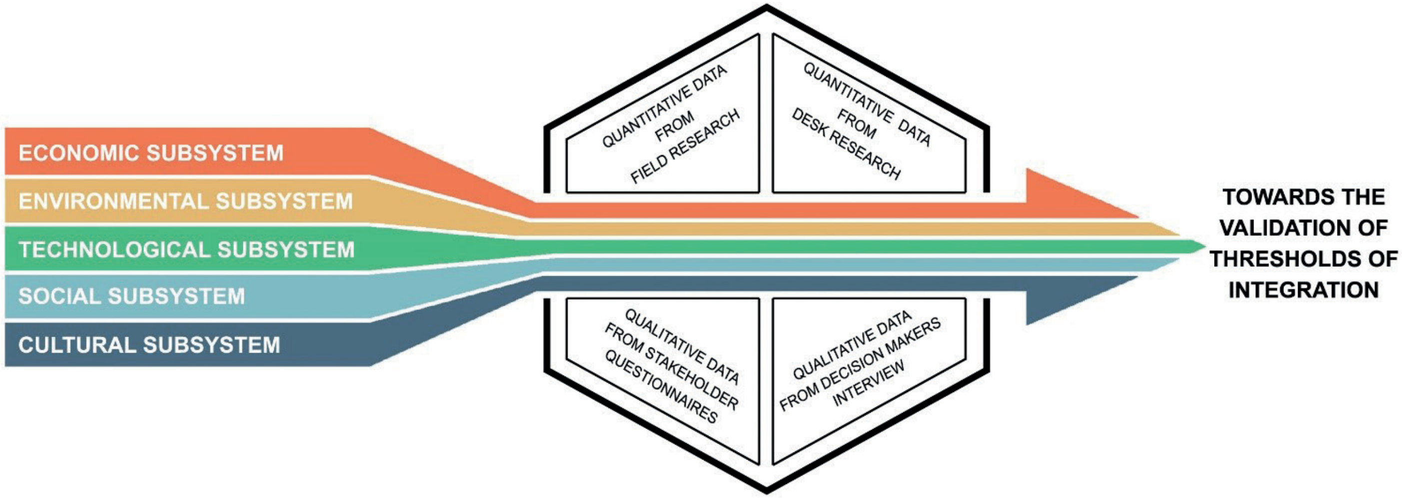


Fig. 84 Towards the validation of thresholds of integration.

The possibility of being able to test how innovative technological solutions can integrate into contexts characterized by significant economic potential and extreme climatic conditions resulted in the possibility of monitoring real impacts. At the same time, the identification of the main categories of decision makers and stakeholders made it possible to select significant knowledge, skills, and roles, consistent with what emerged from the scenario of the research process.

From the participatory approaches, pre-existing conflicts and contradictions emerged, as elaborated through field investigation; revealing the need to integrate, once again, heterogeneous viewpoints on project values in the stages of the regeneration process of the coastal built environment. The complex decoding by the significance of concepts according to frequency (Domain Analysis) and by the centrality of concepts according to the number of links that connote them (Central Analysis) allows the identification of points of convergence among the different decision makers and stakeholders. This is to establish the general and specific relationships, outlining the preferable regeneration process of the coastal built environment. The determination of an order of preference by stakeholders and priority by decision makers, translated as a core set of complex indicators, which guides the creation of a balance between social welfare, economic requirements, and the performance of the built environment. In this sense, thresholds of integration contained a spatial dimension related to physical transformation and a temporal dimension related to the ability to allow the built environment to achieve balance during its evolution. In this way, the structure of a decision tree is configured, prompting critical incites that allow the development of comparative analyses between different experiences to improve new ones. In particular, the Analytic Hierarchy Process (AHP) [219] makes it possible to compare multiple alternatives in relation to the plurality of criteria, quantitative and qualitative, deriving through thresholds of integration an overall innovative solution that appropriately mitigates vulnerabilities. Indicators make it possible to articulate alternatives in order of preference, selecting the best and assigning alternatives to predefined subsystems of the built environment. The replicability of the model focuses on the comparison of design alternatives, criterion importance, and impact on the decision. This ensures the research replicability of the method in other contexts to validate it (Figure 85).

Having combined tools of the need-performance approach related to the systemic concepts of the built environment, the research simultaneously validates the comparison of the horizontal type (between subsystems and the multi-actors operating in them) with that of the vertical type (between the local, national and global scales and the different criteria and tools of application). Taking the opportunity to confront different contexts through research conducted in Europe and Asia, the method was validated in order to understand the transformation phenomena of contemporary cities and study them according to new multi-stakeholder governance approaches. In response to the climate challenges of geographic contexts where existing criticalities and potentials allow for the integration of top-down and bottom-up approaches; the Reticular and Integrated Model represents a governance device within transition policy. The thresholds of integration become experimental tools for innovating approaches to mitigate the effects of climate change through inclusive, multi-scale, and multi-stakeholder visions.

4.2 Validation of the method: transferability, adaptability, and flexibility

Validation of the method verifies the transferability, adaptability, and flexibility of the thresholds of integration by applying complex indicators on built environment types other than New York City and the Americas. The method supports decisions in the waterfront regeneration process by directing conservation and transformation actions to determine the appropriateness of intervention choices. The method improves the performance of the built environment from time to time by testing in different and multiple scenarios the characteristic conditions and climatic, cultural, social, and economic variables of different sites. In the operational setting, therefore, the validation of the method confronts the plurality of existing resources, technological integration requirements, and the performance of the built environment. The validation extends the elements to be considered to the relationship with the site, living conditions, image quality, and the rules and procedures that have determined the development of the site over time.

The validation process verifies the transfer-

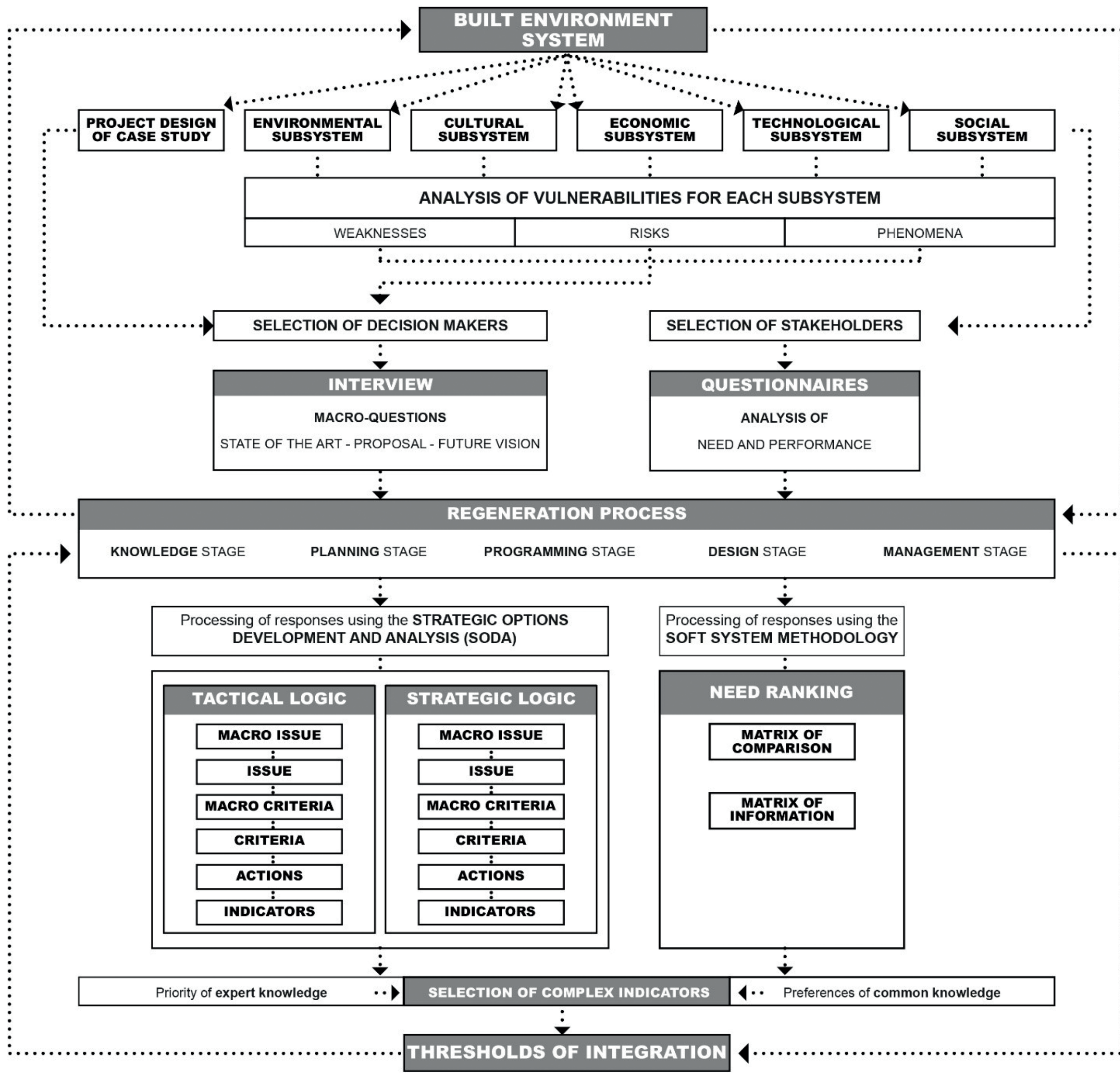


Fig. 85 Decision tree scheme for the research replicability.

ability of the method through the application of the thresholds of integration in the programming phase of the coastal regeneration process. The research demonstrates this transferability through the experimentation conducted on the Iraqi waterfront of Baghdad, yielding in detail how the indicators of the respective afferent subsystems directed each design choice.

At the same time, the validation process tests the flexibility and adaptability of the method through the application of the thresholds of integration on an existing coastal regeneration project. The experimentation conducted on the Italian waterfront of Venice keeps the structure of the complex indicators unchanged; changing only their order of priority due to the specifications of the context. In both validation tests there is a flexibility not only about already given indicators, but also introducing and defining an empowerment of them in relation to different settlement systems.

The transferability, adaptability, and flexibility of the method make it possible to verify from each context the compatibility of regeneration processes in the built environment, based on the appropriateness of integrating innovative technologies in vulnerable contexts. These three features of the method, on the one hand, respond more articulately to the needs of communities in transition and the performance of climate change; on the other hand, they support overcoming the homogenization and uniformity of technological solutions, design choices, and the way of living in the coastal built environment.

The method determines appropriate scenarios of technological integration, refining itself as much as it is tested according to the characteristics of each experimentation and demonstrating how it guides the transition from data to the application, requiring a value-based choice in the decision-making process in both the programming and planning phases of the waterfront regeneration project.

4.3 Key issues in implementing the method in consolidated contexts: the MOSE of Venice in Europe

The adaptability and flexibility of the method are verified through its application to the waterfront of Venice, considering the vulnerabilities of the Italian built environment related to the protection of a heritage, stratified over time, according to established forms, techniques, and materials. Addressing these vulnerabilities requires a different approach, attentive both to the construction of new relationships between the waterfront and flooding mitigation solutions and to the transformation of the forms of preservation of the built environment that, due to gentrification and touristification phenomena, can undermine existing heritages of inestimable value and the communities that inhabit them (Fig. 86).

Through field research conducted at the Shipyard Arsenal, the method was applied to the integration between the settlement system with established identity and the mitigation solution of MOSE (Electromechanical Experimental Module).

Fig. 86 Flooding in Venice, 2021.

From the cultural subsystem, the technological solution is specific work being done for the Ministry of Infrastructure and Transport, commissioned by the former Water Authority, whose concessionary technical executor is the *Consorzio Venezia Nuova* [222]. Culture and nature coexist in MOSE, starting from the environmental actions of morphological regeneration and sanitization of the lagoon to those of mechanical enhancement of integration of mobile barriers for defence against high water. The intermingling of natural and technological elements has thus resulted in the proliferation of a hybrid place where the elements, placed in relation, influence each other; generating a new lagoon system (Figure 87).

Fig. 87 MOSE: comparison of the experimental model and working technology in the built environment.

From the environmental subsystem, the mechanical defensive operation of the mobile barriers is part of a much broader and more complex plan concerning the reinforcement of shorelines as environmental elements complementary to the proposed technological solution. The morphological regeneration of the lagoon, that is, the recreation of the original marine orography, was the first part of an integrated plan of various work which was done for environmental protection in the broadest sense. Mobile barriers for high water defence are the last, albeit fundamental, step in this program of interventions.

From a technological point of view, the MOSE is composed of 4 systems of sluice dams, placed in caissons and operated through hinges. These elements are all prefabricated objects *in situ*, assembled and transported through the principle of buoyancy to the resting point, and then ballasted on the seabed with a catamaran system. The weight of their placement is supported by a system of sheet pile trenches, consisting of about a thousand piles, in order to avert differential subsidence of the seabed during the operation of settling and joining the caissons. They are connected by a double system of hydraulic joints to create a continuity of internal tunnels for the maintenance of technical facilities. They form the base of the defensive barriers; housing the mobile sluice gates as well as the facilities for their operation, which are connected to each other by such tunnels allowing for their technical inspections.

The sluice gates consist of a metal box structure that, when filled with water, remains lying at the level of the channel bottom inside the foundation system. When the tide is high, water is expelled by the introduction of compressed air, which allows the sluice gate to rise, rotating around the axis of the two hinges that connect it to the housing box, so that it assumes its predetermined operating position. When the tide goes out, the sluice gate is again filled with water and returns to its seat. Housing caissons, on the other hand, are multi-cellular concrete structures that, once made, are housed inside a trench dug under the seabed. Finally, the hinges are structural elements consisting of a male and female joined together to absorb the stresses produced by the most intense weather and sea conditions. The MOSE system requires 5 hours and 30 minutes to raise the barrier and to cope with up to 3 meters of tide [223]. According to the life cycle of the barrier, periodic replacement of all gates is planned every five years, and occasional replacement of damaged ones. Installation of the sluice gates and regular maintenance provides for internal and external cleaning, regeneration of paint on damaged surfaces, and replacement of external anodes.

The potential of the integrated technology, therefore, collides with the fragilities related to the amplification of its own wear-and-tear time and the decrease of its vanguard in relation to the intervening temporality between design (2003) and operational testing (2020). This fragility is closely dependent on cost overruns related to substandard design elements and misaligned governance in the implementation and management of the lagoon regeneration process. Among the main critical issues are the premature corrosion of the technical element of the hinge, estimated to have a planned life of 85 years less than the design life; the need to equip the system with a sand ejector to avoid further misaligning the positioning of the gates in the caissons; and the adaptation of the structures located in the Malamocco area of the Venice lagoon to facilitate the flow of ships in rough seas; the functional adaptation of 936 valves and joints between caissons that have deteriorated due to lack of maintenance; the reconstruction of the lunate in the Lido area of the Venice lagoon, which collapsed into the sea the day after testing; the replacement of the Jack-ups with the more economical pontoon-mounted trestle; and all the management and maintenance responsibilities of the solution.

From an economic point of view, the choice of technology ensures both the continuity of exchange between the sea and the lagoon in full respect of the ecological and fish-economic balance; and the continuity of the image of the city's historic landscape (with the tide in a quiet state). MOSE aims to elevate the safety of boat and container flows while respecting the economic exchanges that govern the territory and limiting the visual impact on the landscape.

From a social subsystem, the technology follows control and start-up through human monitoring precisely to hybridize digital to mechanical operation, and most importantly, to avert system failures from an electronic point of view, while leading to increased employment supply and risk awareness.

Specifically, all the cultural, technological, environmental, economic, and social subsystems conditions addressed do not change the structure of the indicators but allow them to be identified in a re-ordered priority based on the characteristics of the testing context. These improve the description of the indicators with more pointed specificities. For example, in the case where risk mitigation strategies are linked to operations of regeneration of the pre-existing natural system, in the environmental subsystem some indicators take a priority role (6.5.2). As well as in the technological subsystem when the adopted solutions are based on research and experiments that increase their useful life cycle beyond an ordinary margin of climate emergency (9.5.2). In the cultural subsystem when general protection policies also include structures integrated to building defence (13.b.1). In the economic subsystem when flood management policies also avoid disruption of operations during the climate event (6.a.1). Finally, in the social subsystem when policies to protect fragile communities also include populations subjected to the risks of gentrification and tourism (9.a.1).

This makes it possible to validate the flexibility of the method by attributing to it the ability to pose as a tool for controlling intersection variables between subsystems of the built environment. At the same time, experimentation also makes it possible to verify the adaptability of the method, attributing to it the ability to hold together a variety of contextual characteristics as a quality requirement of the waterfront regeneration process.

4.4 Perspectives on the application of the method in programming: the Al-Madain of Baghdad in Asia

To verify the transferability and potential for use of this methodology, also in the programming phase of interventions, the case of the regeneration of the Al-Madàin waterfront in Baghdad was chosen. The testing of the method took place during the participation in the international competition Dewan Award for Architecture 2021[1] , allowing the regeneration project choices to be directed towards appropriate technologies both for compatibility with the context and with respect to available resources. The agricultural-rural area covers an area of

[1] https://dewan-award.com/

Fig. 88 Waterfront of Tigris River in Sanctuary of Al-Madàin in Baghdad.

15,000 square meters along the eastern bank of the Tigris River, representing one of the oldest urban agglomerations in the Near East due to its proximity with the various capitals of the historical, political, and cultural importance of Seleucia and Ctesiphon [223]. The integration of the technological solution aims to mitigate flooding of the Tigris River, which during the spring reaches waves of 2 sq. m, carrying up to 40 times more water than its normal capacity, and spilling over into the conflict-damaged section of the Iraqi territory. At the same time, the technological solution must meet the needs of refugees to recover the identity of a community through new forms of guarding the built environment attentive to local characteristics (Figure 88).

The solutions established at the planning stage were commensurate with the area's reduced financial sources, which required the choice of simple but capable technologies to enable contemporary, flexible use of the built environment by extending its functional life to optimize existing resources.

Applying the method the environmental subsystem guided the project towards a distribution of land use (LPN) by determining that 55% is predominantly agricultural (E), 43% permeable (HA24), and 2% swampy in places (CRIMED). The built heritage is deliberately low in density (11.b.2), covering a land area of 3% (17.17.1), comprised of buildings made of poor materials (13.2.1) and of local tradition (IER) that do not exceed two stories in height (11.a.1) and that enjoy cultivable private land (ESN). Notably, 11% of the area is dedicated to integrating flooding mitigation infrastructure (6.5.1) compared to a floodable area of 12%. These conditions highlight the need to ensure risk reduction strategies from inclusive land uses for communities threatened by the river and coastal flooding, environmental degradation, and civil unrest.

The social subsystem guided the performance adjustment of buildings suitable to accommodate 240 refugee women aged 4 to 18 (CNC), resulting in the development of a condition similar to a small rural village (A69) or urbanized neighborhood (13.1.1). The flooding mitigation technological solution aims to defend all the different building types to be integrated into the coast (6.b.1), from residential, institutional and cultural to social, educational and sports (4.7.1). The thresholds of integration directed the choices of the waterfront regeneration process towards the creation of a flood buffer zone (RHE), capable

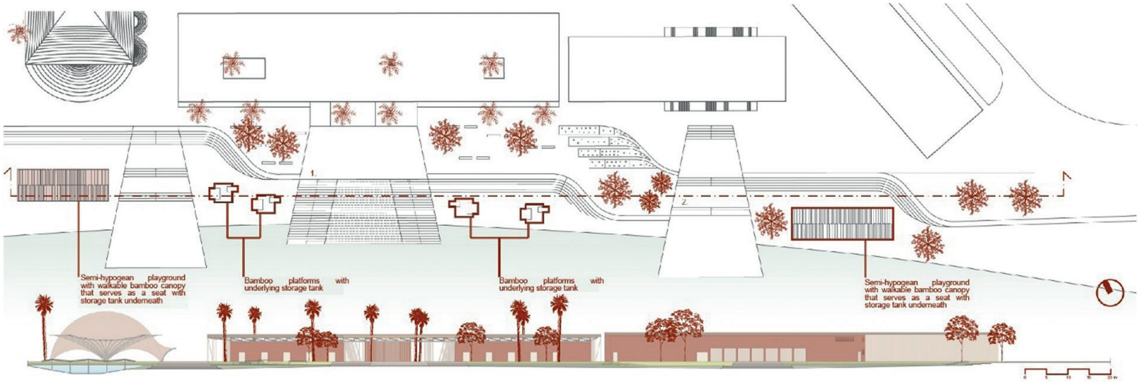


Fig. 89 Framing flooding mitigation solutions in Baghdad, designed by Ciampa, Gargante, Bramante and Incognito Architects.

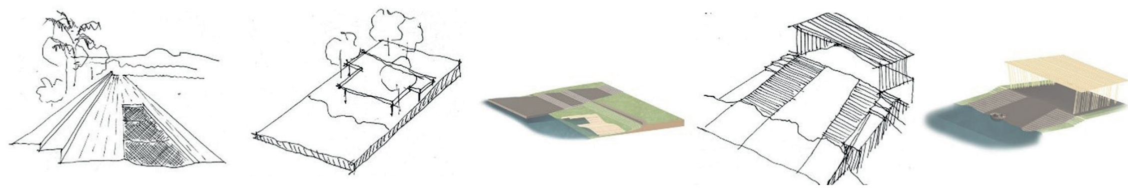


Fig. 90 Recreational flooding mitigation equipment in Baghdad, designed by Ciampa, Gargante, Bramante and Incognito Architects.

of triggering new policies of coastal re-appropriation (12.6.1) and water access (11.5.1). The project responds to climate mitigation issues through a system of stairs, walkways and promenades (CAL) that accommodate neighborhood amenities (Figure 89).

The technological subsystem directed the choices toward a flooding defence system that integrates detention basins (SUS) into recreation facilities (14.2.1). The emptying of the latter is done through special storm drains that lead the water to a storage basin (17.14.1), which features a system of submersible pumps that incinerates (13.1.3), purifies (17.7.1) and sends (15.3.1) excess amounts of water (ECLG) to the irrigation network for green areas and urban gardens (1.2.1).

The Cultural and economic subsystems have directed the choice of intended uses (17.6.1; 14.a.1) for mitigation solutions in the absence of climate emergency (ILPE). These solutions can represent collective equipment (11.3.2; IIM) of a play-recreational type (11.4.1), dividing the system into two different types: the first involves the presence of a large undulating surface made of bamboo, that thickens and expands, allowing the passage of light and air (DER). The latter, through slides carved from the natural slope (ANA) , allows climbing and playing with the natural elements available (11.7.1). The second type involves a system of three staggered platforms (11.3.1) where users can play or create paths (Figure 90).

These technologies could be supported by investment instruments, funds, and incentives from the National Green Banks (9.5.1), i.e., non-profit organizations charged with providing grants, subsidies, and loans, to support a wide range of multi-benefit projects such as this one, which are aimed at improving environmental sustainability (15.7.1), recreational-educational (14.c.1) and disaster preparedness (LEG).

This makes it possible to validate the transferability of the method by attributing aspirations of offering new services to it, in response to the needs of time as well as providing continuity to the identity of communities by defining the character of places through the limits of integration.

5. The future enhancement for the regeneration process of the waterfront built environment between mitigation, adaptation and evolution

5.1 Appropriate technologies in the regeneration processes of the waterfront built environment

The conclusions of the book put the issue of the appropriateness [4] of technological solutions back, developing an assessment method useful for actors in the waterfront regeneration process to determine choices aimed at climate change mitigation.

The appropriateness of a technological solution is such that when it determines corrections to the vulnerability conditions of the built environment, contributes to improving the quality of life of communities as well as transformation and conservation processes closely linked to the momentary condition [4]. Research implements this concept, identifying the limits within which the integration of technological solutions can be defined as appropriate and responsive to the mitigation of existing vulnerabilities without developing new ones.

The method guides waterfront regeneration actions by reshaping the relationships between nature, society, and the market. To determine the appropriateness of a technological solution, the method considers the vulnerabilities of technological, cultural, social, economic and environmental subsystems and relates them to the stages and actors in the process of regeneration of the built environment. The goal is to contribute, in a dynamic form, to the realization of new projects, based on a high capacity for governance and involvement, aiming to produce forms of inclusion and innovation.

The method developed recalls Gilles Deleuze's concept of the "desiring machine" [224] according to which an appropriate methodology should function as a mechanism that relates something to something else, someone to someone else. Indeed, like the desiring machine, the method is a hybrid process that combines the need for climate change mitigation with the 'desire' of communities and the market. This idea, in some ways, is reminiscent of the concept of the device [225] developed by Michel Foucault a few years earlier. To this, however, Deleuze adds a fundamental component, which is the idea of 'flow' [226], interpreted as the set of dynamics that are triggered by the transformations that technologies bring about, integrating with the built environment. Thus, the metaphor of the desiring machine indicates a mechanism that drives both the physical transformation of nature and the creation of a system of relationships through which to assess the impact related to technological integration. This means that innovative solutions accomplish changes not only in the places in which they interact but also in the stages of the coastal regeneration process that follow their introduction. Downstream of these phenomena, the demand for coordination among actors grows, requiring the articulation of knowledge and relationships that must be activated around the technological solutions to be integrated to mitigate the catastrophic climate event.

The process that is generated represents an opportunity both for exploration, with the activation of a participatory observatory involving expert knowledge and common knowledge to rethink transition processes, and for experimentation, with the activation of cooperative networks among decision makers for sharing priorities of choices in response to the needs accrued by stakeholders [227].

This expands the process of involvement and participation in coastal regeneration by linking human agents with non-human agents, who together are called actants. The method thereby articulates a dynamic system [4] in which the actants, by generating a complex network of ties in homogeneous and mutual cooperation, create new balances. In this perspective, the research ascribes to the different actants the possibility of being a "changer" in the waterfront regeneration process, that is, of playing an enabling role within the decision-making processes in which they are involved. From a perspective of circularity and reciprocity [7] if, for example, on the one hand, the user re-enters the process of technological experimentation by influencing both the choice of technologies and interacting in the life cycle of these solutions (through operation and maintenance). On the other, technology, in turn, intervenes in the user's quality of life, reinterpreting the singularities of the pre-existence and the different conditions that identify the context of intervention in which communities live.

Within the dynamics of coastal regeneration projects, networks of mediation between nature and culture are thus established such that they overcome the dichotomy that exists between them. The level of complexity of such networks highlights the need to define the type of link that determines multi-scale project choices concerning different types of actants involved.

The research gives the choice of technology a role in connecting subsystems, and it is possible to establish the Reticular and Integrated Model when the appropriateness of its integration is validated in each of them.

Validation of the method has shown that the Reticular and Integrated Model adopts an iterative design process, allowing it to be refined. This makes the method capable of improving each time it is tested, learning from the changes that subsystems of the built environment undergo in relation to testing new actions to be undertaken to address the critical issues to which they must respond. The use of the method at the planning stage of interventions makes it possible to assess foreseeable changes with respect to the goals of strengthening the identity of a place, guarding the sense of belonging to it, as well as providing participatory forms of knowledge and preparedness for catastrophic natural phenomena.

5.2 Architectural Technology at the urban scale: the Hybrid City proposal

The 86% of coastal developed countries and 64% of developing countries will address their transition by 2050. This will happen by making the built environment habitable through the integration of innovative technological solutions that will increase its market value by $3.1 trillion, thus constituting two-thirds of the world's GDP [228]. This scenario determines the urgency and strategic role in using methods to develop a fertile dialogue among the actors involved in coastal area regeneration choices.

An extremely important issue to be addressed is also the possibility of driving technological dominance over subsystems of the built environment to act in the processes that capitalism triggers on a global scale [68]. Indeed, the impact of a technological solution is identified in new social realities that change with different impacts on the built environment. Human civilization has transformed its way of life over time, adapting to the environment and exploiting progress to mitigate the vulnerabilities of the places where it chooses to live. These kinds of dynamics generate transitional processes that invest the boundaries between man and machine and in which technology acts as an agent of a new physical, social and economic production.

The last major obvious transition was from a pre-modern (1750s) to a modern (1890s) industrial society [59]. Today, we might instead speak of a "hyper-modern" transition [64] in which the speed of progress exceeds the human capacity to adapt to it. According to the latest United Nations World Cities Report [1], the spread of technological innovation is causing a fundamental transformation in the current structure (and meaning) of both the built environment and its communities. To question the vulnerabilities generated by technological innovation and their impact on ways of living is to address this transition over the long term. The domains of nature and culture, of environment and machine, are incessantly redrawn according to their changing boundaries, and the process of regeneration of the built environment can be interpreted as the system of complex forces that stimulates as well as rearticulates their relationships. While the worsening climatic condition is linked to development; the latter is linked to the innovative capabilities of technology to redefine its boundaries.

The method takes up this challenge by directing the actions of the waterfront regeneration process in such a way that the appropriateness of the solution allows its development to be non-conflicting with the built environment. The appropriateness of the technological solution reworks the symbolic content and meanings of spaces at different scales, respecting the identity of settlement systems and society in transition.

This allows local details to be enriched and global criticalities to be mitigated, assuming iterative processes and integrated visions within themselves. Therefore, it is possible to place a different value on technologies than on markets that impose innovation on communities without assessing their real needs. Innovative technological solutions are interpreted as cross-overs of subsystems in the built environment, which change the relationships between them while preserving existing values and creating new ones. The unpredictable climatic dynamics that disrupt such balances redraw not only the interdependencies between the actants but also the power of their relationships.

The purpose of the method is to direct regeneration processes toward an appropriate response to the demands of the climate, adjusting from time to time the structure of relationships between individual subsystems and the entire built environment. Individual subsystems that are affected by the integration of innovative technologies are responsible for value and physical changes at different scales. Therefore, climate change, the evolution of the built environment and communities, and technological innovation, though polarized by different adaptation times and asynchronous speeds of development, find in the thresholds of integration the point of intersection; in the Reticular and Integrated Model, a way of realignment. The goal is not to orient the coastal city to an end state but to provide directions for making it the focus of dynamic processes that strain its speed of adaptation [191]. In this sense, the mixing of heterogeneous entities of the actants is no longer considered critical, but an asset that can make a regeneration process complete in an articulated way.

In this scenario, the transition process results in the formation of hybrid zones in which the interests of the actants exert influence on both the growth and balance of the subsystems of the built environment. Such hybridization makes it possible to clarify the dynamics that are invested in the coastal city through specific operations of reorganizing the links between subsystems that contribute to the performance realignment of the built environment.

Thus, the research contributes to the Hybrid City model [229], in which the impact of a technological solution changes depending on the spatial integration it enables between subsystems, while also generating spill-overs related to the temporal dimension of integration.

The appropriate technological solution reworks infrastructure through the provision of new features offered by innovation, so whenever a new technology is introduced, a process of reorganization of existing relationships must always follow. In the Hybrid City, innovation is, therefore, necessary and inevitable to combine the needs, requirements and performance of the built environment and communities, making this city model an opportunity for synthesis and a potential development scenario for a new "humanism of technologies" [86]. In this vision of the future, the research looks at the transferability of the proposed method to other fragile contexts in order to validate its articulation and identify the necessary adaptations to prioritize actions. This allows for new links between different experiments of the coastal built environment, and thus, between multiple networked models, generating a "networked mesh". Learning from these results, it is possible to transfer the method from system reasoning to a larger scale, the end of which is a "reticular circuit" of coastal cities, in a perspective that moves from Hybrid City to Hybrid World.

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Appendix I

Indicators for constructing thresholds of integration
Indicators of strategic logic

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
The proposal	The intervention policy	Proposal based on the field experience	Planning stage	Long-term planning with intermediate objectives to be achieved incrementally and based on the principle of participatory justice	Environmental subsystem	**Activate long-term planning processes**	**ENVIRONMENTAL GOVERNANCE**	Agenda of plans and processes in the short and long term	– Drafting of Climate Change Panels for periodic review of urban plan objectives	**11.b.2.** Proportion of local governments adopting and implementing risk reduction strategies in line with national legislation
									– Timetable of urban planning programming 2050 2080-2100	**13.2.1**. Number of countries with nationally determined contributions (NDC), long-term strategies, national adaptation plans, and strategies as reported in adaptation communications and national communication
						Identify goals to be achieved incrementally	**RISK AND DAMAGE MANAGEMENT**	Programming climate mitigation actions promoting social positivity	– Programming of intervention actions for flooding mitigation – Programming climate strategies with positive impacts on the community	**6.5.1**. Degree of integrated water resources management implementation (0-100)

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, development and implementation, in line with the Sendai Framework for Disaster Risk Reduction 2015- 2030, holistic disaster risk management at all levels	%	Percentage of local governments that adopt and implement local disaster risk reduction strategies in line with national risk reduction strategies/proportion of total local governments	max	**Indicator 11.b2.** Available on: https://unstats.un.org/sdgs/metadata?Text=&Goal=11&Target=11.b	↑	↓	/	/
Integrate climate change measures into national policies, strategies and planning	%	Percentage of countries with long-term adaption strategies/ national report published	max	**Indicator 13.2.1**. Available on: https://www.istat.it/storage/SDGs/SDG_13_Italy.pdf Database Annuario dei dati ambientali - ISPRA (PSN:APA-00032) Available on: https://www.istat.it/it/benessere-e-sostenibilit%C3%AO/obiettivi	↑	↑	☒	**GOVERNANCE AND PHYSICAL TRANSFORMATION**
This indicator reflects the extent to which integrated water resources management (IWRM) is implemented. It considers the various users and uses of water to promote positive social, economic and environmental impacts on all levels, including transboundary, where appropriate.	Number 0-100	0-100 National surveys are structured in 4 components: policies, institutions, management tools, and financing. Within each component, there are questions with defined response options giving scores of 0-100. Questions scores are aggregated to the component level, and each component score is equally weighted to give an aggregated indicator score of 0-100.	max	**Indicator 6.5.1**. Available on: UN-Water 2012: Status Reports on IWRM. Internet site : http://www.unwater.org/publications/s tatus-report-on-integrated-water-resourcesmanagement/en/ Available on: http://www.unepdhi.org/rioplus20 GEMI – Integrated Monitoring of Wate	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
The proposal	The intervention policy	Proposal based on the field experience	Planning stage	Giving the community a voice at consultation tables with government agencies and developers	Social subsystem	**Promoting participatory justice actions**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Training, outreach and active involvement	– Mapping the social and environmental vulnerability of the site – Drafting the gentrification census status agenda	**13.1.1** Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population
							ENVIRONMENTAL GOVERNANCE	Construction of expert knowledge and environmental awareness	– Calendar of discussion between the parties to inform the population of the risks and shared strategies (Integrated approach to risk management) – Consumer flooding Education courses training – Agenda of the winning best practices implemented	**4.7.1.** Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
The proposal	The intervention policy	Proposal based on the field experience	Planning stage	Identify a holistic approach to be established between the government (for allocation of funds), the mayor, environmental regulatory agencies, and the community in order to raise the coastline (given the existing orography) instead of extending it to safeguard existing marine life	Cultural subsystem	**Promoting participatory justice actions**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Good governance and territorial cooperation processes	– Mapping of local associations active in the area – Political agenda of agreements and discussions between different relevant bodies according to the holistic and participatory approach	**17.6.1**. Number of science and/or technology cooperation agreements and programs between countries, by type of cooperation

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Population at flood risk resident in medium flood hazard zones (Return period 100-200 years; D. Lgs. 49/2010)	%	Percentage of the population residing in areas with average hydraulic hazard (return time 100-200 years pursuant to Legislative Decree 49/2010). For examples the population considered is that of the 2011 Census. The indicator is calculated on the basis of the ISPRA National Mosaic of the hydraulic hazard areas bounded by the District Basin Authorities, with reference to the P2 risk scenario (return time between 100-200 years).	min	**Indicator 13.1.1**. Available on: https://www.istat.it/storage/SDGs/SDG_13_Italy.pdf ISTAT Available on: https://www.istat.it/it/benessere-e-sostenibilit%C3%AO/obiettivi-di- sviluppo-sostenibile/gli-indicatori-istat	↑	↓	/	/
Number of citizens educated for sustainable development in a nation	%	Percentage of number of citizens educated for sustainable development in a nation / Total citizens number (in elaboration by UNESCO w IEA Evaluation of Educational Achievement)	max	**Indicator 4.7.1.** Available on: https://www.istat.it/it/benessere-e-sostenibilit%C3%A0/obiettivi-di-sviluppo-sostenibile/gli-indicatori- istat	↑	↓	/	/
Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge-sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism	%	Percentage of number of science and/or technology cooperation agreements and programs between countries, by type of cooperation with different actors/ closed government agreements (in elaboration by UNESCO and USA Government)	max	**Indicator 17.6.1**. Available on: https://www.istat.it/it/benessere-e-sostenibilit%C3%A0/obiettivi-di- sviluppo-sostenibile/gli-indicatori- istat	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
						Protect coastal flora and fauna by promoting coastal extension	**REGENERATION AND MANAGEMENT**	Management and protection of pre-existing flora and fauna along the coastline	– Agenda of existing flora and fauna – Protecting water quality	**15.7.1** Checks done in application of the CITES Take urgent action to end poaching and afflicting of protected species of flora and fauna and address both demand and supply of illegal wildlife products
The proposal	The intervention policy	Proposal based on the field experience	Planning stage	Aim for conscious planning of the redesign of the new coastal horizon with respect to exerting impacts on direct community activities	Design subsystem	**Promoting participatory justice actions**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Integrated management and planning of technology investments	– Programming of control actions, response, and assistance – Scheduling of Retrofitting Buildings for flood risk and comprehensive strategies panels for protection of buildings, infrastructure, shoreline and environment – Scheduling of investments on defensive technologies and own assumed future profit	**17.7.1** Total amount of funding for developing countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies
The proposal	The intervention strategy	Proposal based on the field experience	Planning stage	Protect what remains of the historic coastal heritage to protect the cultural identity of the place and the community	Cultural subsystem	**Protecting the identity of coastal historical heritage**	**ECONOMIC DEVELOPMENT AND SETTLEMENT PROTECTION**	Integrated management and planning of historical and environmental protection interventions	– Scheduling of soil mechanical transformations. Programming of technological intervention actions. – Programming of the Environmental Department of the District and environmental guidelines. – Programming of the Waterfront Alliance	**14.a.1** Proportion of total research budget allocated to research in the field of marine technology (IOC-UNESCO (Partnering Agencies: UNEP)

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
The indicator represents the number and the results of the checks carried out by the CITES Operating Groups (NOC) of the Italian State Forestry Corps (CFS, currently Forest-Environment-Agrifood Protection Unit of the Carabinieri) in order to verify compliance with the Washington Convention on international trade in endangered species of wild fauna and flora (CITES)	Yes	Presence of number and the results of the checks carried out by the CITIES on Proportion of traded wildlife that was poached or illicitly trafficked	max	**Indicator 15.7.1** Available on: Database Yearbook of Environmental Data - ISPRA (PSN:APA-00032) ISPRA processing of CFS (Corpo Forestale dello Stato) and CUTFAA (Comando Unità Tutela Forestale Ambientale Agroalimentare) data from the Carabinieri Corps.	↑	↓	/	/
Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favorable terms, including on concessional and preferential terms, as mutually agreed	%	Percentage of number of funding for technologies/ total funding for environmental question (in elaboration by UNEP-CTCN (Partnering Agencies: OECD)	max	**indicator 17.7.1** Available on: https://unstats.un.org/sdgs/files/meta data-compilation/Metadata-Goal-17.pdf	↑	↓	/	/
Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular, small island developing States and least developed countries	%	Percentage of total research budget allocated to research in the field of marine technology/ total research budget for environmental problems (in elaboration by IOC-UNESCO - UNEP)	max	**Indicator 14.a.1** Available on: https://unstats.un.org/sdgs/files/meta data-compilation/Metadata-Goal-14.pdf	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
						Protecting the cultural identity of the community	**REGENERATION AND MANAGEMENT**	Physical and symbolic culture advocacy agenda	– Mapping of orographic of the site (coast and river) – Mapping of the historical heritage – Mapping of existing flora and fauna on the site	**DER** the dynamic erosion risk indicator at each World Heritage site, averaged across the Mediterranean region.
The proposal	The intervention strategy	Selection of best strategies to build new ones	Planning stage	Elevate the soil of the coast by inserting new paths planned to actively engage the social sphere	Design subsystem	**Promote coastal elevation modelling actions** **Design pedestrian paths for the community as promenades and aggregation points**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Programming of solution technology processes Training, awareness and active involvement	– Calendar of discussion meetings between the community and designers – Agenda of winning projects implemented to address the same environmental climate problem. – Agenda of active solutions and steps that can be assumed and combined in the future – Agenda of human-monitored, integrated and/or semi-automated technology solutions	**CRI-MED** The Coastal Risk Index applied to assess risk related to climate variability and change at the regional scale in the Mediterranean area
				Incorporate free activities through recreational equipment located in green spaces enhanced by participatory events	Social subsystem	**Promote free and accessible green facilities** **Promote events that increase the active engagement of the population**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Programming a social plan	– Analysis of the population's perception of the site – Analysis of preferences on intervention choices by local people – Schedule of discussion meetings between the community and planners – Mapping of active associations in the area – Scheduling of neighbourhood/ commemorative events – Analysis of demanding preferences expressed by the community – Agenda of the Gentrification Census Status Agenda of district expropriation techniques	**6.b.1.** Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Proportion between the distance from the coastline (in m/year) and mean erosion risk index (index/year)	%	Percentage of distance from the coastline (in m/year) and mean erosion risk index (index/year)	min	**(DER) the dynamic erosion risk indicator** Available on: https://www.researchgate.net/publica tion/328316768_Mediterranean_UNE SCO_World_Heritage_at_risk_from_ coastal_flooding_and_erosion_due_t o_sea-level_rise	↑	↑	☒	**GOVERNANCE AND PHYSICAL TRANSFORMATION**
The indicator is composed of three sub-indexes: Coastal Forcing, characterizing the variables related to climate hazards (storms, drought, sea-level rise) and non-climate forcing (population growth, tourist arrivals); Coastal Vulnerability, integrating the resilience variables (age of population, level of education) and coastal susceptibility variables (landform, elevation); Coastal Exposure, describing coastal targets potentially at risk, the exposure (land cover, population density).	CRI≥0.55	The index of sub-indexes should be under 0.55 value	min	**CRI-MED indicator** Available on: https://planbleu.org/sites/default/files /publications/multi- scale_coastal_risk_index.pdf	↑	↓	/	/
The percentage of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management (PLAP)	%	Percentage of the number who participate on 100 stock of people	max	**Indicator 6.b.1.** Available on: https://unstats.un.org/wiki/display/SD GeHandbook/Indicator+6.b.1	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
				Develop a multiple rezoning strategy to allow developers to build in height rather than extension in the nearshore	Technological subsystem	**Promoting multiple rezoning actions** **Promote settlement development in height with location set back from the waterfront**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Integrated management and investment planning for coastal transformation	– Schedule for the disbursement of public/ private funds for the intervention – Schedule of regulatory controls for land management – Scheduling of profit assumptions for protection interventions – Analysis of investments and site properties Mapping the increase in housing costs of a subject area	**14.2.1**. Proportion of national exclusive economic zones managed using ecosystem-based approaches
							ECONOMIC DEVELOPMENT AND SETTLEMENT PROTECTION	Integrated management and investment planning for the transformation of the population	– Population income mapping – Insurance premium schedule – Relocation incentive planning	**13.1.3.** Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national strategies

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and taking action for their regeneration in order to achieve healthy and productive oceans. For example: (a) National ICZM guidelines and enabling legislation adopted; (b) Number of existing national and local coastal and marine plans incorporating climate change adaptation; (c) % national adaptation plans in place; (d) Fisheries measures in place (by-catch limits, area-based closures, recovery plans, capacity reduction measures); (e) Trends in critical habitat extent and condition; (f) Population pressure/urbanization: Length of coastal modification and kmq of coastal reclamation.	Number	Percentage of number of countries using ecosystem-based approaches to managing marine areas	max	**Indicator 14.2.1**. Available on: https://unstats.un.org/sdgs/tierIII-indicators/files/Tier3-14-02-01.pdf	↑	↓	/	/
Strengthen resilience and adaptive capacity climate-related hazards and natural disasters in all countries	%	Percentage of the local government which implement disaster risk reduction strategies for population/ total local government facing disaster risk	max	**Indicator 13.1.3.** Available on: https://w3.unece.org/SDG/Indicator?id=60	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
The proposal	The intervention strategy	Selection of best strategies to build new ones	Planning stag	Increase coordination and communication capacity between land proprietary agencies (in this case for example New York City and New York State) and coastal water agencies (in this case for example Federal Government)	Economic subsystem	**Promote scaling between jurisdictions in phases of conflict (in this case for example NYC and NYS for land and the federal government for water)**	**ENVIRONMENTAL GOVERNANCE**	Interdisciplinary programming and coordination among departments	– Agenda of the District Environmental Department – Agenda of the Parks Department	**11.7.1**. Incidence of urban green areas on urbanized area of the cities
							REGENERATION AND MANAGEMENT		– Coastal Department Agenda – Coastal Resilience Program agenda – Policy agenda of agreements between the various relevant agencies	**14.c.1.** Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in the United Nation Convention on the Law of the Sea, for the conservation and sustainable use of the oceans and their resources

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
the indicator is the ratio between urban green areas and urbanized areas of cities	%	The indicator is calculated by adding all the "urban green areas" to the urbanized surface. "Urban green areas" are considered green areas managed by public bodies and accessible to citizens, located in the municipal area of the provincial capitals (excluding protected natural areas, wooded areas and uncultivated green areas), and "urbanized cities" the surfaces of the localities classified as "center", "nucleus" or "productive locality" by the Census of the population (2011). Urban green areas include: a) Historic green area (pursuant to Legislative Decree no. 42/2004 and subsequent amendments); b) Large urban parks; c) Equipped green areas and urban furniture; d) School gardens; e) Urban gardens; f) Outdoor sports areas; g) Areas intended for urban forestation; h) Zoological gardens, cemeteries and other types of urban green areas	max	**Indicator 11.7.1**. Available on: https://www.istat.it/storage/SDGs/SDG_11_Italy.pdf	↑	↑	☒	**GOVERNANCE AND PHYSICAL TRANSFORMATION**
Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want"	%	Percentage of number of country affected by flooding which accept ocean policy/ all country affected by flooding (in elaboration UNESCO and USA Governament)	max	**Indicator 14.c.1.** Available on: https://unstats.un.org/sdgs/files/meta data-compilation/Metadata-Goal-14.pdf	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
							ECONOMIC DEVELOPMENT AND SETTLEMENT PROTECTION		– Programming Zoning Laws	**11.3.1.** Ratio of land consumption rate to population growth rate
	Negatives arising from the implementation of intervention	Feasibility analysis of the project	Programming stage	Increased loss of symbolic elements in which the community recognizes itself	Environmental subsystem	**Regenerate the symbolic environmental and natural elements** **Protect the identity value of the port community**	**ENVIRONMENTAL GOVERNANCE**	Integrated management and planning of environmental interventions	– Agenda of guidelines for the preservation of historic port sites – Scheduling of limits to spatial transformation of the port area and neighborhood/commemorative events – Mapping of existing orography, flora and fauna at the site – Agenda of the District's Environmental Guidelines and Department - Planning of the Coastal Resilience Program	**11.a.1.** Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
This indicator conveys the number of countries that have ratified the ILO Maritime Labour Convention of 2006. ILO conventions are legally binding international treaties drawn up by the ILO's constituents (governments, employers and workers) and setting out basic principles and rights at work. The ILO Maritime Labour Convention (MLC) is a single, coherent instrument embodying as far as possible all up-to-date standards of existing international maritime labour conventions and recommendations, as well as the fundamental principles to be found in other international labour conventions. (working by UN DOALOS, FAO, UNEP, ILO, other UN-Oceans agencies)	%	Percentage of soil sealing from artificial land cover per capita	max	**Indicator 11.3.1.** Available on: https://unstats.un.org/sdgs/metadata?Text=&Goal=11&Target=11.b	↑	↓	/	/
Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning	%	Percentage of number of countries that have national urban policies or regional developments plans that (a) respond to population dynamics, (b) ensure balanced territorial development, (c) increase local fiscal space	max	**Indicator 11.a.1.** Available on: https://unstats.un.org/sdgs/metadata?Text=&Goal=11&Target=11.b	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
The proposal	Negatives arising from the implementation of intervention	Feasibility analysis of the project	Programming stage	Increased risk of distorting the historical image of the place by widening the coastline	Cultural subsystem	**Protecting the morphology of the coast**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Planning and coordination of the 2050 urban plan	– Agenda of the gentrification census status – Mapping of active communities on the site – Agenda of guidelines for the preservation of historic sites	**15.3.1.** Soil sealing from artificial land cover
						Protect the historical image of the place		Training, outreach and active involvement	– Schedule of discussion meetings between the community and planners – Analysis of demand preferences expressed by the community	**11.4.1.** Strengthen efforts to protect and safeguard the world's cultural and natural heritage
				Increased incompatibility between the technological intervention and the pre-existing environmental system	Technological subsystem	**Promoting the integration between the intervention and the pre-existing environmental system**	**ENVIRONMENTAL GOVERNANCE**	Scheduling of Technology and Environment Integration interventions	– Programming of technological intervention actions. – Planning for the zoning law – Environmental guidelines agenda – Coastal Department programming – Programming of the coastal resilience program	**17.14.1.** Number of countries with mechanisms in place to enhance policy coherence of sustainable development

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
By 2030, combat desertification, regenerate degraded land and soil, including land affected, drought and floods, and strive to achieve a land degradation-neutral world	%	Percentage of proportion of land that is degraded over total land area	min	**Indicator 15.3.1.** Available on: https://www.istat.it/storage/SDGs/SDG_15_Italy.pdf	↑	↓	/	/
Total expenditure per capita on the preservation, protection and conservation of all cultural and natural heritage, by source of funding (public, private), type of heritage (cultural, natural) and level of government (national, regional, and local/municipal)	%	Percentage of total expenditure per capita on the preservation, protection and conservation of all cultural and natural heritage, by source of funding (public, private), type of heritage (cultural, natural) and level of government (national, regional, and local/municipal)	max	**Indicator 11.4.1.** Available on: https://www.istat.it/storage/SDGs/SDG_11_Italy.pdf	↑	↑	☒	**TRANSFORMATION OF SOCIAL AND ECONOMIC CONTEXTS**
Enhance policy coherence for sustainable development	%	Percentage of countries with mechanisms in place to enhance policy coherence of sustainable development / total country affected by environmental problem (in elaboration by UNESCO and USA Government)	max	**Indicator 17.14.1.** Available on: https://www.istat.it/storage/SDGs/SDG_17_Italy.pdf	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
				Excessive scale of intervention planning and related danger that developers will increase land costs by forcing the community to be unable to regenerate their buildings to the imposed protective measures	Social subsystem	**Promote targeted intervention on the territory** **Promote operations to curb private investment** **Promote financing actions for the adaptation of buildings to the new protective measures**	**RISK AND DAMAGE MANAGEMENT**	Integrated management and investment planning	– Programming strategic panels for the protection of buildings, infrastructure, coastline, environment – Programming district awards and grants – Scheduling of funds allocated for response and regeneration from environmental damage – Scheduling of discussion calendars to inform the public of risks and shared strategies said (integrated approach to risk management) – Scheduling of disbursement of public/private funds for response – Scheduling of regulatory controls for land management – Schedule of costs of projects implemented by call for proposals (private investment index)	**12.6.1.** Public Institutions that adopt forms of social and/or environmental reporting
The proposal	Programming of funding	Funding related to cost/time/technology	Programming stage	Aim to manage public and private funds for economic support of maintenance plans based on investment and safeguard forecasts	Technological subsystem	**Activate public-private partnership for maintenance plans**	**REGENERATION AND MANAGEMENT**	Integrated Management and Maintenance Agenda	– Agenda of funds and maintenance cycles – Agenda of the costs of projects to be carried out by announcement – Agenda of investments in defensive technologies	**ECLG** The country has mechanisms to ensure co-ordination across levels of government

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle	%	Percentage of Public Institutions that have adopted forms of social and/or environmental reporting on total public Institutions	max	**Indicator 12.6.1.** Available on: https://www.istat.it/storage/SDGs/SDG_12_Italy.pdf	↑	↓	/	/
Effective collaboration with actors at all levels of government is critical to develop integrated, coordinated strategies that make the best use of the resources available	%	Percentage of number of all strategies that make best use of technological and environmental resources/ total strategies adopted	max	**(ECLG) The country has mechanisms to ensure co-ordination across levels of government indicator** Available on: file:///C:/Users/franc/Downloads/6f1f6065-en.pdf OECD regional development working papers 2018/02, indicators for resilient cities, I. Figueiredo, T. Honiden, A. Schuman	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
						Drafting investment and human safeguard forecasts	**RISK AND DAMAGE MANAGEMENT**	Programming of insurance funds	– Programming Insurance Research – Programming of funding provided for response and regenerate from losses	**1.2.1.** Proportion of total government spending on essential services (education, health and social protection)
				Use public funds ($1.4 billion) for the construction of the coast site by taking advantage of the redevelopment of the previous park in terms of elevation	Social subsystem	**Activate public funding for altimetric coastal modelling through the active participation the association**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Monitoring and management of population welfare levels	– Schedule of discussion meetings between the parties to inform the population of the risks and shared strategies (integrated approach to risk management) – Management of activities resulting from site redevelopment	**11.5.1.** Deaths and missing persons for landslides
							ENVIRONMENTAL GOVERNANCE	Programming associations for coastal soil modeling	– Agenda of soil modeling types – Programming of interventions for elevation modification – Programming of interventions for coastal extension - Mapping of active local associations for land transformation	**A 69** Number of voluntary non-profit organizations, including NGOs, political sporting or social organizations, registered or with premises in the city, per 10 000 population

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Level of investment in essential services that can provide education, health and social protection to residents, to fight the risks of poor health, homelessness, inadequate housing, unemployment, poverty and social isolation	%	Percentage of level of investment in essential services that can provide education, health and social protection to residents, to fight the risks of poor health, homelessness, inadequate housing, unemployment, poverty and social isolation / total level of investment in essential services	max	**Indicator 1.2.1.** Available on: file:///C:/Users/franc/Downloads/6f1f 6065-en.pdf OECD regional development working papers 2018/02, indicators for resilient cities, , I. Figueiredo, T. Honiden, A. Schuman	↑	↑	☒	**GOVERNANCE AND INVESTIMENTS**
Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	%	Percentage of number of deaths, missing persons and directly affected persons attributed to disasters / 100,000 population bitten by damages	min	**Indicator 11.5.1.** Available on: https://unstats.un.org/sdgs/files/meta data-compilation/Metadata-Goal-11.pdf	↑	↓	/	/
Defined as the number of voluntary non-profit organizations, including NGOs, political sporting or social organizations, registered or with premises in the city, per 10 000 population.	%	Percentage of number of associations per 10.000 population	max	**Indicator A 69** Available on: http://80.120.147.2/GAIA/Reports/ind ics.html	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
				Use federal, state, and municipal funds because of collateral costs for roads, materials, and supervening technological complexity	Design subsystem	**Activate inter-institutional funding path** **Activate collateral cost containment strategies of the intervention temporary disruption of roads, the materials and the eventual technological complexity)**	**ECONOMIC DEVELOPMENT AND SETTLEMENT PROTECTION**	Integrated management and planning of coastal interventions	– Programming of investment in mitigation technologies – Programming of state investment in coastal defence – Programming awards and district funds for coastal defence – Programming of the operation and maintenance phases of projects – Programming of economic practices adopted in the winning projects already implemented – Scheduling of insurance premiums for damage from climatic events	**17.17.1**. Amount in United States dollars committed to public-private partnerships for infrastructure
The proposal	Programming of funding	Funding related to cost/time/technology	Programming stage	Use public funds allocated for a waterfront with recreational uses so that it can be accessible to all walks of life	Cultural subsystem	**Activate public funding for new land use** **Promote land use with recreational functions** **Promote social accessibility**	**ECONOMIC DEVELOPMENT AND SETTLEMENT PROTECTION**	Social site mixity management	– Site demographic mapping – Housing mapping of the site – Mapping the financial level of the site – Planning review of zoning laws – Mapping the increase in housing costs of a subject area – Mapping the income of the population – Gentrification census status agenda – Programming subsidy investments	**11.3.2** Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships	Number	Amount in United States dollars committed to public-private partnerships for infrastructure	max	**Indicator 17.17.1**. Available on: https://www.istat.it/storage/SDGs/SDG_17_Italy.pdf	↑	↑	☒	**GOVERNANCE AND INVESTIME NTS**
By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	%	Percentage of cities with a direct participation structure of civil society in urban planning / management that operate regularly and democratically	max	**Indicator 11.3.2** Available on: https://www.istat.it/storage/SDGs/SDG_11_Italy.pdf	↑	↑	☒	**GOVERNANCE AND TRANSFORMATION OF SOCIAL AND ECONOMIC CONTEXTS**

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
				Use public-private funds to establish governance of operation and maintenance as well as investment and construction aimed at balancing and protecting the coast and people through the sale of property rights	Economic subsystem	**Activate public-private financing partnerships to establish governance of construction, use, operation and maintenance**	**RISK AND DAMAGE MANAGEMENT**	Integrated damage and investment management	– Award agenda and district funds – Mapping public funding – Mapping the rising cost of housing in a phenomenon-prone area – Selection of experts for site drainage	**9.5.1.** Investment in R&D on total investment fixed and stock of capital (PSN:IST-00683)
						Activate public-private partnerships to acquire land rights	**RISK AND DAMAGE MANAGEMENT**		– Guidelines for the construction of flood management systems – Coastal Department programming – Coastal resilience program agenda – Waterfront Alliance agenda – Mapping of damages to the health of citizens	**IAD** Insurance against disasters
				Use public funds to address the shared risk produced by climate change by targeting the preservation of shared life and providing opportunities for all actors to relocate	Environmental subsystem	**Activating public funding to safeguard human life** **Activate public funding to address the shared risk produced by climate change** **Activate public funding to give all stakeholders an equal chance to move**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Planning and coordination of human safeguard	– Scheduling of discussion tables between community and planners – Training of national incident management assistance teams – Scheduling of distribution of emergency supplies – Scheduling of housing assistance – Scheduling of public assistance – Scheduling of disaster recovery centre training – Coordination of emergency vehicles (mobile emergency response support) – Social vulnerability mapping of the site	**IER** Level of investment in emergency response

Descriptio of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending	%	Percentage of R&D expenditure on GDP	max	**Indicator 9.5.1.** Available on: https://www.istat.it/storage/SDGs/SDG_09_Italy.pdf	↑	↓	/	/
Buildings with insurance cover for high-risk hazards relevant to the city	%	Percentage of buildings with insurance cover for high-risk hazards relevant to the city	max	**(IAD) Insurance against disasters indicator** Available on: UN- Habitat, 2022	↑	↓	/	/
Municipal budget spent in fire, in flood, police and emergency services	%	Percentage between municipal budget spent in fire, in flood, police and emergency services / total municipal budget emergency services	max	**(IER) Level of investment in emergency response indicator** Available on: Cutter, Ash and Emrich, 2014	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
	Intervention technologies	Selection of cutting-edge technology	Planning stage	Passive technology solutions such as the wall and active ones such as water-activated barriers and slats should both work at same time	Economic subsystem	**Promote the simultaneous operation of active and passive technologies** **Promote passive technologies as barriers and walls** **Promote active technologies such as artificial intelligence**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Agenda and coordination of profitable solutions	– Agenda of defensive technologies – Agenda of global intervention strategies – Agenda of winning projects implemented to address the same problem – Mapping of passive and active solutions – Mapping of conceivable solutions in the future	**IIM** Investment in mitigation
The proposal	Intervention technologies	Selection of cutting-edge technology	Planning stage	Intervention technology is the combination of the setback of the settlement system and the construction of breakwaters/ protection walls	Environmental subsystem	**Promote the construction of breakwaters** **Promote actions to set back the settlement system**	**ENVIRONMENTAL GOVERNANCE**	Planning and coordination of coastal transformation actions	– Schedule of meetings for discussion between the parties – Programming of zoning laws – Programming of new land uses – Scheduling of comprehensive intervention strategies – Agenda of technological solutions – Agenda of intervention actions for the site – Programming of investments for defensive systems	**LNP** Land-use plans that have been developed with reference to local hazard risk assessment and that have been subjected to a formal consultation process

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Ten-year average per capita budget for mitigation projects	%	Percentage of Ten-year average per capita budget for mitigation projects	max	**(IIM) Investment in mitigation Indicator** Available on: Cutter, Ash and Emrich, 2014	↑	↓	/	/
Risk-based, inclusive and participatory urban planning is central to an effective resilience-building strategy. Land- use plans include: master plan, hazard mitigation plan and emergency response plan. Formal consultation process involves high-risk minority population groups and technical experts.	%	Percentage of number of land use plans/ local hazard risk assessment	max	**(LNP) Land-use plans that have been developed with reference to local hazard risk assessment and that have been subjected to a formal consultation process** Available on: Arup, 2015	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
				Intervention technology deals with filling the riverbed by excluding walls at the mouths of the harbour and aggressive pumping systems	Cultural subsystem	**Promote non-invasive technologies** **Promote visually not impactful technologies** **Promote mechanical actions to fill the river**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Scheduling of controlled coastal modeling interventions	– Orographic mapping of the site (coast and river) – Mapping of existing flora and fauna on the site – Planning of soil transformations – Programming of technological intervention actions – Programming of the resulting income activities – Programming of the waterfront alliance	**IPLE** Innovation takes place to lead the economy
				Intervention technology is constantly evolving and monitoring when needed by human control due to both lack of cost and maintenance funds feasibility	Design subsystem	**Promote the use of semi-automatic technologies** **Promote the construction and use of technologies for cost containment and feasibility**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Integrated management and agenda of technology integration interventions	– Agenda of winning projects implemented to address the same problem – Agenda of human monitoring technology solutions – Agenda of conceivable future solutions – Agenda of integrated and/or semiautomated technologies – Agenda of the costs of projects realized by call for proposals	**17.18.1** Statistical capacity indicator for Sustainable Development Goal monitoring

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
An environment that supports local business development and innovation provides greater livelihood opportunities for its population and is less reliant on external economic influence	%	Percentage of number of new businesses registered within the city in the past year/ per 100 000 population	max	**(IPLE) INNOVATION TAKE PLACE TO LEAD ECONOMY Indicator** Available on: Case Western Reserve University, 2018	↑	↓	/	/
By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts	%	Percentage of Sustainable Development Goal monitoring/ sustainable development goal prefixed	max	**Indicator 17.18.1**. Available on: https://www.istat.it/storage/SDGs/SDG_17_Italy.pdf	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
				Intervention technology should be represented by draught pump mechanisms and urban parks bearing with people relocation strategies	Social subsystem	**Promote drainage pumps as defence technologies** **Promote the planning of urban parks as buffer areas** **Activate strategies for studied relocation of people**	**REGENERATION AND MANAGEMENT**	Public awareness and mobilization	– Analysis of demand preferences expressed by the community – Analysis of site investments and properties – Mapping the increase in housing costs of an area subjected to the phenomenon – Mapping the income of the population – Agenda of district expropriation techniques – Agenda of insurance premiums – Agenda of relocation incentives	**RHE** Retrofitting or designing houses exposed a level of natural hazard
							REGENERATION AND MANAGEMENT	Surface management of coastal areas	– Mapping of pumping strategies – Review of zoning laws – Parks department agenda – Coastal resilience planning	**CAL** Change in Coastal areas lost

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Retrofitting or designing houses that can properly withstand the expected level of hazard exposure is a prevention measure that makes infrastructure more robust	%	Percentage of housing units exposed to a high level of hazard that has been designed or retrofitted to withstand the force of the hazard	max	**(RHE) Retrofitting or designing houses' exposure to a level of natural hazard Indicator** Available on: OECD regional development working papers 2018/02, indicators for resilient cities, , I. Figueiredo, T. Honiden, A. Schuman	↑	↑	☒	**GOVERNANCE AND TRANSFORMATION OF SOCIAL AND ECONOMIC CONTEXTS**
The indicator measures the percentage of change in Coastal areas lost	%	Percentage of change in Coastal areas lost/ total coastal areas	min	**(CAL) Percentage of change in Coastal areas lost Indicator** Available: http://earthtrends.wri.org/searchable _db/index.php?theme=1	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
Future vision	Integration level	Design project of the intervention	Design stage	Integration is based on rezoning policies related to community needs (not investors) to the goal of avoiding gentrification with bottom-up approaches	Social subsystem	**Activate rezoning operations based on community needs** **Promote bottom-up planning**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Scheduling of rezoning operations based on approaches to protect the resident community	– Social vulnerability mapping of the site – Discussion calendars to inform the population of risks and shared strategies (integrated approach to risk management) – Training of consumer education courses – Review of zoning laws – Planning of land uses – Mapping of active site associations – Analysis of the population's perception of the site – Analysis of the population's preferences for action – Programming of district awards and grants – Programming of costs of projects implemented by call for proposals	**CNC** Citizens' networks in communities are active
				Integration determined by the adaptive capacity that develops downstream of a climate event through the financing capacity of the hydraulic machine in terms of building, operation, maintenance	Environmental subsystem	**Promote actions of adaptive capacity to climate events** **Promote plans to finance the hydraulic machine in construction, operation and maintenance**	**REGENERATION AND MANAGEMENT**	Integrated management and investment planning for the selection, implementation, operation and maintenance of the hydraulic machine	– Government investment planning – Government investment programming – Programming of district awards and funds – Scheduling of management phases – Scheduling of maintenance cycles – Scheduling of discussion meetings between the parties – Mapping of funding provided for response and recovery from damage – Guidelines for building flood management systems	**ESN** Expected sheltering needs

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Training increases awareness and preparedness. It can be extensively carried out in schools, hospitals and the workplace	%	Percentage of population that has received training on first-aid and emergency response skills in past two years	max	**(CNC) Citizens' networks in communities are active indicator** Available on: OECD regional development working papers 2018/02, indicators for resilient cities, I. Figueiredo, T. Honiden, A. Schuman	↑	↑	☒	**GOVERNANCE AND TRANSFORMATION OF SOCIAL AND ECONOMIC CONTEXTS**
Safe hazard shelter vs. expected public demand	%	Percentage of population that could be served by city's access to stock of emergency shelter for 72 hours	max	**(ESN) Expected sheltering needs indicator** Available on: Arup, 2015	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
				Integration depends on the solution choice (in the case examples 20% soil modeling to cover the highway serving as a gap)	Design subsystem	**Activate planning according to the defensive technology choice**	**ENVIRONMENTAL GOVERNANCE**	Construction of an environmental site transformation model	– Agenda of global intervention strategies – Agenda of technologies of implemented winning projects – Agenda of FDR guidelines (highways)	**HA24** Land development controls
						Activate a modelling strategy for infrastructure	**TECHNOLOGICAL INNOVATION AND INVESTMENT**		– Agenda of interventions for elevation modification – Orographic mapping of the site	**E** Ecology green area surfaces
							REGENERATION AND MANAGEMENT		– Agenda of intervention solutions for the site – Agenda of soil modelling types	**SUD** Sustainable urban development (Wetlands function as flood buffers)
Future vision	Integration level	Design project of the intervention	Design stage	Integration can be associated with the choice of technological solution, which, if modified in accordance with the needs of the community, can be financed by public funds and private investors	Economic subsystem	**Activate technologies shaped by community needs, available public funds, and developer goals**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Training, raising public awareness of the climate event	– Mapping fragile territories prone to flooding – Mapping of extreme climate events that have occurred – Mapping of climate prediction scenarios for the examined area – Mapping of tidal level, sea rise and flood days – Mapping of temperature and peak days – Mapping of flood and drought days – Mapping water capacity of reservoirs and sewer infrastructure – Discretization of flooding patterns	**ANA** Awareness and alert Training increases awareness and preparedness

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Defined as a composite of questions on land use and building code regulations	%	Percentage of land use/ building covered surface	min	**Indicator HA24** Available: OECD regional development working papers 2018/02, indicators for resilient cities, , I. Figueiredo, T. Honiden, A. Schuman	↑	↑	☒	**INNOVATION AND INVESTIMENTS**
Permeable surfaces reduce the risk of floods, which destroy buildings and infrastructure. Green areas increase quality of life and well-being (sports, leisure and stress relief)	%	Percentage of Green area (hectares) per 100 000 population (ISO 37120) or average percentage of pervious surfaces	max	**(E) Ecology indicator** Available on: OECD regional development working papers 2018/02, indicators for resilient cities, , I. Figueiredo, T. Honiden, A. Schuman	↑	↑	☒	**GOVERNANCE AND INVESTIMENTS**
Flooding is the most frequent among all natural disasters, and its impacts in cities are especially harsh	%	Percentage of wetland loss	min	**(SUD) Sustainable urban development indicator** Available on: Jha, Bloch and Lamond, 2012	↑	↓	/	/
Percentage of school children educated in disaster risk reduction	%	Percentage of school children educated in disaster risk reduction/ total children educated in a district	max	**(ANA) Awareness and alert Training increases awareness and preparedness indicator** Available on: UNISDR, 2008	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
							RISK AND DAMAGE MANAGEMENT	Training, raising public awareness of the climate event	– Training of national incident management assistance teams – Coordination of emergency vehicles (mobile emergency response support) – Selection of experts for site drainage – Scheduling of public assistance – Scheduling of disaster recovery centers – Scheduling of event preparedness courses for the public	**LEG** Local emergency groups organize residents and volunteers to prepare for and react to shocks and disasters

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
They contribute to higher local mobilization and civic engagement. They have greater communication capacity among residents, which further contributes to raising awareness and preparedness levels.	%	Percentage of neighborhoods with emergency groups (e.g. local Red Cross groups, voluntary firefighting associations, etc.)	max	**(LEG) Local emergency groups organise residents andvolunteers to prepare for and react to shocks and disasters indicator** Available on: USAID	↑	↓	/	/

Appendix I

Indicators for constructing thresholds of integration
Indicators of tactical logic

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
State of the art	Type of vulnerability of the site	The analysis of site affection	Knowledge stage	The most prevalent type of vulnerability is flooding, which will increasingly and intensely affect coastal metropolises	Technological subsystem	**Activating intervention strategies from the most prevalent type of vulnerability in the coastal metropolis (flooding)**	**ENVIRONMENTAL GOVERNANCE**	Expert knowledge construction of preponderant environmental vulnerability	– Mapping fragile territories prone to flooding – Mapping of extreme climate events that have occurred – Mapping of climate prediction scenarios for the examined area – Mapping of tidal level, sea rise and flood days – Mapping of temperature and peak days – Mapping of flood and drought days – Mapping water capacity of reservoirs and sewer infrastructure – Discretization of flooding patterns	**HA15** Permanent rural, contemporary and built heritage housing
					Environmental subsystem	**Activate the strategy of environmental problem based (flooding)**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Construction of intervention processes in response to the climate event	– Programming of the waterfront alliance – Scheduling of agreements among the various cooperating entities – Scheduling of actions in response to the event – Scheduling of actions in response to the damage	**6.5.2.** Proportion of transboundary basin area with an operational arrangement for water cooperation

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Defined as the percentage of rural dwelling units that are likely to last twenty years or more given normal maintenance and repair, taking into account locational and environmental hazards (eg floods, typhoons, mudslides, earthquakes).	%	Percentage of housing units damaged by flooding/ total number of coastal houses of last 20 years	min	**Indicator HA15.** Available on: http://80.120.147.2/GAIA/ Reports/indi cs.html	↑	↓	/	/
Integrated Water Resources Management (IWRM) is an approach to managing water in a coordinated way. It takes into account the different water sources as well as various users and uses in a given situation, with the aim of maximizing positive social, economic and environmental benefits. It uses catchments and aquifers, as the principal unit of water management, and stresses decentralization of governance structures and active stakeholder participation in decision-making	%	Calculated – for any spatial unit (country, region) – as the percentage that the total surface area (in kmq) of transboundary basins that have an operational arrangement for water cooperation makes up of the total surface area of transboundary basins (km2). GIS data on the extent and location of transboundary basins facilitates the spatial analysis, corresponding datasets available globally	max	**Indicator 6.5.2.** Available on: Convention on the Protection and Use of Transboundary Watercourses and International Lakes: a globalizing framework http://www.unece.org/env/water.html Reporting under the Water Convention http://www.unece.org/fileadmin/DAM/ env/documents/2015/WAT/11Nov_171 9_MOP7_Budapest/ECE_MP.WAT_2015_7_reporting_decision_ENG.pdf GEMI – Integrated Global Environment Facility's Transboundary Waters Assessment Project http://www.geftwap.org/ Treaties on transboundary waters	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
	The potential of the site	Empower the site	Knowledge stage	Potentiality depends on strategic economic investment location that could increase the political power of the site and protect the community	Economic subsystem	**Protect the resident community** **Enhance the strategic economic position of the site** **Promote political empowerment actions related to the site**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Construction of an economic development plan and environmental and social protection of the site	– Mapping social vulnerabilities in the area – Community assistance allocation agenda – Agenda of insurance premiums for damage from climate events – Mapping of damages on the health of citizens – Mapping of increased housing costs of an area subjected to the phenomenon – Mapping of funding provided for response and regeneration from damages – Coastal investment agenda – Agenda of average property values – Agenda of investments in industries – Agenda of investments in site infrastructure	**6.a.1.** Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan
State of the art	The potential of the site	Empower of the site	Knowledge stage	The high potential depends on the possibility of using existing land	Design subsystem	**Promote existing land use** **Activate regeneration and redevelopment operations**	**REGENERATION AND MANAGEMENT**	Coordination of coastal regeneration operations and redevelopment of the existing coastal park	– Orographic mapping of the site (coast and river) – Mapping of projects implemented by announcement – Programming of the parks department – Programming of the coastal department – Programming of the coastal resilience program	**6.6.1.** Change in the extent of target elements of water-related ecosystems over time

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
A government-coordinated spending plan is defined as a financing for the water and sanitation sector, assessing the available sources of finance and strategies for future needs "International cooperation and capacity-building support" implies aid in the form of grants or loans by external support agencies. The amount of water and sanitation-related Official Development Assistance (ODA) can be used as a proxy for this, captured by the Creditor Reporting System (CRS) of the Organisation for Economic Cooperation and Development (OECD)	%	Percentage of the amount of water and sanitation related Official Development Assistance a government receives, and the total amount budgeted for water and sanitation in a government coordinated spending plan	max	**Indicator 6.a.1.** Available on: Transboundary Freshwater Dispute Database (TFDD) at Oregon State University http://www.transboundarywaters.orst.edu/publications/atlas/index.html River Basin Organisations http://www.transboundarywaters.orst.edu/research/RBO/index.html	↑	↑	☒	**GOVERNANCE AND TRANSFORMATION OF SOCIAL AND ECONOMIC CONTEXTS**
Definitions of target elements: – Protect implies a reduction or eradication in loss or degradation. – Restore implies a reversal of loss or degradation. – Mountains, Forests, Wetlands, Rivers, Aquifers and Lakes include ecosystems that provide freshwater-related ecosystem services. – Wetlands are further defined under the Ramsar Convention as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water. The Ramsar Convention broad definition of "wetland" is used, which includes rivers and lakes, enabling three of the biome types mentioned in the target to be assessed - wetlands, rivers, lakes - plus other wetland types.	%	Percentage of change in water-related ecosystems over time (% change/year). The indicator would track changes over time in the extent of wetlands, forests and drylands, and in the minimum flows of rivers, volumes of freshwater in lakes and dams, and the groundwater table	min	**Indicator 6.6.1.** Available on: Monitoring of Water and Sanitation-related SDG Targets. http://www.unwater.org/gemi/en/	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
State of the art	The potential of the site	Empower of the site	Knowledge stage	The high potential depends on the strategic location and cultural identity value (in this case of Sea Port City and Bronk Avenue)	Social subsystem	**To protect the cultural identity value of the site** **Enhance the strategic location of the site**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Coordination of coastal protection operations for the environmental and historical value clothed in the collective memory of the resident community	– Programming guidelines to the preservation of historic sites – Scheduling of limits to land transformation – Schedule of discussion meetings between the community and planners – Analysis of demand preferences expressed by the community – Scheduling of neighborhood/ commemorative events – Scheduling of new land uses	**14.5.1.** Coverage of protected areas in relation to marine areas
State of the art	The urgency which with to intervene	The analysis of emergency of the site	Knowledge stage	Behaviour in urgency requires immediate action being the site one of the main entry points of flooding in territory	Environmental subsystem	**Activate immediate response strategy to the phenomenon**	**RISK AND DAMAGE MANAGEMET**	Expert knowledge construction of risk and damage management	– Training of national incident management assistance teams – Coordination of emergency vehicles (mobile emergency response support) – Scheduling distribution of emergency supplies – Scheduling of housing assistance	**13.1.2.** Number of deaths, missing persons and persons affected by disaster per 100,000 people

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
By 2020, conserve at least 10% of coastal and marine areas, consistent with national and international law and based on the best available scientific information. Protected areas, as defined by the International Union for Conservation of Nature (IUCN), are clearly defined geographical spaces, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values. Importantly, a variety of specific management objectives are recognized within this definition, spanning conservation, restoration, and sustainable use: Category Ia: Strict nature reserve Category Ib: Wilderness area Category II: National park Category III: Natural monument or feature Category IV: Habitat/species management area Category V: Protected landscape/ seascape Category VI: Protected area with sustainable use of natural resources	%	The percentage of marine sites contributing significantly to the global persistence of biodiversity. The indicator is computed by dividing the total number of KBAs wholly covered by protected areas by the total number of KBAs in each country, and multiplying by 100. “Wholly protected” is defined as >98% coverage to allow for resolution and digitization errors in the underlying spatial datasets	max	**Indicator 14.5.1.** Available on: They are disseminated through the Protected Planet knowledge product http://www.protectedplanet.net/, which is jointly managed by UNEP-WCMC and IUCN and its World Commission on Protected Areas (WCPA). TITTENSOR, D. et al. (2014). A mid-term analysis of progress towards international biodiversity targets. Science 346: 241–244. Available on: http://www.sciencemag.org/ content/ 346/6206/241.short. UNEP-WCMC (2015). World Database on Protected Areas User Manual 1.0. UNEP-WCMC, Cambridge, UK. Available on: http://wcmc.io/WDPA_Manua	↑	↑	☒	**TRANSFORMATION OF SOCIAL AND PHYSICAL CONTEXTS**
From the perspective of data availability and measurability, it is proposed to build a composite indicator which consists of “directly affected”, or those who are: – Injured or ill (the number of people suffering from physical injuries, trauma or cases of disease requiring) – Evacuated – Relocated and to measure the number who suffered direct damage to their livelihoods or assets – People whose houses were damaged or destroyed – People who received food relief aid	%	Percentage of summation of data on related indicators from national disaster loss databases. Make the sum a relative figure by using global population data (World Bank or UN Statistics information). Relativity is important because population growth (expected to be 9 billion in 2050) may translate into increased hazard exposure of population	min	**Indicator 13.1.2.** Available on: Sendai Framework for Disaster Risk Reduction 2015-2030: (http://www.preventionweb.net/files/4 3291_ sendaiframeworkfordrren.pdf)	↑	↑	☒	**GOVERNANCE AND TRANSFORMATION OF SOCIAL AND PHYSICAL CONTEXTS**

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
						Activate strategies aimed at studying the inflow of waves	**ENVIRONMENTAL GOVERNANCE**	Construction of an environmental monitoring database	– Disaster recovery center agenda – Meteorological monitoring of water levels – Implementation of the flooding map	**13.3.1.** Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula
				Behaviour in urgency requires the active involvement of the community, which could thereby defend cultural but not social identity	Social subsystem	**Promote community involvement** **Activate actions that protect cultural identity** **Activate actions for the social regeneration of the site**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Creating a cohesive community aware of its identity	– Mapping of social vulnerabilities in the area – Schedule of meetings for discussion between the parties – Planning of the zoning law – Programming of intervention guidelines for the protection of coastal identity heritage – Preservation of historic urban features (representative streets or buildings) – Programming commemorative or representative events of local culture – Gentrification status agenda – Agenda for private investment on the site	**13.1.1.** Number of countries with national and local disaster risk reduction strategies
State of the art	The most affected area of the site	The criticality of the area	Knowledge stage	One of the hardest hit areas is the project site (Manhattan and the South Bronx)	Technological subsystem	**Activate a technological solution starting from the vulnerable affected area**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Construction and testing of localized technologies	– Mapping of fragile territories prone to flooding – Scheduling of climate panels – Analysis of tidal and flood levels	**13.3.2.** Number of countries that have communicated the strengthening of institutional, systemic and individual capacity- building to implement adaptation, mitigation and technology transfer, and development actions

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula	%	Percentage of number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula /Total world country	max	**Indicator 13.3.1.** Available on: https://unstats.un.org/sdgs/iaeg- sdgs/metadata-compilation/	↑	↑	☒	**GOVERNANCE AND INVESTMENTS**
Unplanned urban development (e.g. informal settlements, overcrowding, inadequate infrastructures) exacerbates vulnerability to climate change impacts and hydro-meteorological and geological hazards. Over half of all coastal areas are urbanized and 21 of the world's 33 mega cities lie in coastal flood zones. Undermining natural protective barriers combined with rapid population growth and inadequate capacity to adapt. Several dimensions of poverty are closely related to environment, which is often affected by natural disasters. Better management of natural resources can themselves strengthen the resilience of the poor, by both reducing the natural hazard and offering resources	%	Percentage of summation of data from National Progress Report of the Sendai Monitor/ Disaster of year country	max	**Indicator 13.1.1.** Available on: National Progress Report of the Sendai Monitor, reported to UNISDR Sendai Framework for Disaster Risk Reduction 2015-2030: (http://www.preventionweb.net/files/4 3291_ sendaiframeworkfordrren.pdf)	↑	↓	/	/
Number of countries that have communicated the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions	%	Percentage of number of countries that have communicated the strengthening of institutional, systemic and individual capacity- building to implement adaptation, mitigation and technology transfer, and development actions /Total world country	max	**Indicator 13.3.2.** Available on: https://unstats.un.org/sdgs/iaeg- sdgs/metadata-compilation/	↓	↑	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
							TECHNOLOGICAL INNOVATION AND INVESTMENT	Coordination of investments for the testing of flood defensive technologies	– Innovative technology solutions agenda – Investment agenda to cope with the phenomenon	**9.5.2.** Researchers (in full-time equivalent) per million inhabitants
					Environmental subsystem	**Activating the local based intervention strategy**	**ENVIRONMENTAL GOVERNANCE**	Coordination of geo-referenced flood defence operations	– Mapping fragile areas prone to flooding – Mapping of extreme climate events that have occurred – Mapping of climate prediction scenarios for the examined area – Mapping of tidal level and inundation days for the site – Mapping of the water capacity of the site's reservoirs and sewage infrastructure – Schedule of the types of flooding at the site – Waterfront alliance schedule for the site – Agenda of winning projects implemented to address the same problem	**15.3.1.** Proportion of land that is degraded over total land area
Future vision	The management and maintenance of the site	The possible failures	Management stage	Control management depends on the use of funds calibrated not on investment in the short term but in the care of operation in the long term	Social subsystem	**Activate strategies for managing the financing of the intervention over the long term**	**ENVIRONMENTAL GOVERNANCE**	Coordinating the disbursement of funds arranged to deal with the environmental emergency	– Maintenance fund schedule – Maintenance cycle scheduling – Guidelines for the design and construction of flood management systems – Programming insurance research	**13.a.1.** Mobilized amount of United States dollars for climate action technologies per year starting in 2020 accountable towards the $100 billion commitment

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Research who studied technological solution to face the climate change mitigation and adaption solution	%	Percentage of number Researchers (in full-time equivalent) per million inhabitants	max	**Indicator 9.5.2.** Available on: https://unstats. un.org/sdgs/files/met adata-compilation/Metadata-Goal-9.pdf	↑	↓	/	/
This is relevant indicator of the functioning of the system, its adaptive capacity and resilience to perturbations (e.g., floods, drought), and thus its capacity to provide ecosystem services in a sustainable manner over the long term. This indicator is defined as the amount of land area that is degraded	%	Percentage of the spatial extent (hectares or sq. km) expressed as the proportion (percentage) of land that is degraded over total land area	min	**Indicator 15.3.1.** Available on: Sendai Framework for Disaster Risk Reduction 2015-2030: Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020. Sendai Framework for Disaster Risk Reduction 2015-2030: (http://www.preventionweb. net/files/4 3291_ sendaiframeworkfordrren.pdf)	↓	↑	/	/
Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible	%	Percentage of mobilized amount for climate action technologies/ total mobilized amount	max	**Indicator 13.a.1.** Available on: https://unstats. un.org/sdgs/iaeg- sdgs/ metadata-compilation/	↑	↓	/	/

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
Future vision	The management and maintenance of the site	The possible failures	Management stage	Control management depends on the use of funds calibrated not on investment in the short term but in the care of operation in the long term	Social subsystem	**Activate strategies for managing the financing of the intervention over the long term**	**ENVIRONMENTAL GOVERNANCE**	Construction of flood defence infrastructure investment plan	– Infrastructure Investment Agenda – Guidelines for the design and construction of flood management systems	**9.a.1.** Total official international support (official development assistance plus other official flows) to infrastructure
				Control management depends on the level of community education in the care and management of the hydraulic machine	Design subsystem	**Promote training courses for community employment in park management and maintenance**	**PARTICIPATION, COHESION AND SOCIAL IDENTITY**	Training, awareness and active involvement of the population in the management phases	– Scheduling of maintenance cycles – Scheduling of creative activity management contracts – Agenda of guidelines for the management of flood control systems	**13.b.1.** Number of least developed countries and small island developing States that are receiving specialized support, and amount of support, including finance, technology and capacity-building, for mechanisms for raising capacities for effective climate change-related planning and management, including focusing on women, youth, local and marginalized communities

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Total official international support (official development assistance plus other official flows) to infrastructure	Number	Total net official development assistance (ODA) to economic infrastructure (purpose code 200). Data expressed in US dollars at the average annual exchange rate	max	**Indicator 9.a.1.** Available on: OECD, 2014 Official Support for Private Sector Participation in Developing Country Infrastructure	↓	↑	/	/
Rationale and interpretation: As the effects of climate change are becoming more evident and acute, the need for effective climate services is greater than ever before. Climate services underpin climate action and achieving SDGs. Nevertheless, the GFCS High level Task Force had identified 70 countries that do not yet have sufficient capacities to develop and use climate services. This is a major focus of the GFCS and local and marginalized communities	%	Percentage of data for global and regional monitoring: – Number of LDCs receiving support for raising capacities of LDCs for effective climate change planning and management – Project information (focus country, timeframe, objectives, description, benefits, activities, deliverables, sectors, partners etc.)	max	**Indicator 13.b.1.** Available on: http://www.wmo.int/gfcs/ http://www.wmo.int/gfcs/ projects- map http://library. wmo.int/pmb_ged/wmo _1065_en.pdf	↑	↑	☒	**GOVERNANCEAND TRANSFORMAT ION OF SOCIAL CONTEXTS**

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
Future vision	The expectation of the intervention	Design project of intervention	Management stage	The forecast over time of the project includes a promenade with different heights and walkways to form new landscapes	Design subsystem	**Promote the creation of new landscapes** **Promote modeling operations for walks at different heights**	**REGENERATION AND MANAGEMENT**	Construction of a waterfront transformation plan for the creation of a new coastal landscape	– Plan programming of 2050 mitigation – Programming flood hazard amphibious structures – Coastal department agenda – Waterfront alliance agenda – Waterfront zoning mapping – Agenda of soil modelling types – Schedule of interventions for elevation modification – Programming of interventions for shoreline extension – Mapping of site flood levels	**12.b.1.** Number of sustainable tourism strategies or policies and implemented action plans with agreed monitoring and evaluation tools
Future vision	The expectation of the intervention	Design project of intervention	Management stage	Forecasting in project time could work if the discrepancy between what is proposed to win federal funds and what is really achievable ceases	Social subsystem	**Promote a feasibility plan (from economic goals to technological realities)**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Building an integrated management model for investment in technology solutions	– Land transformation planning – Environmental guidelines agenda – Programming of the coastal resilience program – Programming of investments – Scheduling of revenues and benefits of vulnerable site protection	**11.5.2.** Direct disaster economic loss in relation to global GDP, including disaster damage to critical infrastructure and disruption of basic services

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products	%	Percentage of the framework for measuring tourism exists (International Recommendations for Tourism Statistics 2022) as well as the framework for environmental- economic accounts (System of Environmental Economic Accounts 2022), but a linking of the two is required	max	**Indicator 12.b.1.** Available on: System of Environmental Economic Accounts 2012 (SEEA 2012) Tourism Satellite Account: Recommended Methodological Framework (TSA: RMF 2008) https://unstats.un.org/sdgs/files/met adata-compilation/Metadata-Goal- 12.pdf	↑	↑	☒	**GOVERNANCE, TECHNOLOGY AND TRANSFORMAT ION OF PHYSICAL CONTEXTS**
Direct loss is nearly equivalent to physical damage. The monetary value of total or partial destruction of physical assets existing in the affected area. Examples include loss to physical assets such as damaged housings, factories and infrastructure. Direct losses usually happen during the event or within the first few hours after the event and are often assessed soon after the event to estimate regeneration cost and claim insurance payments. These are tangible and relatively easy to measure. Direct Economic loss in this indicator framework consists of agriculture loss, damage to industrial and commercial facilities, damage to housings and critical infrastructures	%	Percentage of number of direct disaster relation to basic service and infrastructure. The original national disaster loss databases usually register physical damage value (housing unit loss, infrastructure loss etc.). Need conversion from physical value to monetary value according to the UNISDR methodology. After converted, divide global direct economic loss by global GDP (inflation adjusted, constant USD) calculated from World Bank Development Indicators.	min	**Indicator 11.5.2.** Available on: National disaster loss database, reported to UNISDR https://unstats.un.org/sdgs/files/met adata-compilation/Metadata-Goal- 12.pdf	↑	↑	☒	**TECHNOLOGY AND INVESTMENT**

Macro-question	Question	Macro-issue	Issue	Macro-objective	Subsystem	Objective	Macro-criteria	Criteria	Actions	Name of indicator
				Prediction in project time could work if there is significant investment in the pushed technologies	Cultural subsystem	**Promote investment in innovative technologies**	**TECHNOLOGICAL INNOVATION AND INVESTMENT**	Building the range of cutting-edge technology solutions	– Agenda of winning projects implemented to address the same problem – Mapping of technological solutions – Agenda of the costs of projects implemented by call for proposals	**9.b.1.** Proportion of medium and high-tech industry value added in total value added

Description of indicator	Unit of measure of the indicator	How to calculate the indicator	Indicator direction	Source	Priority of decision makers	Preference of community	Relevant impact	Incidence
Classification of industry by technological intensity is based in R&D intake in manufacturing output. Higher the share of R&D expenditure higher the level of technological intensity. MHT sectors are classified at 3-digit level of ISIC.	%	Percentage of the sum of the value added of MHT to the total value added of manufacturing. Rationale and interpretation This indicator captures the innovation and technology endowment in manufacturing. It reveals the level of production technology in manufacturing of an economy, which makes it highly policy relevant indicator	max	**Indicator 9.b.1.** Available on: Data are available from the annual industrial survey. INDSTAT database of UNIDO contains time series data for more than 170 countries. https://unstats.un.org/sdgs/files/met adata-compilation/Metadata-Goal- 9.pdf	↑	↓	/	/

Appendix II

The interviews with decision makers

The transcribed responses are a selection of all those used for the research process described in the book. The selection is based on the most interesting questions discussed through the lens of Architectural Technology. The responses were obtained from videotaped interviews or from e-mail exchanges authorized by the interviewees, who agreed to make their statements for and in support of this specific research. Other purposes are not permitted and will be punished if they occur without the prior consent of all parties and the authors.

Professor of Geography, Hunter College, City University of NY
Director of the CUNY Institute for Sustainable Cities (CISC)
Member of the Earth and Environmental Sciences Program at CUNY Graduate Center

What are the biggest vulnerabilities of the New York City ecosystem? How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

The most vulnerable natural system would be the beaches, right, as I understand it for Manhattan itself, we have lost I think 90% of the lowest areas close to the water. The wetlands, if you will, or the people that call them that, there is one small piece that's left up in Northern Manhattan and that's probably going to go (away) pretty soon too, due to both sea level rise as well as degradation. Therefore, if you talk about the natural system, I think those are very, very vulnerable, particularly to sea level rise. What is this problem and how do we address it immediately, well, people are talking about many things. (For example) bringing back the blue belt and this-and-that. I think those are great ideas, particularly along the Lower East Side area, I have seen models and they look great. That could certainly help to address these issues; I am not quite sure whether it is feasible or not and we will talk about that later.

What are the greatest resources and what are the biggest obstacles of the proposals that have been made?

I think the fact that it is close to the water. It has the East River right there and it looks out into the lower bay; I think those are incredible resources. They do have some parks along the water, some sorts of natural areas, but it is very limited, most of it is built up. Not all that land, particularly on the Lower East Side, was originally part of Manhattan. In addition, as you very well know if you read the book Manhattan it is in there. Therefore, there is not a lot of 'nature' down there that has been altered by people. The biggest obstacle to coastal protection would be development and land ownership and private proprieties. You know, even when you look at administration, as you very well know, they wanted to model its whole program after the idea of sustainability and had all of these sustainability plans, but this administration was very much a promoter of land development. In addition, when you spoke to his group and the office of sustainability, they would always say to us, we are not really considering nature conservation because land is the most important commodity that we have and we need to develop it. Its motto, even after Sandy, is 'built back'. Build back, and that is promoted by academics here too, as well as in other places. Whether that is the right strategy, we will have to see because if we have another storm again and it is going be another tragedy, et cetera, and, as you know, we are still suffering from the effects of Sandy. You know, the L-line, the underground trains, the tunnels to New Jersey, they still need to be fixed, and we still have not done it. It takes a long time so those are important vulnerabilities. This gets into the next question in terms of feasibility. How are we going to stop the land development along the shore? It is very difficult. I think people want housing along the shore. Two types of houses are in demand. They want to buy houses along the shore or apartments at very high levels where you have these huge buildings. Now you can wake up and look out the window and it is almost as if you are higher than a helicopter; with these helicopter views and this is what has been promoted at the high end, the luxury end. Then on the other, high-luxury end are those on the water so you can wake up and look at the seashore and you can look at Brooklyn. If you are in Brooklyn, you can look at Manhattan. They are in incredibly high demand. What this means is that there is a lot of risk for developers, but there are also a lot of rewards. Therefore, they want to do that, they are hoping for the reward by building in those areas and then gaining and reaping the profits.

Of the proposals that have been made, which do you think are most feasible? Which will likely to most effective?

I think they are two different things. I do not really know all the proposals, but I know that big berms have been proposed and I like that very much. I think, and I do not know it very well, but if they would retreat a little from the shore, I think they would probably be better off. You know, to create a berm and then to retreat a little bit so that those properties would not be at risk or as vulnerable. Would they be less at risk or vulnerable or whether that is feasible is an open question. Moreover, I don't know of a lot of the other proposals. I guess that people will opt for the wall or the berm. Potentially even something like they did in London to put out in the bay, and as they did in Italy, in Venice, to put something out in the bay to prevent the water from coming in. I think that might be an option although it is incredibly expensive for us to do. I think probably what will happen we will build a wall, and the people behind it will be much more protected than others outside the wall. As you probably know that in planning there are always winners and losers. It is usually the meek, it is usually the politically disenfranchised that end up on the short end of the stick (losers).

What is missing in the resolution of the flooding problem? What are the actions that should be carried out? What are the actions that should be avoided? To what extent is 'technology' (e.g., pumping stations, movable barriers) a solution? Are there any good non-technological solutions?

In terms of technology, I am in the middle. I do not like big Geo-Engineering Projects, but I think technology has to be part of the solution. There are going to be many aspects of the solution, and certainly, technology is a part of that. However, I think the big questions are what are we going to give up? It depends on how you define the trade-offs, some might say, for example, let the water come in and out, but you will need to give up something, these real front private proprieties. Now on the other hand, if you build the wall, you are going to have to give up the ability to work with nature. In addition, rather make things more resistant as opposed to resilient to those things. It might be more effective on one hand, but then again, it is going to be a big wall, so there are all of these trade-offs. I probably would place myself somewhere in the middle, only because I know it should be a combination of things, a little bit of giving up, a little bit of wall, et cetera; so that nobody is happy so (because) those types of solutions are never picked. The take on the transition, because we are talking about transitions, they happen over long periods. Therefore, if you look at history, and you look at all the environmental changes that have occurred and how all of the people have responded to environmental changes, they have taken a very long time. In addition, they have had terrible effects; many times before people have responded, in this country. For example, if you look at New York City's history, early on, New York City in the 1700s, and late eighteenth century, New York City was not a very nice place, growing rapidly after the revolutionary war and it had privatized water system. People got sick every year, terribly sick, you had yellow fever and cholera coming in later on, and nothing happened. This is like decades and decades, it took like 40 years of constant (issues), fires, and environmental problems, and finally the city had to do something. From 1790 to 1830, 40 years, almost every summer, you had a disease. People were leaving the city and no work was being done before someone finally said we have to do something. They privatized the water system, they socialize the water system, and they brought water into the city, clean water, as well as water for fighting fires and all this other stuff. However, it took 40 years of that. Here we have these tragedies, we have Sandy, they are not every year and I guess that this is going to have to happen many times, before this culture, this society, reacts. If you base your evidence, base your knowledge on what happened in the past then that is how I see it. The other thing, the other part of the problem that is going to make these changes is a shared risk; so if you are a wealthy person and I am a poor person, we share the same risk, but that does not happen much anymore. If this risk is here, I will just buy something else and move somewhere else, so that I do not have to act. I think we are seeing the play out in our government, in the USA at the federal level because we are not sharing the same risk. Anyway, those are some of the things that are important if you start to talk about some of these issues.

What do you think of the new design strategies for New York City? Which are the key factors to design a good waterfront? Who are the key actors in bringing about a solution?

Certainly, talking about the actors, I think, there is no doubt that everybody has to be involved. What that means is that there are actors that are part, use and own the waterfront, and government actors, all have to be involved. The problem is when you do that, it takes a long time because nobody agrees on anything; this is part of democracy. This is the sloppiness of it. That is not the best mood for organizing, but it is probably the best of the worst. That is probably who I would say the actors have to be, (even) with all of the misgivings of that. Design strategy, as I mentioned, there should be a combination, I think, because this stuff is going to happen over the long run. We should plan over the long run. I know that is difficult but it is like planning for the non-fossil fuel society, we not just going to jump into renewables, that is just not going to happen. Therefore, you have to plan for that; that has to be the long-term goal, but there have to be intermediate goals all along the way. So what I would suggest, just like that, take a page out of RBG's (Ruth Bader Ginsburg) book, she's a very very famous woman in the US, she sits on the Supreme Court and she's a fighter for women rights, and during the 70's she was very instrumental in changing law, to help women gain more rights; their standing in front of the court. What she said, is that you cannot do all one time, you have to do it incrementally, one piece at a time. She was strategic and very, very successful. Therefore, that is what we have to do in these terms, to teach it as well as carefully with a long-term goal in mind, and the long-term goal, I would say, is retreat. The projections that I see, it is going to get bad because of climate change. If you believe what the models say will happen, and I believe them, as best as we can, this is our best guess about what's going to happen in the future is many many thing are going to be problematic in the future; sea level rise only one part of it. You have to imagine that with the sea level rise again, stronger typhoons you going to get, heat, real heat, some of the model outputs that I have been dealing with, it's scary when you see them.

Every time we build something, something else is destroyed. In creating these new strategies, what do you think can be lost?

I know there is a strong group in our society that is for preservation, and as you know, Columbia has a big preservation group. It is important to preserve certain things and I think that society has to decide what they want to preserve. Maybe we do not want to preserve all the statues, you probably know, we had this big debate about which statues we want to pull down and which we want to keep. Some of the things should be kept. There are things that help give a place meaning, and help give that neighborhood coherence. Which ones should be kept, I do not know, that is a social decision that has to be made. But I'm definitely for keeping some and you have to lose some, you also have to bring in new things, otherwise everything looks like Venice.

What do you think is most likely to happen in the next 10 years?

The next ten years is like the short-run. I think it would depend on many things, if we do have another Sandy-type event, which was a once in 500-year event, it depends what we see in the next event. But we will see more events like Sandy. In fact Sandy is such a big event, I do not think we would see another in the next 10 years. We might see some more hurricanes, all the same, strong events that happened last year, if we start to see this (activity) a lot, people will take notice and say, 'okay, even the rich will share the risk and we have to do something'. I do not foresee that like immediate change, I think we will start to see (eventually) people say this, and also, what is going on at the national level, and how that affects us. That is also a really important driver though New York tends to be much more, I don't want to use this term, much more liberal than the national government. There is a sense here that we do think that climate change is happening and that we want to start to address it. Although again, the biggest lobby in the New York City is real estate, they are very, very powerful and they are not going to give up easily.

Which are the best strategies to mitigate the vulnerabilities? What can be the threshold of integration between the existing settlement system and the proposed technologies solutions?

What does vulnerability mean? Vulnerability has several different components: one of them is the shock of it, obviously, there is going to be the storm surge and the sea level rise, how often that comes, that is part of vulnerability. The other thing is how much is exposed, how many people are exposed, how much infrastructure is exposed. The third element is the sensitivity; is the population there sensitive to those types of shocks? Is the infrastructure sensitive? As we have known, our infrastructure was very sensitive like you had all those tunnels and all that water got in there, and you had the subways; it's incredibly sensitive to being flooded and now we are working our way into preventing or to decrease that kind of sensitivity. In addition, the final component, which is very important, is called the adaptive capacity. The adaptive capacity is both 'how do we forestall future events'; when we see something coming 'how do we prepare for that' as well as when it comes and hits us 'how do we respond'. What we need to do is act on all of those fronts, we want to decrease expose, decrease sensitivity, because I don't know if we are going to be able to decrease the shock event and we want to increase our adaptive capacity. Which is both governmental, social, economic, and all of those things. As you know, for example, early warning systems, when something happens, was very good at, closing things down so people really prepared for it. Not as good at that, when close things down and do not have the storm, it is a problem. It is one example of that, the other thing is that after the event comes, we have to be ready. How do we deal with this, how do we cope with it, how to protect people and other stuff like that. As you probably know, there are these incredible, heroic stories during Sandy when Hospitals were closing down you had people coming into the city to help, moving patients out. Much of that was informal but it should be more formalized for when we start to see these kinds of things, we can act and react very quickly. In our society, in the USA, it is very difficult to do that because it is so de-centered; people do not like to have centralized plans.

How do the technological solutions affect the territory, both in terms of tangible impact and on the city dynamics?

Certainly, and if they wanted to, they could build out so it is more resistant, with walls and pull-out platform; that kind of thing. Maybe the first couple of floors will be empty, so that the water could come in and out. There are other solutions too, and I think that potentially that would happen, although that would happen slowly because of there was already built environment down in Lower Manhattan and the Lower East Side. They have already started to move at that stuff because that happened from Sandy; as you probably know they had all of the HVAC (Heating Ventilation Air Conditioning) systems and lots of energy systems were located in the basements and the cellars, and then they got washed out. After the storm, they started to move all that stuff out. Now they have to move it up and they have to find places to put that; that will probably happen more and more. You probably start to see a lot more of that if you do get more of these storms and that is how we will adapt, how we will cope, I am guessing. People will never give up and it will be something like that. In addition, it is probably the best way to go, as I said, it has to be slowly and planned over time. My guess is that we will have to retreat.

Which are the future perspective for the neighborhood? How do you imagine the future of the New York City and what do you think about the Humanhattan?

I think it is very interesting, when I saw that I thought this is really a nice way of combining both nature and built environment and everything else. I think it is very interesting and very clever. It has this berm and part of it has the natural 'U' that is elevated and could protect things but at the same the time was still natural. The thing about these projects, though, is that they look very seductive but when you put them into practice, they may not be that successful. We used to have this idea of the vertical form and how it looked on paper it was all so beautiful and they have drawings where they have skyscrapers and the farms and the cows and the corn and everything else, but we are so far away from building these buildings. Technically, it is not feasible but it was very seductive. So while these types of projects that these architects (draw) inspire us and they are beautiful, we have to be careful, it has to be planned out and it may take a long time. It may not be as beautiful as this in the end, right? And the community has to want to do it. At least in this country because in other places, they have a different type of government system and people have a different cultural background; so yeah, we can do that. The government says 'do this' and we will say 'yes, we'll do it'. I do not believe in an immediate response like that, I think it has to happen over a long period of time. And it probably has to grow organically. Something like that would be a planned project where the government says 'we're going to put this big berm in' and I just do not see that happening here.

President and CEO of Metropolitan Waterfront Alliance

What are the biggest vulnerabilities of the New York City ecosystem? How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

The biggest vulnerabilities is actually probably where we sit right now, much of Lower Manhattan is almost at sea level and was flooded terribly during the Superstorm Sandy. A lot of Manhattan is actually on higher ground but at the lower part as you go on either side of the island, the Lower East Side on the East side and Tribeca on the West Side. So this whole area of Lower Manhattan, below south of Houston Street is very vulnerable. Also 125th Street is a valley, a natural valley right by Columbia University, where they are building a big campus would also be a quiet vulnerable area. There used to be a river that went right through there back before now.

What do you think can be done about the proposal, which has been made? What solutions do you think are the most affective?

Well, the fact that we are having an interview today, on March 14th, just about three or four hours ago the Mayor of New York made a brand new proposal to do a large infill project right where we sit, from the Brooklyn Bridge right down to the Battery, to protect the Financial District (FiDi is the short name for it) and the Seaport District where my office is right now. This will be an interesting sign, it is a dynamic and bold proposal: so this particular section still remains quite vulnerable to storm surge and perhaps the sunny-day flooding as sea level rises more and more. Therefore, something needs to be done; an infill project is a controversial one, the city has not filled in much of its harbor for generations now, since Battery Park City was done. As environmental detriment that some or all people think could be quite harmful to the fish around the harbor.

What are the greatest resources and what are the biggest obstacles of the proposals that have been made? which do you think are most feasible? Which will likely to most effective?

The original BIG proposal to build berms and nice park as you probably know has been jettisoned. And now they are building giants of a park wall. I think pumping stations are a part of it because if the water does breach the walls then it is a technological solution too. And you know another part of climate change is the likelihood of cloudbursts or massive rain events. We have seen already in subsidies, Copenhagen and others, the tremendous detriment in environmental and economic, and even loss of life effect. So I think all of it above is probably a solution like the barriers. I prefer barriers that allow connection to the water that will improve the quality of life in terms of a park. That sort of thing is what was originally envisioned.

In this regard, about the cost of building, what are the vulnerabilities? Can the intervention in these areas involve the risk of damaging the cultural evolution or loss of identity of this place? And about the axiom when we build something, something is lost. What is at risk of being lost in your opinion?

In the Seaport district is sort of one of few historically preserved sections of New York. The Mayor's proposal will have a profound effect; this is where the birth of the ferries came, with Fulton's Ferry and Clermont going back and forth from Brooklyn to New York. This is where the original One World Trade Center was, right across from us is where all the commerce happened. Therefore, the cultural heritage of what this neighbor represents will be change tremendously; so how to preserve same of that and preserve access and connection to the water is what the Seaport is all about. It is a question to be answered by the plans of the mayors before or any of the mayors' plans going forward.

What do you think of the new design strategies for New York City? Which are the key factors to design a good waterfront? Who are the key actors in bringing about a solution?

The new design gets brand new and we are just looking at it as we speak; I think there is a sort of two-tier barrier at the Battery Park. There is Battery Park City, which has its own barrier system that is being built. A deployable barrier is being developed for the north that is proposed for the Two Bridges section and the East Side coastal Resiliency as you go further north to 23rd Street on the East River and the new one down here. I think what is important about all of these is to create design solutions that protect but also do not cut off. Therefore, parks are good at that; piers are good too, so bring them together. And there is who pays for and governs it. So I think you have to pretty forward four different groups of people: people who can design very well and can think creatively and working with the community; people who are going to figure out how to finance it (because where is the money going to come from to build it and maintain it); people who are going to think about how to best govern it; and finally the most important thing is how are we going to communicate best. Break through, people have to understand the urgency of now at this moment that is so important to all of us.

In this regards, do you think to protect the waterfront is a good use of public funds? If not, in your opinion, what would be a better option because New York City will have a large amount of money to be made available to solve this problem?

I guess there is three types of prisms to look through in that area: one is the cataclysm, of course, which we have to be prepare for. The will be more major storms that will be surges. We are a vulnerable city for that; so we have to have defenses for that. Then there is what we call sunny-day flooding. How do we let the water go in and out as the level rises and the tides get higher and higher? There has got to be a rule through that. Then the third one is on the date, you know, when the 99.9% of the days there will not be a storm and we want to enjoy our waterfront. We have a great harbor, we have the greatest harbor probably in the whole world and it is being used for so many things now. People enjoy parks next to water, enjoy kayaking in water, they enjoy transportation in the water, so we're not going to move New York City anytime soon.

In your opinion which are the best strategies to mitigate the flooding vulnerabilities?

I think that the best solutions, you know, after Sandy, one of the places that did best was Brooklyn Bridge Park. It was designed as soft edges, it was designed to let the water in and let the water out. A park is a wonderful solution toward sea level rise. The berms could be done in a park also as a soft edge. There are basically three solutions in New York, to put it bluntly: you could harden the edge with a beautiful berm or with a wall, you can make a soft edge that lets the water in or out and you can also retreat. There are some areas in some neighbors, but I do not think in downtown New York, because this such a vital part of the city for transportation and commerce. However, I do not think this area will be retreating soon. Those are hard questions ad tough choices, you know, expensive and politically expensive. It is going to be hard to tell a neighbor that you cannot be there anymore. Moreover, I think that's a dialogue that has to start.

What do you think is the most likely to happen in the next ten years and how will the mitigation solutions affect the area both in terms of tangible and intangible impacts on the city dynamics?

I am an optimist and I think there will be a new realization that this it is a national problem. This is a global problem everywhere, but here this is a national problem that demands a national solution. I am hopeful that resources to create great change on how cities adapt themselves to the reality of climate change are going to happen. I think it has going to happen for Miami, for New York, for Los Angeles, every place that is on the water; even for other places. Then I think that in ten years we will be having the hard conversation about what to build, where to build and where to retreat.

Director of resilience of Metropolitan Waterfront Alliance

What are the biggest vulnerabilities of the New York City ecosystem?

There are many vulnerabilities for Manhattan and New York City as a whole. There is a risk that we face just to direct loss of life and property. Sort of during big storm surge event, but there is also risk of loss of way of life with thinking about how the regular sea level rise and regular type of flooding that we experience during a sunny day, it is going to change the way that we relate to our coast. So there is environmental considerations of that, there is equity considerations of that in terms of who is and is not able to move or who is going to get some level of resiliency integrated into their neighborhood. So those are all cached under the 'how do we respond' question. There is both an opportunity, a huge challenge and a tremendous cost to how we adapt. However, it is something that has never been more important.

In your opinion which are the best strategies to mitigate the flooding vulnerabilities?

Best strategies come from the collaboration with the communities that live there, whose help us to really developing the waterfront. I think is necessary for an inclusive process. I think that was the original vision of the Lower East Side Coastal Resiliency Project, there would be a sort of community-lead process. Unfortunately, that was not handled to well at the end. That is something that we can learn a lot for how we approach it for the future. The best strategies are going to depend on a different neighborhood, so the strategy for Lower Manhattan is more likely to be a harder approach, you know, raising buildings or putting a district barrier, as we were talking about. The strategy for Broad Channel and Jamaica Bay is probably quite a different one because they are having that regular tidal flooding on their little island. So reducing density in that neighborhood and offering options for people to equitably relocating, should they choose to, I think those are solutions that are being considered in those areas at high risk. In the Lower East Side where you have this real density of population, I think some sort of larger integrative flood plain protection strategy makes sense, which is what we are going towards now. There are many details in there that you could make it greener by having habitat at the edge or on it. Also lead by a community process that is solid.

What could be the new views for the neighborhood? What do you imagine is the future for New York City? What do you think is most likely to happen in the next 10 years?

In the next 10 years is a long term but it may take longer. I know we are supposed to be in construction by 2021 for that project and others. I walk through to Seaport, I think depending on where you are in the Lower East Side, and it is hard to get to there right now so they are already cut off from the water's edge because of the highway that is right there. I think it is going to be hard to see that water because they have planning and zoning laws protecting these views directly down to the water. That is something that I think about a lot after this announcement about this new project, or any project that we need to do in Lower Manhattan. That we have these nice sightlines down to see the Seaport ships and the old docks, and sometime Brooklyn, with boats passing by. I think those things change, depending upon the design that we could be talking about.

About the future project, what do you think about specifically?

There are components of project that are being carried forward in a way. It is a concept iterative process, certain things were thrown out, and certain things were kept. We have to have a big solution where there is a lot of criticality of structure and population and jobs; I think that is what we are reckoning with in Lower Manhattan. I think there are other areas where folks may argue that ‘what about my neighborhood’. Addressing our critical structure in the area is very important but also making sure, we have a plan for addressing other areas and communicating about them. We have one in ten jobs is in Lower Manhattan and all of our train lines come through here so that’s the line that the city is pushing in protecting in the priority way.

Trenure Track Professor of Ocean Engineering of Stevens Institute of Technology, New Jersey

How do you think the flooding problem can be addressed? How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

This first question is the most difficult question of all list. I mean there are many ways this can be addressed: one is through building a barrier across the harbor with gates (just what I am involved in; our research is related to right now), another one is to build barriers on the waterfront, another one is to change zoning (and in certain places that might be the most effective). Nevertheless, I do not think you are going to change the zoning of the South Street Seaport (LES), in Lower Manhattan, which is a 300-year-old neighborhood, and improve the problem. Therefore, zoning could help in some places with the lower population density, like suburban neighborhoods on Staten Island, South Queens or South Brooklyn, but it may not be a good solution for Lower Manhattan with a high level of density. You can retreat and give up, but again that is probably not going to happen for Lower Manhattan. You can advocate for some parts of New York City, but at present, that is not considered a plan for New York City, to have any place being retreated. However, they are changing zoning - right, govern is working with changes to zoning for certain flood hazard zones. Therefore, they are trying zoning on some level. Other ways to address the flooding problem: could be to stop burning fossil fuels that is a part of the flooding problem, but there is already a flooding problem just from natural hurricanes. Therefore, the re-zoning wouldn't solve the problem of a low-lying elevation neighborhood. There is always going to be a risk, but at least you can reduce the acceleration of the sea level rise and it is deterioration into the coming century. That is a way to address the flooding problem in the long-term. With regard to the sea levels rise for New York City, this is a very serious problem because we have a flooding risk without the rise in sea levels and it is very episodic and random when there is a storm. Very few places are being flooded by sea level rise alone. There are a few low-lying neighborhoods built on wetlands, not anywhere on Manhattan, but in other parts of New York City. They are getting flooded multiple times per year and even then, it requires storm surge of a foot or two feet on top of a spring tide, the biggest tides of the month, in order for there to be flooding. New York City is not very low and there is a certain amount of elevation in every neighborhood just to be above normal tide. Whereas New Orleans, for example, is below sea level, so New Orleans has an existential threat more than New York City. New York City has many elevated neighborhoods where maybe 5% of the population is at risk of storm surge but sea level rise will make that worse. Over a 100-year time scale, New York City has a lot of risk from sea level rise and having regular repeated flooding every day or every month. Places like Florida and New Orleans have much more risk.

What do you think can be done? Of the proposals that have been made, which do you think are most feasible? Which will likely be most effective?

One of proposal is to do nothing, I do not think it is a proposal, but it may happen. I doubt it will happen, but it could happen. Another proposal is to just be prepared for storms with moveable barriers. And they're already planning for South Street Seaport where they can put moveable barriers in place, attach them, make them watertight, hopefully, and block a storm surge that will come once every twenty years. Which, I would say, is about the risk for South Street Seaport because there is a high waterfront and then the neighborhood is low behind it. During Sandy, it got over-topped and then the neighborhood filled up with water, catastrophically, for approximately three blocks, but really high-value property. Therefore, it is more like a once in twenty year flood right now to go over that waterfront and that is not a very high frequency right now. With sea level rise it becomes much more of a high frequency. So right now, the city is preparing to have temporary protection measures. You can have sand bags but this is one-step better having temporary walls. Then beyond that, there is the BIG U type plan, Seaport City, or whatever it is going to be called. Where they build massive vertical protection and you have a whole neighborhood out on the water. Those may not succeed. They may not be funded and they are big challenges. However, they are what the city is trying to do and they are what the neighborhood wants, especially property owners. They can cost many billions of dollars and involve building into an estuary, which may not be allowed by law. They might require changes to law. There are big challenges for full protection. During Sandy Battery Park City was very protective and it is also high elevation, unlike South Street Seaport which is 300 years old and compressed and very low that is not a landfill, it was actually open water at one time.

What could be the technological impacts of these innovative solutions? Is there a risk of incompatibility between the technological system and the pre-existing environmental system? What could be the indicators of the inability to adapt the site to the new technology?

There is a risk of incompatibility with building out "Seaport City" (which I will call it even though that's not its name yet). When you build that out into the estuary, you are destroying the estuary or a part of the estuary, so there is definitely an incompatibility there because you are eliminating a part of the estuary. How important that part of the estuary is, is debatable. There is definitely an incompatibility with the existing when you create a landfill; then also that blockage of the East River waterway, where parts of the blockage will accelerate the water with the tide and may move flooding to another place through reflection. There could be a case where you are helping protect one place, but worsening the other by increasing water levels there. It may not occur so sometimes it needs to be studied. Concerning the inability to adapt, one challenge would be to build up a higher neighborhood up by the water then you still have the lower neighborhood behind it so the challenge would be the rainwater.

What is missing in the resolution of the flooding problem? What are the actions that should be carried out? What are the actions that should be avoided? Who are the key actors in bringing about a solution?

Every time you build on the estuary, you destroy the estuary. So there are a lot of possibilities there and definitely you know when you blockage the East River is just to move a flooding in other place as a reflection and in this way you protect a place but destroy another place.

What kind of technological system should be used? What costs would it entail? Would kind of maintenance you like to see? To what extent is 'technology' (e.g., pumping stations, movable barriers) a solution? Are there any good non-technological solutions?

I am not very familiar with the core of maintenance and funding for maintenance. Sometimes in the United States, it is written into law what the future source of maintenance funding would be, but I think it is a real challenge. You can see with construction in the United States, maintenance is a topic that is not planned very well. You think of subway systems and most technologies that have to do with infrastructure are not planned in the United States (which have to be maintained and are costly). Right now New York City and New York State are begging the federal government to help with the AMTRAK tunnels because of their damage from Hurricane Sandy. Therefore, there is this whole fight over maintenance and it is not popular or sexy to fund the maintenance. It is only good to build the new bridge and so it is a problem with politics. The maintenance is not funded, it may be part of a cost-benefit analysis, but that does not have anything to do with actual funding. It is just sort of an evaluation metric. My sense is that maintenance is not funded and it is a real problem.

Another concern I have (with respect to technologies) is that we will build barriers in the water and that can help for 50 years. But then that system would have to be dismantled and no one will have the money to do it and that system will be in place where it will be an inadequate design, leading to worse disasters. That is a problem that I see, such as with Katrina. In New Orleans, that is exactly what happened, the system was not maintained and was not updated properly only until 3000 people died. That disaster could have been avoided if people did not have the sense that there was protection in place that did not really work. Therefore, there is some danger in the long run that you are not really solving this problem.

Every time we build something, something else is destroyed. In creating these new strategies, what do you think can be lost?

Definitely, parts of the East River can be lost, parts of history can be lost or modified, or their value lessened and changes. New York City is always changing and always getting rebuilt. But a neighborhood like South Street Seaport is one of the few places with history. There is a danger of destroying history, neighborhoods (or changing them), definitely a possibility of destroying nature if you build out into the river. In the case of the South Street Seaport, the solution could be to preserve some of the water on the waterfront in exchange for having development; so it would be a patchwork of development and waterfront. That would be one way to preserve that historical nature. The best solution, to me, is to stop causing sea level rise because it is too unsolvable and impossible solution to keep causing it.

How do the technological solutions affect the area, both in terms of tangible and intangible impact on the city dynamics?

The city's dynamics are always changing so it will not be impacted in terms of its functionality. We have a lot of gentrification in the city anyway; whether or not flooding will cause it should not be a problem. I do not think gentrification in these neighborhoods is affected by flooding. In addition, they are not affected by chronic flooding. The community is affected by something like Hurricane Sandy every twenty years, so I do not think that chronic flooding is harming the property values or causing a property value problem that we can solve. I think it changed only where the richness is. Take the Two Bridges for example, right, I don't see why flooding would change that neighborhood to cause gentrification. The South Street Seaport already has all of its gentrification; it is already done. This makes me think that all the technological solutions like building barriers offshore, in the harbor, does become more attractive. Because then you do not need to change the waterfront dramatically. I am not sure about putting all of those barriers in an estuary either. It does show that it is a difficult problem because you cannot just change the waterfront everywhere; I do not like the thought of changing the estuary. However, I have been involved in an ongoing study that shows what the impact of a surge barrier does to the estuary. If they could find the money, where in a design many gates allow flow then in normal conditions lessen the impact on the estuary; if that has proven true, it is a good solution. You can have a small impact on the estuary and no impact on the neighborhoods that is an attractive solution. The one trouble there is that it only blocks storm surge and does not block the sea level rise in the everyday tide; so in 50 years you might still have a problem. That is attractive solution and then you can build a sea wall three feet or five feet high and you do not have to build them ten feet or fifteen feet high. It makes barriers more attractive than technology of offshore protection. Like any bay system, you have an inlet and then all the neighborhoods around. Having all of that inland protection system) in the case of the whole New York Harbor it is still something like $100 Billion. Versus $2 Billion if you install something local, depending on if you put some say around the Verrazzano Narrows or Sandy Hook to Rockaway. It is still very expensive, but makes it more attractive when you think about it that way.

What could be the new views for the neighborhood? How do you imagine the future of the New York City waterfront?

I know about the Rebuild by Design more than the Big U project and I know there are many challenges that were not dealt with such as rainwater and flooding from underneath the city. It is turning out to be dramatically more expensive than what was anticipated by the science and engineering. I think those projects are good attempts at solving this problem but they are not respecting how expensive it will be to protect everyone on the shoreline. In effect, you are just protecting the Lower part of Manhattan, but in this area, you still have 400 miles of coastline with its communities. Therefore, to spend $100 Billion just on Lower Manhattan seems shortsighted. It seems too expensive. There is the area of Wall Street also 50 feet (around the island) in elevation difference; 20 feet in where we are now so there is a huge amount of New York City's industry around. I'm thinking another solution would be to move people and leave these places and have them allow for water and flooding to come and go. If you build a wall then the water comes and sits. To have some neighborhood test it out, some places have done this, to have pathways where water can come and go. I would say you eliminate the berm waterfront all together, just have a dock, let the water come and go, and make the rest a museum of the history. Stop having the area be commerce and stop trying so hard to be dry. Then move where people live because 95% of New York City is higher than 10 feet elevation; move people over the course of decades to high ground. Then have densification of high ground. New York City does not take a solution like that one because they think they have the money to do other solutions and think there is no problem with people staying exactly where they are. My idea for technology would be to create good systems for paying people to move if they own property and create mechanisms for densification on higher lands because the population of the city is a challenge. The challenge is to let the neighborhood change to accommodate the water. So if it is Wall Street the problem then move Wall Street; a lot of it did move to Jersey City when 911 happened. The change happens from decade to decade, we are just resisting causing the change. I think the city just wants everything to be protected and act like there is no forcing, but things move around from decade to decade a lot. Therefore, I think that moving people and changing zoning should be a much heavier weight than it is.

Structural Engineer at Mueser Rutledge Consulting Engineers

How do you think the flooding problem can be addressed? How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

Rising flood levels is a serious concern for New York City. The city is surrounded by water and had a hard edge bulkhead, which has not yet been retrofitted to address the rising sea levels. To address this risk in the short term, deployable flood barriers are considered as a quick and inexpensive way to address the problem without building a permanent barrier. Some of the concepts include, bolted in stanchions and metal panels, which can be installed with a 48-hour advance notice, inflatable barriers and flood doors to address flooding within a hyperlocal perimeter. However, water is incompressible and when stopped at one location, it will spill to the immediate vicinity where it can. In a densely populated metropolis such as New York City, even a small offset will affect tens of thousands of people worse than they would be otherwise. The owners of high value assets have commissioned the deployable flood barriers. The low income communities, which do not have the means to afford such solutions, will be affected by the diversion of flood waters and depend on the public agencies to help protect against such natural disasters. Lower East Side is one such vulnerable pockets of the city where the storm surge from upper harbor collides with the volume of floodwaters funneling in from Long Island sound. Portions of Queens and The Bronx around Hells Gate are vulnerable due to a high tidal range owing to constriction of channel and the Rockaways and south shore of Stan Island which are prone to storm surge first hand. Hurricane Sandy, in 2012, exposed the vulnerability of various neighborhoods to a storm event. Although the return period of a storm event of such magnitude is not immediate, it is a problem that needs urgency in tackling; mainly because a more global and comprehensive planning and policy is required to protect the community as a whole considering the timeline of construction, reconstruction and retrofitting existing structures.

What do you think can be done? Of the proposals that have been made, which do you think are most feasible? Which will likely to most effective?

There are no easy solutions for a densely developed metropolis such as New York and especially in a neighborhood like Lower Manhattan. It is built up to the waterfront; Battery Park City does not have much horizontal offset from the water and the on the east side, FDR Drive offers some horizontal offset. Of the options considered, berms and locally deployable barriers are more practical for the near term and long term. In addition to these, a few other options such as raising the bulkhead elevation, repurposing lower floors of buildings, securing tunnels and utilities against storm surge to recover from a flood event faster and more extensive measures such as burying FDR under raised parkland with berms could create a horizontal and vertical offset required. Construction schedules, impacts on the neighborhoods during construction and financial implications may dictate the options implemented and it could be a combination of permanent features and temporary features with some accommodation to absorb the flooding but improve resiliency.

What could be the technological impacts of these innovative solutions? Is there a risk of incompatibility between the technological system

and the pre-existing environmental system? What could be the indicators of inability to adapt the site to the new technology?

Innovative solutions considered thus far include large deployable barriers to prevent flood risk. Geography and existing population distribution in cities like New York pose severe challenges to implementing such systems. In an effort to protect a few areas considered high value, the adjoining neighborhoods end up being adversely affected by such measures. Some of the disadvantages of innovative solutions are that they are not fiery legible after implementation and not scalable to rising sea levels. Therefore, initial planning should consider all possible scenarios to factor in with design life and this could prove to be very expensive.

What is missing in the resolution of the flooding problem? What are the actions that should be carried? What are the actions that it should be avoided? Who are the key actors in bringing about a solution?

In my opinion, repurposing of existing buildings in Lower Manhattan, for example moving vulnerable systems and occupancies out of the flood plain elevation and special zoning within flood plain will need further consideration. There is no silver bullet that will resolve all flooding issues for all neighborhoods. It may have to be a combination of systems strategically deployed across the region. "One size fits all" solutions need to be avoided.

What do you think of the new design strategies for coastal regeneration? Which are the best strategies to mitigate the vulnerabilities? What can be the threshold of integration between the existing settlement system and the proposed technologies solutions?

Lower East side of Manhattan is in a uniquely vulnerable location due to high probability of water piling up due to confluence of the surges from the Long Island sound and from upper harder. But Lower East Side of Manhattan has the horizontal offset in the form of parkland which can be taken advantage of to create berms to prevent flooding in the adjoining neighborhoods. As the sea level rise continues, adapting and integration will become necessary and inevitable. In addition, landscaping features to absorb some flooding will help improve resiliency. The planning and implementation will need to be staged and in the near term, localized deployable barriers will bridge the gap until the time that permanent solutions are implemented.

What do you think New York City should do considering the large amount of money made available to solve this problem? What do you think is most likely to happen in the next 10 years?

Comprehensive planning and implementation are crucial given the population size and assets at risk. Considering the geography and population distribution and other challenges, the allotted budget will be strained to address all issues. Robust transportation infrastructure, communication systems and well-planned information channels are just as important. Office of Emergency Management has been working on studying various options for the city and has been compiling and disseminating information for the communities in the area so they can be better prepared for storm events. Educating communities in regards to storm preparations, to secure or evacuate and having supporting transportation infrastructure are crucial to absorb, recover and adapt and minimize losses. If the transportation and communication systems improve, it could convince more people to move out of densely populated city zones and reduce the risk from extreme events.

What kind of technological system should be used? What costs would it entail? Would you like what kind of maintenance? To what extent is 'technology' (e.g., pumping stations, movable barriers) a solution? Are there any good non-technological solutions?

Technological solutions such as movable barriers were studied and considering the geography, construction costs and long term maintenance costs to keep the barriers ready to be deployed at any moment and its varying effects on different communities. The solutions will need to be a combination of options that can best suit the local needs. In some areas hard barriers may be necessary and in others berms and soft features such as marshlands, permeable zones and channels to absorb the surge may be economical and work better.

Every time we build something, something else is destroyed. In creating these new strategies, what do you think can be lost?

When we built hard barriers, the risk is the water simply gets diverted to adjoining areas and make flooding worse in those areas. When we build berms, it blocks the views for people living on lower floors and ground transportation networks and utilities need to be rerouted / reconfigured and secured and the community's interaction with the waterfront will be affected.

How do the technological solutions affect the territory, both in terms of tangible impact and on the city dynamics?

Technological solutions need to be implemented in specific locations to be effective. For the New York geography, deployable flood barriers were studied for Long Island sound, Verrazano narrows and Arthur Kill. By preventing water from getting past the barriers, water will be diverted to adjoining neighborhoods and increase the scale of flooding on those areas.

What could be the new views for the neighborhood? How do you imagine the future of the New York City waterfront?

The Humanhattan project, for example, is a good option for Lower Manhattan; especially for Lower East Side where there is sufficient horizontal offset between the waterfront and the residential zone. The properties behind the sand dunes performed much better along the south shore of Long Island during Hurricane Sandy. Communities, especially residents living in the lower floors will lose view of the waterfront once the berms are built.

Structural Engineer at AmerCom Corporation

How do you think the flooding problem can be addressed?

This is such a complex issue because it is such relatively small area or neighborhood with such a huge population. I think it should be addressed from two fronts, the natural or environmental front to research why these more frequent events occur, then from an architectural / engineering front to address how to use science to better protect our infrastructure from flooding.

How serious are the rising sea levels for NYC?

Depending on the sources or viewpoint you believe either very serious or just the natural progression of the ocean. I personally believe with this particular area, quite serious, say 7.5 or 8 out of 10 serious.

What general areas in your opinion are most vulnerable?

All existing topographic areas that are vertically at or below sea level. Maybe even areas up to five feet above sea level.

Is this a problem to be addressed immediately?

Based on the damage from Hurricane Sandy and the frequency with which we are experiencing these events, as soon as possible is prudent.

What do you think can be done to minimize flooding?

I think the waterfront area is so compressed for space, in a sense almost over-utilized, that any solution would have to be so innovative with a purpose to preserve and protect the existing while simultaneously addressing the present and future protection requirements of even more powerful natural storm events. I realize from a design standpoint this may seem to be the impossible, but some outside of the box thinking is required here.

Of the proposals that have been made, which do you think are most feasible?

I think a combination of the introduction of pump systems and underground piping, water diverting barrier systems, active building protective countermeasures in concert with a comprehensive research program into the source of changing climactic conditions contributing to more frequent storm events. This would probably help address the macro issue of storms and the resulting, micro issue of flooding damage to the surrounding properties.

Which will likely be most effective?

The mechanical systems would have the most short-term affect and benefit.

What could be the technological impacts of these innovative solutions?

In conjunction with the mechanical systems, electronic monitoring devices and early warning systems could be installed on the mechanical devices and surrounding area to minimize the impact of surrounding damage and possible loss of life.

Is there a risk of incompatibility between the technological system and the pre-existing environmental system?

In most projects there is a risk of incompatibility. The typical design convention is to demolish and remove or simply abandon in-place a pre-existing system; then either append to the existing or install a new, independent system all together. The area and nature of this particular area is paramount to this philosophy. History has shown us that in the city, existing systems are somewhat layered or have been through time. Therefore, in some cases, the underbelly of the city is illustrative in the sense that if the system is too costly to remove, it may be abandoned. Having said that, this area deals with the waterfront where there may be less existing infrastructure in-place. Therefore, the risk of incompatibility is high.

What could be the indicators of inability to adapt the site to the new technology?

Some indicators of site specific obstacles may include the elevation of the site, environmental constraints or even communal concerns. For example, the site may be below sea levels and require itself, which could eliminate the implementation of a passive technological solution for instance requiring mechanical de-watering techniques. Then there is the possible environmental constraints, which could be overridden by potentially detrimental impacts on marine life and ecosystem. Finally, the community always has their final say, so the location of the site may be sensitive to the community in the sense that they may not like to see walls or pipes or pumps blocking the view of the river.

What is missing in the resolution of the flooding problem?

A comprehensive plan of action.

What are the actions that should be carried out?

Weather events and especially hurricanes are chaos in general. Hurricane Sandy for instance was a massive event, but having said that, during Hurricane Sandy there was chaos for weeks. Especially on the lower tip of Manhattan, there were issues with flooding in the subways to Hoboken and Brooklyn for weeks. Further evidence of the storm surge and it has negative impacts on lower elevation infrastructure. One of the most important lessons learned from that storm from a functional perspective would be to have all critical systems (electric, mechanical and otherwise) moved to higher elevations. The problem with many buildings and the subway system at that time was that all of the control systems were located in the basements or subway and were flooded. They were inoperable, so the properties lost power; the trains could not run, etc. Without electricity to the critical systems you cannot get them up and running when you need to. Therefore, I believe those are being or have been moved to remote locations or higher elevations.

What, if any, are the specific actions that should be avoided?

In my opinion all action taken in flooding prevention is advancement so none.

Who are the key actors in bringing about a solution?

The public officials including the Governor, the Mayor, engineering department officials, community organizers and local property owners.

What do you think of the new design strategies for New York City? Which are the key factors to design a good waterfront? Who are the key actors in bringing about a solution?

I know a few new regulations have been implemented on the East Side as a result of the storm. New building codes have been implemented for flooding prevention. Specifically dealing with foundation design, basement and first floor construction. The existing structures may be difficult to retrofit, but any new construction could be designed with blow-out walls or raising the First Floor elevations, minimizing with the ceiling heights, etc. Positively speaking, in my opinion, the new design regulations are a welcomed result of a nearly catastrophic situation.

Which are the best strategies to mitigate the vulnerabilities?

Some of the strategies should be to relocate control systems off-site, reinforce or retrofit building foundations for additional loading and implement the mechanical flood protection systems.

What can be the threshold of integration between the existing settlement system and the proposed technologies solutions?

When discussing settlement from an Engineering perspective, we limit it to a maximum allowable of 1” (or 2.54 cm). Therefore, I would say any proposed technological solution that will cause settlement of beyond 1” would not qualify as a viable alternative for integration.

What do you think New York City should do considering the large amount of money made available to solve this problem?

The greatest obstacle to large-scale projects is usually the funding source. The funds should first be appropriated through a commissioned study, which generates a preferred proposal in terms of a solution. At that point, the City should apply for Federal aid or contributing funds. And generally speaking, as with all public dollars, the allocated funding should only be spent on a specific solution that meets or exceeds the benefit/cost ratio.

What do you think is most likely to happen in the next 10 years?

Unfortunately we are not a proactive society, we have become more reactive in our nature. The response to a disaster has improved greatly while the implementation of new countermeasures has fallen off. That may be in part because of the news cycle, there is this big event, then the sum comes out, there are people there to help, but then the cameras move to the next news cycle. Unfortunately, we just cast light on the issue but have not addressed the source, so where in this loop. I think regulations will slowly be implemented to address flooding, but I am not too hopeful of any meaningful improvements. That is where you come in.

What kind of technological system should be implemented for flooding prevention?

Currently the City is looking into extending the tip of Manhattan further south into the harbor some 500 ft. I think this is being proposed for further space, land improvement, as well as additional revenue generating source. This should be capitalized upon and a flood prevention system should be built in. Provided the environmental impacts are minimal, I think the system should include a new underground piping network to divert water directly to the harbor south of the city. The system could utilize back-flow prevention gates (or weirs) which would only open in the event the water gets to a certain critical level and prevent back-flow into the system. Breakwaters in the river and water diverters could supplement this new network. Finally, a mechanical backup system with electronic real-time monitoring of the roadway above could help minimize flooding at the street/building level.

What costs would it entail?

From my experience the cost including initial research, A/E design costs, utility costs, right-of-way costs, construction costs and contingency costs would reach $1-2 Billion.

What kind of maintenance would you like to see implemented?

I would like to see an infrastructure inspections program similar to the NBIS Bi-Annual bridge inspection program implemented. The system would be partially inspected every two years on a rotating basis of critical components. Repairs would be based on the recommendations of these inspection reports.

To what extent is 'technology' (e.g., pumping stations, movable barriers) a solution?

The lesser extent the greater issue is understanding why these natural weather events have grown more frequent.

Are there any good non-technological solutions?

Technology is everywhere today so that is difficult to say. You cannot get a cup of coffee without being faced with a computer-stamped receipt. The idea of breakwaters in the river, or water diverting barriers or weirs may be a consideration, but I would still consider these technology per say.

Every time we build something, something else is destroyed. In creating these new strategies, what do you think can be lost or destroyed?

I have found that proposals can be destructive in certain aspects and constructive in others. The goal is always to provide a solution that minimizes negative impacts and maximizes the benefit to the consumer, in this case, the general population. There are examples including the use of say Imminent Domain everywhere in the area, in which case, you must take a property to build what is essential to the betterment or the greater good of the public. I am sure initially no one wanted the Brooklyn Bridge, for this very reason. But today it is one of the most iconic landmarks in the city, and it is still essential in its use, still functioning well. So I believe to implement these barrier systems, you would probably need more space for the proposed system so you could lose waterfront properties (and the right-of-way behind them) in the form of businesses, residential and commercial. If the system moves forward into the water, then you have the environmental impacts to consider in terms of Riparian Right Impacts, waterway impacts and marine life impacts.

How do the technological solutions affect the waterfront, both in terms of tangible and intangible impact on the city dynamics?

From my experience in state or federal projects, the two can either be independent or similar in the sense that the goal is not to hinder but to improve. The tangible impacts can be beneficial if you can implement a system that prevents the type of flooding experienced in the past. The city dynamics can be affected by the possible loss of community gathering areas, something as simple as parking spaces, and/or businesses in the area. The Fulton Street area, which was once a port-like active and thriving fish market area, has become a hip community gathering area with bars, movie theaters, shopping and restaurants in very close proximity to the waterline. In some cases below, so protecting an area like this would maintain or improve city dynamics while affecting this area would degrade the city dynamics.

What could be the new views for the neighborhood?

Every neighborhood in the city has its own character and this particular one is no different. The real difference, or human, material difference being the value of the properties in this neighborhood based on it is proximity to everything central to New York City. The engineering difference is its proximity both vertically and horizontally to the coastline which makes it more vulnerable to natural disaster and their impacts. I think moving forward the two breeds of difference need to be integrated into the design proposals for Architectural and Engineering proposals moving forward.

Director of Waterfront and Open Space Planning of New York City at Department of City Planning of New York State

What are the biggest vulnerabilities of the New York City ecosystem? How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

The biggest vulnerability depends on what you are looking for vulnerabilities. Therefore, if you are looking at the impacts to residents of Manhattan, it is probably urban heat. Study-after-study has shown that more deaths are caused by heat than other natural systems. The flooding is just one face of it, while heat is likely the greatest risk to the residents of Manhattan. The city is made up of its residents, but also it is made up of a complex system. As a whole if you branch out to all of the other systems you can make a reasonable argument that flooding is one of the greatest risks that we face as well. These take two different forms, there is the infrequent storm events, like Hurricane Sandy, and then there is what is going to happen to sea level rise absent of the storm. Just one a daily basis what is going to happen with sea level rise? Those are both issues that need to be contended with in Manhattan. So looking at where the flooding is most likely to occur with infrequent storm event like Hurricane Sandy there is a significant portion of lower Manhattan, in the Financial District as well as the Lower East Side. When looking at just sea level rise, absent of storm events, it is specific locations looking at the 2050's and thereafter the 2080's. Have you looked at the flood hazard maps on the website that is actually a good place to start. From the preliminary FEMA flood maps you can see that there is a significant portion of The Bronx and Lower Manhattan as well as a large section of the East Village and the Lower East Side that is at risk. That is a different picture than looking at high tide in the 2050's. Therefore, the piers themselves are actually a little misleading because the LIDAR, which is the basis for this information, most likely underestimates the elevation of the pier. And that is why it's being shown as all flooding, whereas you might get some level of flooding along a portion of the area of the FDR but that may be ameliorated by raising the bulkhead at the shoreline edge. However, you will see that it's really quite limited in Lower Manhattan by the 2050's. Now if you were to jump to the 2080's you'll start seeing a few more pockets of very high end projections; these might seem more frequent regular flooding that, again, might be able to be reduced by elevating the bulkhead.

Are there particular projects using technology, with a park for example?

Just last week the Mayor announced the Lower Manhattan Coastal Protection Study. Therefore, they looked at the specific area. Looking to the East Side, in the first phase of the East Side Coastal Protection study; that's where they're going to be building an elevated berm within this park and have other walls to provide protection for this whole area. This will stop at Montgomery Street. The next phase will become more difficult because there is less physical space to work with. Now an idea that was proposed last week would be filling a portion of the river to provide protection. For one, natural and man-made coastlines shift and so this is a fairly arbitrary border right now of where the land meets the water. That's not to say that we are taking it lightly, this is a major undertaking and there are environmental impacts that we have to understand, but as a whole, this is something that because we have such limited land to deal with and such valuable real estate and such massive infrastructure here. There is a possibility of further exploring what it would mean to fill this area and because that would be one way of addressing both the likely flooding from daily sea level rises and storm events.

In terms of the flooding of this area, what are the Environmental Impacts? Technological Impacts?

The environmental impacts still have to be studied; this waterway has much cleaner water than we had previously and as a result we have more productive life in the waters. We still have to study that. The technological impacts are still being explored as well. What was really being announced last week was that this is the start of the process, not the completion of it. We have done some preliminary analysis to understand the risks and there are some very significant limitations to being able to address those risks because the geography is so confined.

In terms of cost to manage and maintain this flooding protection system is high in your opinion?

It is and that was part of the announcement last week as well. This would without a doubt be an expensive proposition. How that gets funded is still in question. In the United States the federal government may be willing to put up the money for this, but maybe not. And if they don't, the city may seek to take it on itself and in order to do that is looking into the possibility of having development on that levee itself for the purposes of paying for it.

What are the greatest resources and what are the biggest obstacles of the proposals that have been made? which do you think are most feasible? Which will likely to most effective?

The greatest resources are that a significant portion of the funding came from the Federal Government after Hurricane Sandy to get started on the project first phase. That has been of major benefit to the city. The biggest obstacles are that it is still a very confined urban area. And weaving coastal protection through a confined urban area has proven quite difficult; contentious that it has been in the planning and design process for several years because of the challenges of determining a pathway for the berm. We are using floodgates at certain locations.

Usually to protect the coast from flooding what kind of system do you use?

We will be elevating sections of the shoreline here in the park to keep the water out. That is going to require large storage tanks for rainwater inland of the barrier to collect all of the rainwater and so that is going to be a part of it, as well as the flood barriers in certain locations.

What are the vulnerabilities of coastal build heritage? Can intervention in this area involve risk of cultural evolution and loss of identity of the place? Is the level of fragility high?

So that is very much a concern and we started hearing that last week with Lower Manhattan that by building out into the river you have the possibility of significantly changing the neighborhoods. That is something that will warrant more discussion as this project proceeds.

What do you think of the new design strategy for Lower Manhattan? What do you think are the factors in designing a good waterfront and what are the key factors in bringing about a solution?

I think it depends on what section we are talking about. There are a couple of different solutions we are looking at. Particularly within the Financial District, this is an area where it's very difficult for us to find solutions that can address the risks we face going forward because it's such a confined area; it wouldn't be the first choice to fill in the waterways, but that may very well be what is necessary. When all else fails you have to go with the option that is the least bad. In order for that project to succeed and for it to maintain a good waterfront if you are going to elevate it up you still need to maintain the relationship with the water's edge itself. And so that becomes a question of design and programming of the site as well.

Every time we build something, something else is destroyed. In creating this new strategy what do you think can be lost and what do you think is most likely to happen in the next ten years?

I think of it more as renewal. A rebirth of what was there previously. Therefore, in the instance of the East Side Coastal Resiliency we are taking a park that is well used and well loved, but it will be better in the end. Better for the purposes of resiliency and it is going to function better as a park. We do run the risk in other areas, particularly in Lower Manhattan, there will be impacts to the waterway. That is going to be a very difficult conversation with the permitting process we will be able to weigh those trade-offs and that is something that is going to be discussed over the next ten years.

Do you think that revitalizing the waterfront is a good use of public funds? If not, what would be a better option? What do you think NY should be considering for the large amount of money to solve this problem?

Given my title and my role within the city, of course I think it is a good use.

How do the technological solutions affect the area, both in terms of tangible and intangible impacts affects the city dynamics?

This is an interesting question because we do not know as of yet. There are other examples of what has happened in other cities like in the city of New Orleans after Hurricane Katrina and, after the rebuilding, the city dynamics changed rather considerably. And that through a great number of small decisions, the cumulative impact was that the city became lighter and wealthier. The tourism market has grown considerably since Hurricane Katrina in New Orleans. And that is a concern here as well that we want to make certain that our 520 miles of waterfront in the city and that the vast shoreline we have able to be protected and that the diversity of the residents remains. For example, the Rockaways is residential. There are a few pockets where it is less developed. There are some vacant properties but this was an Urban Renewal area in the 1960s. Mostly the Rockaways are developed and have their own complex dynamics. Lower Manhattan because of the density of it makes it a challenge.

What could be the new views for the neighborhood? What do you imagine is the future for New York City waterfront?

I think it was a very strong concept and a good effort to try to integrate coastal protection into the urban fabric. To be clear it was a concept design, it did not go into the details of how these things would actually be built and how they would work. I think that is why what we are seeing now that as the project through design, it has to change some. For instance within East River Park the original design was that the line of protection was going to be adjacent to the FDR highway. But as we began to design that project we recognized that that would be significantly more expensive. And that would make the construction much more difficult because it would require closing the highway for significant portions of time for the construction. While it looked very nice in the renderings, when it came to the actual designs and the hard decisions that had to be made about how you actually do construction we realized that probably wasn't going to be feasible. That is why the project shifted and is now looking at elevating portions of the park itself, not just up against the FDR. That is the type of thing when projects are in concept should be expected to evolve. That is also why in Lower Manhattan we are looking to do an outboard solution rather than what was proposing along the FDR itself.

You discussed that the solution could be fill in part of the coast, could the same solution be used on the LES as The Bronx?

On the Lower East Side you have a little more land. It is a very different geography and you have more space to design your coastal protection.

Mayor's Representative in the Public Design Commission

Adjunct Professor in the Urban Planning Program at Graduate School of Architecture, Planning and Preservation of Columbia University of New York City

What are the biggest vulnerabilities of the New York City ecosystem? How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

Rising sea levels are a very serious problem because all the science and all the technology and the analysis shows that sea levels are rising even faster than was anticipated and Manhattan, New York, is surrounded by water and the water is warming as well. So that the area, certainly in terms of the city, that are most vulnerable are clearly those areas that are adjacent to the water, the East River, the bay and so on. So in Manhattan, certainly, and this is the area in which damage occurred with Sandy. Certainly Lower Manhattan and Staten Island are where so many houses are built right on the bay. Recently, this is something very hard to do, there has even been government orders to not rebuild some of the houses and for the owners of those houses to be compensated but we have many examples of tremendous damage from Sandy that has still not been rectified. So it is extremely serious, Brooklyn, Coney Island and Brighton and so on, this is right on the ocean and we have to have a coordinated plan. I think New York has made some commendable progress in that regard: for example on the Lower East Side changing the parks and the areas if you like for play. It making them more consonant with what will be the damage from climate change but not necessarily hardening, but more providing the land in such a way that the water comes in and then recedes and does not create the damage. I am clearly over-simplifying. In addition, I did some work in Brooklyn with students and we were working in the community of Gowanus, in Brooklyn, where there is an industrial canal built 150 years ago but is no longer to be used in the same way. There is an example of gentrification, of the area becoming completely different used for housing and bigger buildings along the canal being a place for recreation and for enjoyment; that's great. But we all have to be thinking in a coordinated way while preserving the extraordinary vitality and diversity of New York.

What do you think can be done? Of the proposals that have been made, which do you think are most feasible? Which will likely to most effective?

Well I think all the projects from Rebuild by Design, by the so-called Big U, and many others, are extraordinary, excellent and very expensive. Publicly financed planning efforts to change the coastline, to reflect the needs of climate change and to relate the changes that are essential to the needs of changing populations. The Lower Manhattan is a very dense area; so here is the difficulty. It has always been dense with both tenements and various buildings and above all, housing projects for lower income people. These continue to exist but there is also changes that occur, they are building higher buildings, bigger buildings for more affluent populations. So the dynamic of the market urging this and at the same time there cannot be this ignoring that it is going to be flooding again; that the waters are rising. So I think that there are and have been a number of important measures taken by the New York City government, but it cannot be the City alone. And I think there ar e questions now of will there be enough money to complete this correctly and at the same time the science can tell you what to do? I think it takes a long time to implement the specific plans them and so they have to be modified and changed, again on the Lower East Side, the East River, the FDR Promenade, they're changing that again.

What are the greatest resources and what are the biggest obstacles of the proposals that have been made? which do you think are most feasible? Which will likely to most effective?

I do not think that I am equipped enough to give a definitive answer to the question. When you looked to some technological solutions e.g., pumping stations, movable barriers, as you described but there are also a lot of non-technological solutions, you know, creating land, that marsh is softer land that can be compatible with the flooding with the water. The Dutch have done that successfully. After Hurricane Sandy, with Rebuild by Design many Dutch experts came here and they, for good or ill, they questioned, you know, the hard barriers and levees, for example in New Orleans that the federal engineers love to build but they didn't succeed, they failed. New Orleans changed the whole route of the Mississippi River, which was fundamental at the time, by remitting the trading for industrial production. It had the effect, over time, exacerbating the flooding over time. So you can say New Orleans is an unnatural place, in fact levees were built and then changing the route where there could be flooded and they thought you could stop it with the levee. Sandy proved that was not going to work and also the levees failed, in part, because they were built badly, but a different way to do it. That challenges the shipping, the kind of industrial work. If you are going into shrimp farming, and all, you can leave the soft land and the marshes. The Dutch, I can remember when they came, they showed some place that live with the water, let it come in and go out, but you can live with some of it close to you; that's very complicated. I think that works in New Orleans, it can, I think, I'm sure, this can work in a place and should be implemented in very vulnerable areas, I mean you know, what is going to be really with the Rockaways, and Southern Queens, and Brooklyn, and Staten Island. They have to be able to live. When you push away the water from a place, it can push it into another place, the so-called technology with all of its complexity is known what the effect of this action on that. But know how and to whom, that is the engineers and others can have know it, but are the engineers and all really in a true dialogue at work with those who have to live there or who know the way the community works.

What are the vulnerabilities of coastal built heritage? Can the intervention in these areas involve risks of cultural involution or loss of identity of the place? Is the level of physical fragility of coastal settlements high?

Certainly the solution or the government or the developers look at the situation and say 'we must modify the shacks and the fishing and so on'; this is something of the past. Then there are those who say 'what do you mean, not only are you wiping out the socio and economic and cultural life but perhaps we are learning that the way those uses manifest were more compatible, congenial with what the effects of new climate action. But look, I think what probably may be beginning to happen, but not in the best way, is that though there may be a widespread recognition. Some more articulate, some more conscious, there are those who don't say it, but they understand say 'wait a minute, there really are significant changes' even if those who say 'we don't really believe in climate change' but they saw community or storms getting bigger or with greater negative affect or winds that have never been seen in this area. It has to be multiple solutions, let's change the built fabric completely. Because New York and other communities did build this City; it is very desirable to live near water, rich people like the views in big houses.

I sometimes think govern would probably disagreed but the Williamsburg-Green Point Plan, and one of the major points of it was the rezoning, which was to build higher and count on the views of the water. The political thing was that every private developer was involved and there were to be view corridors. These are and were attempts at 'balancing' and I am not sure it is working, but certainly that's been transformed there. I think the risk and the likelihood of the effects of climate change are clearly occurring at a faster rate than anticipated. That means that the water level is likely to raise one foot or whatever in 75 years, or in 50 years, this is nothing in terms of time and if that can happen, that is an acceleration and that we already see is a damage to the built fabric. For many years Long Island was very vulnerable, but before Sandy and after Sandy, and the Hamptons is a big spit of land called West Hamptons beach where many wealthy people live there and built wonderful houses that were damaged by storm after storm with a great deal of damage. The rich people invest a lot of money in insurance and not everybody has it and after Sandy too, you know the federal govern rebuilt again. It could be said as an example to understand that that is not a place to build again but the wealthy were building, and the cost and the government was no only paying for it, but the insurance was paying for it too.

There are different kinds of strategies have to be. There are some areas that are politically and economically advantaged and received more money. In the US and in New York State there is a certain contradiction, there is always the inequality and disbursement, but also there has been with national emergencies some change because planning that does not occur centrally in the US unlike other places. So when the Stafford Act was passed from the national government that was a big change. And hence when you have an emergency in the Unites States, then the States ask 'declare a national emergency where we are' and then money can flow to that particular state. The distribution of money is very complicated and this is a big deal to change. But what are the risk areas? There are going to be big earthquakes (for example) in California and this is going to be a very big deal; and it is more centralized, paradoxically it may be easier in some other countries But it is fair to say that New York saw major damage after Sandy and then it was taken very seriously.

What do you think of the new design strategies for waterfront regeneration? What do you think are the factors to design a good waterfront? Who are the key actors in bringing about a solution?

I've seen some of the designs for the changes in the Lower East Side. As a plan for a waterfront I have been impressed with the apparent variety of the planned activities but also even as the plans occurred in places where there were planned marshland or rock and they are changing those areas. I think they are rethinking some of these areas and they had to change them or adapt them. For example, on the FDR Drive and moving up through Manhattan from 15th, 17th, and the 20th I think there has been some rethinking geologically and in terms of access of coming from the upper side of Manhattan. I have seen some of the presentations and they are changing. There are good planning efforts and adaptations after Sandy, but you cannot do it alone. New York is very wealthy, but this cannot be done without federal money. It has to be every level of government from the State and the Federal.

Every time we build something, something else is destroyed. In creating these new strategies, what do you think can be lost? What do you think is most likely to happen in the next 10 years?

Ten years is a short period of time. One of the things that has been alleged, post Sandy, on the

Lower East Side at least it gets publicized that there has also been a continuous outreach process, iterative meetings, continuing discussions with members of the community and testing out and so on. And of course in planning the wise people can decide and tell you what to do, but the others say the solution is not good enough so the climate is very volatile between planners and citizens. So when you have a very volatile and articulate community and a well-organized one, however, there are no illusions, I don't think because it is always very dicey, did the outreach process to the community, and we had thirty meetings and did that work? What does it need to work? You have to have the expert. It seems ridiculous that the planners in their goals and their ethics say in the age of the master planner, certainly not in Robert Moses, but the master-planner cannot be. We can also be quite intense and passionate, from the people from the housing project to everybody. Everybody really knows a lot and they really do know how serious the problem is, because they experience it. How to get to the water, but there are not new pedestrian paths, they know how why. That is very micro, some know very well and differently, but without experience, they really do not know. Also they can show what they may know, but the expert should say how, why and because it is their work about the human processes so everybody should know.

Do you think revitalizing the waterfront is a good use of public funds? If NOT, then in your opinion, what could be a better option? What do you think New York City should do considering the large amount of money made available to solve this problem?

When we talk about the redevelopment of the riverfront it is basically different. If the primary use of public funds and how they are used in implementing them now, then the focus should be one a combination of recreational uses, access to the waterfront by many different populations and users. These are similar but can be aimed at different kinds of population, then also if you are adding to that, is the addition of other, newer kinds of buildings for housing and even commercial use, because all of that is being dealt with. On the first ones and the recreational, the major questions are always 'is there access in the investment for everybody?' Not only demographically for children or old people as well as those who are active, but for everyone. For example the existing public housing may be for the people who are not normally getting (public housing) and live there when normally they can't get there. It could be many conflicts with the kind of facilities. I think the goals and the strategies have been well intentioned; I am not an expert on the designs but, I have seen a number of them, and I think that they are important to continue with and can be a model. But I think what are you asking (it depends), in America and in New York, there is almost always a combination of public investment and private investment. And if it is private investment, the private gets an incentive to gain more profits and to build what will yield a profit, this is always the dynamic.

Which are the best strategies to mitigate vulnerabilities? What can be the threshold of integration between the existing settlement system and the proposed technologies solutions?

The most vulnerable population and who are they and how to address their vulnerability to change the environment. If there is a storm, can they leave? Before Katrina, thousands of people could not evacuate and many died in that storm. The experts said it will be there in three days so you should evacuated the area, but the people with money heard the warnings and they could take their cars and they left. Many people died in Katrina, and they were mostly poor people because they could not get out. That did not happen during Sandy, but with Katrina, many people died. I mean that is being changed and all people should be informed to leave with their cars and everything else. So the vulnerabilities in the system created the vulnerability in the form of humanity. The government helped them and now the organization of transportation it is a circle and there are vulnerabilities but it is linked to the humanity so there is a very different typology in New York. Now they try to be more ready. So I mean among other things the environmental, now I'm doing a studio on super tall buildings that are built, you know, with safety but they're built as right regulation and they don't have to go through the public reviews. So it may be a combination which is very hard in a country and an economy where the land use must change and it is more equitable but it also has to be quite widespread environmental regulations. Environmental regulation is important and there a lot of ways like no plastic bags, 25 years ago we lived without plastic bags, but now there has to be a regulation and there are penalties. Like the land at the beach, the wealthy people say 'I bought this land at the beach'. There are some other wealthy people who have gorgeous houses, and then the City says 'you are not the only one who enjoy the beautiful beach' and then they build a sidewalk and they just lost some of their properties. The goal is to change and get maximum access and equality for maximum number of the population especially in the city. I do not want stay with many people, I just want to stay quiet on the beach. Now look, we went to Coney Island when we were little and had no money, you go there with thousands of people on the beach there, I don't want to go there now. I do not like it but at the same time, the resources are too finite and the dangers are far too great to the people. Keep them away and you will see there how the society can be changed. In design and build design there is a brilliant example in rebuild by design and I hope the same destiny for Lower East Side.

How do the technological solutions affect the territory, both in terms of tangible and intangible impact on the city dynamics?

This is such a big question. In Battery Park City there is such a huge combination of very expensive investment. It was a consequence, in part, the push to build the World Trade Center on the part of the Rockefellers to make NY a more modern economic development. But the landfill and the excavation, there was a brilliant idea for Battery Park City that said 'let's extend the city'. Now Battery Park City is an example of innovation but also, to some degree, of imitation of some older examples that planners and others though would work. Such as, looking at the promenade there that is public and then going back (from there) they established new street system. And at the time the designers looked at and designed the promenade and people thought it looked strange, but the designers are still around today. Because then there was no regulation in it and they should protect it too. If you look the way Riverside Drive and also the roadways along the Hudson which now are being changed and added to again, so Battery Park City is an extraordinary example of innovation and imitation of it. I mean one time it was very clean and pristine; you could go there and not even think you were in New York. Instead now there is a very interesting article in the New York Times about Hudson Yards saying Battery Park City was done back then and Hudson Yards is not doing that even today, creating its own city.

The Lower East Side meaning something different, like the Two Bridges, completely huge and that is on Urban Renewal land, that is why it is so complicated. I think it is possible but it is complicated because New York does not have the same ability to demolish, completely sweep and knock down and rebuild huge areas like Robert Moses. And the highways, it is harder with multi-groups as well as politically to do that. It can be transformed by default if these changes are going to affect enough people. If the people are not going back to their buildings in Staten Island who lived there for 150 years are not going back to their homes. The only way and it is very unusual, but after the flooding, they could not build there again. So they absolutely don't permit people coming back to build where the water come in and there really has to be much more prohibition. And build more densely further back, but that is not easy to happen. The government will compensate them for their loss, but it is complicated whether it is fair or not.

What could be the new views for the neighborhood? How do you imagine the future of New York City waterfront?

The Lower East Side is one of the most fabled neighborhoods, it is the place of immigration that has changed rapidly in the last 30 years and it is going to change more rapidly because now there are plans to rezone. For example, Canal Street, make it more residential. The market will change, and in social terms, it will change in physical terms and it is important to maintain the number of younger people. And people moved to other areas than that street and they work in Wall Street, they are living in little apartments. It is interesting, you know, the Chinese community is large, there are four more China-towns now and this phenomenon is fantastic. The Chinese living in such numbers and they maybe come to the shop, but there is also Sunset Park; this is the line when they came, the immigrants take the L trains and get off the subway and the first stop you can see are the blue skies.

Adjunct Professor and Assistant Director of Urban Design Program at Columbia University of New York City

How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

Rising sea level have a significant impact on all coastal cities, and New York is no exception. New York faces a particularly high level of vulnerability due to the large population residing near its coastlines, from Lower Manhattan to the Rockaways or to the Bronx, encompassing hundreds of miles of coastline. This issue is especially grave because of the extensive underground infrastructure, including subways and trains, which are at risk of flooding. The flooding experienced during Hurricane Sandy was just a glimpse of what is likely to occur again, and potentially even worse, in the future. Determining the most vulnerable areas involves both physical and social considerations. Many individuals live and work along the coastline, but there are variations in vulnerability between living and working, so the people in the South Bronx or in the Rockaways, those are their homes and their homes were threatened. In Lower Manhattan, few people reside there, but it is the economic heart of the region if not the economic capital of World; so the function of Lower Manhattan is obviously vital to the region as well. It does need to be addressed immediately, but doing things could take years. We must strike a balance between short-term and long-term planning to adequately prepare for the future.

What vulnerabilities do stakeholders face? What risks of economic exclusion could arise from coastal interventions? What factors could lead to market depletion?

Stakeholders in coastal areas, including Lower Manhattan, are primarily concerned with the safety and preservation of their homes and neighborhoods. Following Hurricane Sandy, the prevailing policy and practice have been to raise homes and move essential services above ground level. Public housing projects have been at the forefront of this effort, with ongoing initiatives to elevate central services. I know plenty of Architects who are designing raised pavilions next to buildings to relocate electricity and heating systems, ensuring they are out of harm's way so everything is being moved up. Whether it is single-family homes, multi-family homes or public housing, there are, of course, many problems in terms of funding allocation. So public housing is starved in New York City. Following the past two years, NYCHA is essentially bankrupt. And it is going to get worse. This is a difficult item, not only for maintaining the buildings, but also for making them safer in flood emergencies. Therefore, that is why The Rockaways are so threatened. There is public housing along the East River as well that was flooded, their basements were flooded, during Hurricane Sandy so that is a special vulnerability. Regarding economic exclusion in coastal areas and its impact on the market, I think that Lower Manhattan is a special case, completely. Lower Manhattan is an economic heart of the region and attracts substantial investment. Whether that's wright or wrong, that is where the money will be spent, because the stability of the market place and the stability of the stock market is probably the main concern for those in power. That (concern) is that the market must be protected, the literal stock market places of business. Despite the growing prominence of online and cloud-based business, physical infrastructure still plays a crucial role in the workforce, and city leaders will prioritize protecting these brick-and-mortar workplaces in urban districts to ensure market stability.

Which strategies are best for mitigating the impact on the waterfront regeneration? What level of integration can be achieved between the existing settlement system and proposed technological solutions?

In terms of technical aspects, I am not an expert. The Lower East Side and the South Bronx are very dense with very different socioeconomic and racial backgrounds, resulting in complex social dynamics. While it may be easier to argue for saving Lower Manhattan based on economic terms, it is harder for the Lower East Side and the South Bronx. And that is a terrible thing to say, but they do not have a lot of political power, whereas Lower Manhattan is the center of influence. The strategies which include berms, walls, wetlands and mitigation ponds and such things are all possible, but even in the past year The Big U has been trimmed; they kind of cut it back down. And they are talking about building a huge berm and putting a park on top. But that would take ten years and the construction of that itself would be an incredible disruption. People are questioning how they can continue living amidst the threats and how communities can cope with a construction site along the entire park edge for ten years. They'll phase it, they'll do certain things to mitigate construction problems; so I don't really know the answer to that. And I think that in the shorter term, public housing will get its surfaces raised because that is actually a definable construction job that they can do on a one-by-one and on a case-by-case basis. However, when it comes to small tenement buildings, low-rise housing, and six-story housing, finding solutions for massive flooding is challenging. It is difficult to envision a comprehensive solution for small property owners who own one or a few buildings and lack the financial means to protect their basements from flooding. Overall, the search for solutions is ongoing, and the integration of existing settlement systems with proposed technological solutions remains a complex and unresolved issue.

What do you think can be done? Of the proposals that have been made, which do you think are most feasible? Which will likely to most effective?

One of the major concerns is that some companies may invest and protect themselves in the near future, but the large construction project are not going to be sufficient for the next few years and there is going to be an uneven level of protection. Some proposed solutions, such as the Big U project and combinations of walls and berms, have been considered. More recently, there have been discussions about extending the island land. Manhattan has been expanding since day one, and now there is talk that parts of Lower Manhattan will extend out to absorb the floodwaters or surges, and while that is a totally possible thing to do, again, it will be private and public money. A lot of private money will be required, but also they will demand that public money must be spent. That is kind of a middle-term solution as it typically takes five to eight years for such extensive projects to be completed, for example the World Trade Center, it took them 4-5 years just to excavate the land for the World Trade Center and put the land for Battery Park City. And that was a very slow moving, early-stage, primitive version of what we would be doing now. But it's a big operation and it doesn't happen overnight. And that's why Battery City is so interesting, because it is all landfill and it is entirely possible that is a very reasonable solution, although extremely expensive. The bigger picture is who is going to make decisions about what will be saved now, what will not be saved now, what will be saved in five years or what will be saved in ten years. I do not know who is making those decisions, if there is a State-level or City-level organization that actually has any power to decide these things. I do not think so because it is very threatening to the status-quo of power. So in some ways, some of the land is owned by the State of New York and some of the land is owned by the City of New York, and the federal government owns some of the space in the water. In all cases of dealing with the coast, there is an incredible governmental problem. Different types of governments find it hard to work with each other (for example) New York City and New York State have a terrible relationship, if you follow them, the Mayor and the Governor are always fighting because they have a different constituencies and different interests. So the World Trade Center is a very good example of a State project in the City, because the State owned that land. Therefore, there was a lot of tension for many years. Therefore, when it comes to flood protection, it is clear that there are different political levels of decision making that need to be looked at. When it comes to flood protection, it is evident that political decision-making occurs at various levels, including city, state, and federal. So when you studied the South Bronx you have to work with these different government entities presents significant challenges.. You know, how far is New York City saying we should build into the bay. You cannot control the political decision making to do that. So it is a huge thing. Again, it is a long-term project not a short project. It is possible for them to build jetties, so that sometimes slows down surges, like the beaches on the South shore.

Who are the key actors in bringing about a solution?

In New Orleans, Hurricane Katrina was a failure of technology as well as politics. And so technology is always going to be part of the solution, but it's never a clear-cut question. So the pumping stations failed, not on the ocean-facing side but on the back of the city. The water came around and in through the canals, and the pumping stations were not up to its capacity. Technology can be effective when it is accompanied by social and political considerations and proper implementation. In the case of New Orleans, the construction of levee walls in African-American communities did not adhere to proper standards, highlighting the importance of comprehensive planning beyond technology. So, you know, there is still so much that isn't quote-unquote technological because technology is never separate, it is always a part of social and political interaction. There is a lot of talk and Kate Orf has worked a lot with landscape and how to integrate water management with earth moving, with natural organisms that can help build flood-slowing, water-slowing barriers. She was part of the Rebuilt by Design competition here in New York and she did a very famous project called "The Oysters". Some people actually are not fond of the project, but the fundamental importance of it is that we can start building today for the long-term to slow down the approach of water and to create a thicker barrier that slows down the water, that re-directs it to rebuild wetlands, which develop naturally. If you look at a wetlands map from 100 years ago in the New York area, you would be amazed by how much there was. Also, oysters: there were once buckets and buckets of oysters! If you went to any restaurant in Lower Manhattan there would be piles of shells of oysters. And they were there because it was the right mix of water and plant life and docks at the water's edge. So that idea of semi-technological meaning using technologies built into natural systems so they are integrated or combined solutions are really one of the ways in which you can essentially reduce the amount of flooding that will eventually take place.

In different places there are different actors; for instance, on Long Island, the south shore, and Staten Island, different plans are devised by the city and towns to extend wetlands and create areas that are less vulnerable to flooding such as park. This involves the implementation of mediating actions that incorporate both landscape and urban elements.; also getting communities to realize that some of the outlying housing needs to be raised immediately where some of the inland housing doesn't. I would say that all the solutions are a different form of technology, not specifically pumping station of movable barriers, but who decides where they go, how big are they, what is the capacity of the pumping station, is it even a good idea, does it actually really help. Understanding the number and distance of pumping stations required is another significant aspect that needs clarification.

Every time we build something, something else is destroyed. In creating these new strategies, what do you think can be lost?

I think the building of berms in the abstract sounds like it could be a delaying tactic for water. The question is where are they located? How are they designed and who is going to pay for them? It is hard to image. I do not see the political will on the part of the State or on the part of the City. They do not spend money unless there is money to be made. In the World Trade Center they put land there because they were going to build something there. People were worried that extending the land out from Lower Manhattan means going to actually build more on it and it is not going to be wetlands; it is just going to be smart skyscrapers. And so nothing happens in New York without some kind of payback. Given the limited federal support available nowadays, it becomes even more uncertain where the necessary funding will come from.

Do you believe that revitalizing the waterfront is a good use of public funds? If not, then in your opinion, what could be a better option? In economic terms when means a new project on the value of the life of local inhabitants and buildings? Do you think revitalizing the waterfront with private funds could comport massive influence on project and new land use?

Revitalizing the waterfront with public funds in the Lower East Side, considering the existing highways, small parks, and buildings, is indeed a good use of resources. However, I also think that is a concept, that is an abstraction, but how will decisions get made, who decides how it happens? I think you need to ask; the people who live there need to know what is going on. The people who live there need to recognize the threat. I think it is a good use of public funds, the question is whether the people in power will spend the public funds and where will that money come from? Somehow, the Governor, a future President and the people with access to capital will put public money in. There are enough businesses in the City who would also put money in if the Federal government would do it too. There is going to be some future ideal circumstances in which public and private funds will be provided. The question would be: are there ways that they will get their money back? And so businesses and governments may demand that there will be new housing or new businesses or a new Battery Park. This is the fear of the people who live in the Lower East Side and in the Southe Bronx is that the only way to pay for protection is to sell the rights to the land, either by loans or by debt or by government giveaways. The only time money will flow is if there is a way that the private market can make more money back. No one is really talking about that much because that would be kind of a dynamite for the people start talking about new construction in order to pay for flood protection. Another policy could be that someone may say 'whatever you spend in Lower Manhattan, you have to spend on the Lower East Side'; it is a political game that may have to go re-writing of policy that says: 'how can we make flood protection more democratically spread?'. Yes, Wall Street business is important, but so are the people who live here. I do not know what is being discussed in the political realm as to how to pay for this project. They have not put a shovel in the ground, and I look forward to the day that they start digging and supposedly there is money there, but we'll see. Some of it is quite controversial, but for the people who live there, it is no small thing.

What do you think are the best investors in the redevelopment of the area? Do you think the same can then be taken care of future maintenance and management costs?

The use of the word "investors" has the implication of the private market and I do not think it should be a private undertaking. I think it should be a public undertaking, or at least some publicly-led undertaking, because everything will always be a mix of public money and private money. I think the reality is that there will always be a mix of public and private funds, not just in New York, but all over the coastlines. Because state laws vary from state to state, insurance companies may compel cities to take action by threatening to withdraw insurance coverage if they do not implement measures to improve the situation. So in part, the insurance industry, is already affecting policies in places like Miami, for example, where insurance companies are saying 'we are not going to have flood protection insurance until you do these things to improve the protection'. So, in some ways, there is an investor-led effort to actually take good action. Maintenance and management are, once again, sources of tension because historically in New York, for the past 100 years or 75 years, public construction and maintenance, including highways, bridges, tunnels, and water systems, have been the responsibility of the government and publicly maintained. It is highly debatable whether this trend will persist. For example, we have Brooklyn Bridge Park, which is privately owned and situated on private land. The State of New York leases the land to a private entity, and the funding for the park comes from the new buildings constructed around it. A lot of businesses and governments are looking because it is "Net Zero" to the government to that model. And that aspect remains untested: when Brooklyn Bridge Park gets flooded next year, who will bear the cost? It is a fascinating problem because the concept of private or semi-private parks is likely to become more prevalent. It is possible that some of the redevelopment projects we discuss could involve the creation of additional private parks leased to the public, while the land itself is owned and funded by the private sector. Consequently, the management and maintenance of such parks pose significant uncertainties. Indeed, maintenance is a pressing challenge in our era.

What do you think is most likely to happen in the next 10 years?

I think that in the next years there is going to be a couple more flood events. I hope they are not terrible, but statistically they are happening more. I think the Lower East Side might be affected again and hopefully not worse. I have very mixed feelings about Big U, because I do not understand who is going to pay for it. I also do not know enough about it, but as far as I understand it appears that it may not offer a high degree of flexibility, as it is unclear how much of it consists of permanent structures versus wetlands and similar features. I think it is clear why it is there, it is the international capital, so they are going to protect that. I accept that, even though I know that is not necessarily good for the people on the Lower East Side, not good for the people in the Rockaways. I believe it would be beneficial to implement a policy that requires addressing other areas in addition to Lower Manhattan. Saving Lower Manhattan while neglecting the rest of New York City would be counterproductive. Furthermore, even if Lower Manhattan is repaired, if the subway system remains unusable, it would severely impact accessibility and hinder the city's functionality. If you think of New York without the subways, then New York will not exist. Therefore, fixing Lower Manhattan is a small piece of the puzzle.

President and Chief Executive Officer of Battery Park City Authority

How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

Rising sea levels pose a significant threat to New York City. The impact of events like Hurricane Sandy clearly demonstrated the severity of the issue, affecting not only specific waterfront communities but also the city as a whole. Staten Island, Queens, the Bronx, Brooklyn and Downtown Manhattan were all significantly affected. You have people who lose their homes or their homes are damaged, but it can also affect the employment of people who depend on jobs in the neighborhoods that are affected and it can devastate public spaces that people enjoy too. Additionally, the recovery efforts to regenerate homes, reopen business, and rehabilitate parks and beaches are time-consuming, costly and painful. It is important to recognize that Hurricane Sandy was not the most extreme type of storm that could occur. There are worse types of storms than Sandy that are happening now. So now I do think it does need to be addressed immediately and I think it needs to be addressed yesterday, because more storms are coming and storms are getting worse. I think the responsible thing to do is to prepare and to protect ourselves because the alternative is much worse.

What do you think can be done? Of the proposals that have been made, which do you think are most feasible? Which will likely to most effective?

I believe resilience is a complex issue, I think everybody agrees that we need to do something. You know it is a challenging question to answer 'how do you do it'. And it is challenging because, from an engineering perspective, it is clear that there is not a one-size-fits-all solution for protection. When you look at sub-surface conditions or what is already built or where the water is today you have different types of environments that you have to contend with and so you have to come up with many different solutions. On top of that, you have to take cost into consideration and time to implement because this is an urgent matter. It is crucial to develop solutions that are resource-efficient and can be implemented quickly. I certainly have become convinced that, to the extent we can find passive measures to employ, then that's the way to go. This involves changing the landscape and elevating land where feasible, as relying solely on mechanical systems can introduce additional risks in terms of operation and maintenance. Finding the right approach necessitates a combination of strategies, but considering the landscape is an essential aspect to consider at some point in the process.

Which are the best strategies to mitigate the vulnerabilities of waterfront regeneration? What can be the threshold of integration between the existing settlement system and the proposed technologies solutions?

You know, that is exactly what we have been closely examining in Battery Park City. For instance, when we consider the Southern boundary of Battery Park City, we encounter various components. We have Wagner Park, which is a large area of green space. Adjacent to it, we have the Museum of Jewish Heritage situated along the waterfront. On the other side, there is Pier A, which is basically floating on the water at a low point. In response to these diverse conditions, we have determined that a combination of measures is necessary. For example, we plan to flood-proof the museum building itself to serve as a barrier, while also employing landscape modifications in the park by elevating it to the required level. This approach aligns with the passive protection strategy we discussed earlier. Regarding Pier A, since it is located right on the water, we must focus on effective flood-proofing measures for the building. However, considering the presence of traffic, businesses, and visitors in the area, we also need to incorporate temporary deployable measures that utilize technological or mechanical systems. The goal is to strike a balance between protection and preserving the usability of the space for the public, as well as for those who live and work in the area.

What vulnerabilities do stakeholders face? What risks of economic exclusion could arise from coastal interventions? What factors could lead to market depletion?

I believe that economic exclusion is an important aspect to consider not only in terms of resiliency but also in overall development discussions. When we examine the impact of Hurricane Sandy, we can see that it affected neighborhoods with a wide range of economic backgrounds, form the Wall Street area to less affluent neighborhoods. When implementing resiliency measures, it is crucial to actively involve the community in the process. It is important to educate and raise awareness among the community about what is happening and to seek their input. By doing so, we can ensure that public's extension and enjoyment of those spaces is protected. If development measures, such as the new Seaport City concept or any other initiatives announced by the administration, it is essential to keep in mind the ongoing needs of the city, such as affordable housing, schools, and community facilities. Striking an appropriate balance is necessary to achieve sustainable development that addresses both resiliency and the needs of the community.

Who are the key actors in bringing about a solution?

I do not have extensive knowledge about technological solutions, although I have learned about various measures that can be employed. There are deployable options, such as slats that can be filled in advance of a storm to create a wall. There are other types of measures where you have water-activated barriers that rise one way or the other. Then on the passive side, you have a string walls that you build where you can change the landscape and you know the engineers that we work with have made the point, many times over, that it is worth limiting those technological solution where you can to reduce risk. You wanted to be sure that you have to continuously test and maintain any technological measure that you put into a place. This requires ongoing resources and staff. You also want to make sure that they work and they connect. So, there is a growing number of deployable measures that are out there that are interesting, but we need exercise caution in looking at them because we want to minimize risk as much as possible.

Every time we build something, something else is destroyed. In creating these new strategies, what do you think can be lost?

Space is a precious commodity in New York City and when implementing these measures, it is crucial to consider the impact they have on spaces used by people. This is why community input is so important in the decision-making process. Certain measures may not only affect the appearance of a park but also alter its landscape. Even if you are keeping it public, you are keeping it beautiful, and you are being environmentally responsible, it is still in change and it is still something different than what was there before. Therefore, I think that people had to be mindful of what that change is and what that means for people. From an environmental perspective, particularly in areas like Seaport City, there may be considerations related to building out into the water. This entails acknowledging and respecting the ecosystem present and addressing the consequences of such alterations. As a result, numerous factors need to be taken into account when making decisions regarding these measures.

Do you think revitalizing the waterfront is a good use of public funds? Do you think revitalizing the waterfront with private funds could comport massive influence on project and new land use?

I think the resiliency needs to be a priority for the government and it is crucial to allocate public funds appropriately, particularly here in New York City where this is at the forefront of many people's minds. Resiliency measures require coordination among various entities and jurisdictions, and it is important for the government to take a leading role to develop a comprehensive and holistic solution. However, resiliency initiatives can be costly, and the government does not have a bottomless vault of money. Therefore, the question is 'How do we fund these measures?'. Even if you can invest public funds, for some of it, it is unlikely that you can cover the costs without some form of public-private partnership. Coordination and collaboration with stakeholder input are necessary in this regard. The private sector has valuable contributions to make, as it possesses talent and resources that can be utilized. Successful partnerships between the public and private sectors do exist, but it is important to ensure that a holistic strategy is employed. In pursuing resiliency efforts, it is crucial to consider the community being impacted and to integrate their needs and concerns into the overall plan.

What do you think are the best investors in the redevelopment of the area? Do you think the same can then be taken care of future maintenance and management costs?

I think there are many pieces to this equation, and one big piece is what do you build and how do you build it. That is what everybody is talking about right now: we need protection. You can't make a decision regarding protective measures or resiliency without taking into account the maintenance and operational aspects of supporting those measures in the future, and the resources that will be necessary whether it is people or money or technology, in that regard. I think that is why it is important to explore measures that minimize the maintenance and operational needs. For instance, incorporating elevated parklands and utilizing sub-surface barriers that can support the construction of parks. Furthermore, we should be prepared for the possibility that our resiliency needs may increase in the future if we fail to address the challenges our planet is facing. But you know, it's inevitable that in some places you're going to need technology, deployable, so I think in terms of planning ahead and really being honest about the investment that is going to be needed, (then) people also need to talk about the operations and maintenance components of those things too. And also be braced for the fact that if we don't get our act together on this planet, our resiliency needs might only grow and whatever we do now we unfortunately may need to add to it later in 30, 50 or 100 years from now. Therefore, our investment should be made in a way that allows for future adjustments and scalability, avoiding the need to start from scratch or rebuild entirely. We need to seek out scalable solutions that can adapt to changing circumstances.

What do you think is most likely to happen in the next 10 years? How do you imagine the future of the New York City waterfront?

There is currently a significant momentum-surrounding resiliency, with various community members and elected officials actively engaged in discussions and work. It is not just talk, we are very busy with design and engineering for several projects right here in Battery City, there are projects under way on the Lower East Side and now they plan for more work. Therefore, I am optimistic that the progress is going to be made over the next 10 years, but I think the progress needs to be made even sooner than that. I think it needed to be made yesterday. I think we need to be looking at what we can do in the next year, two years, three years, because hurricane season is just a couple of months away this year. And so it is already behind schedule as a community although in Battery City we are trying to make up for lost time. Although some communities, like Battery City, are striving to make up for lost time, progress needs to be accelerated. While the City and Battery Park City Authority are investing in resiliency, it is hoped that the federal government will recognize the need for greater investment in this priority. However, the implementation of these measures requires attention to detail, including engineering assessments, subsurface analysis, budget considerations, and determining what is feasible in each situation. And what has happened over time is that we have learned a little bit more about what can actually be done which may look a little different than what we thought even just a few years ago. But I think, in essence, even if it looks a little different, the measures are different, the uses are different, overall that kind of theme of what you had runs to this in many ways. While not familiar with the Humanhattan project specifically, it is important to emphasize the involvement of the community in this process. Resiliency measures will affect various aspects of people's lives, such as housing, workplaces, recreational areas, and educational institutions. It is essential to ensure that these measures not only protect individuals but also respect and consider the human and community aspects. Changes are necessary because if we fail to act, nature will force changes upon us. Thus, we must take an active role in driving the process while being mindful of the human dimension and community impact.

The development of grow of technology and the human ability to adapt to them is different, so what do you think about the dehumanization of the cities?

I think there is all of this work now being done on what they are calling smart cities. And so using technology to collect all kinds of data but also provide all kinds of services and I'm interested in that. In battery Park City we are looking at that, I think there is some important information and services you can provide. It is recognized that technology can offer important information and services. However, as the job has progressed, there has been a growing appreciation for the value of traditional open spaces and public parks. And I look at a new development like Hudson Yards, with its height, cleanliness, and abundance of technology. I have not been there since it has opened. I was only there while it was under construction. I worry about the ability for us to just enjoy public spaces, open spaces and quiet spaces, and just naturally connect with each other. While technology offers many benefits, there is a worry that we may have reached a tipping point, where our obsession with technology outweighs the focus on the human component. It is important to strike a balance and consider the human aspect more attentively, rather than being excessively fixated on technology.

What do you think is the best technology to protect the land by the flooding?

I do not prefer the idea of building a wall as a protective measure. Instead, I prefer the approach of elevating the landscape, particularly in the case of public parks. In trying to bring the park up higher and also with sea level rise you also then have to change how it interacts with the water because, right now, we have this esplanade, all these walking places along the river. I worry they are going to be too low one day. I do not just think it is about elevating it but how it meets the water. Figuring the way to do that, and is sensitive to the natural environment, and again is something that can last for many decades to come because worry that whatever we do we will always have to keep bringing it up. And I think about Battery Park City here, where we are sitting now in this 92 Acres that wasn't here 50 years ago, that was all river. I think there is something to be said for building out into the water to give you more space to respond and protect against it. Again, there is the environmental concerns and I don't want to diminish them, but I think there is something to be said for that, I think with Battery Park City, what was successful when they did it is that they made so much of the public space. When they built all of these acres it is not all dense corporate towers, but they built apartment buildings, schools, and cultural institutions, but also a third of it is Public Park. And I think if you are going to build space, you should create value for the people.

Lawyer and Founder of Tenants United Fighting for Lower East Side and TUFF-LESS Chief of Two Bridges Community

Do you feel there are enough public attractions in the area like parks, theaters, playgrounds, ball fields, etc. or does the waterfront need more?

I have been a resident of the Two Bridges Community for 22 years and I have been living in New York City since 1985. I am the major representing person of Lower East Side Community Residents. That is one of the things we are missing, open space obviously is a premium for New York City. In Two Bridges we have a lot of impermeable surfaces and a lack of open spaces. We need everything; we have asked several times to expand one of the piers when it started being taken over by the Sanitation Department (NYC) and Fire Department (NYC). We have asked to see if we could put some new roofing over there to allow for more open space, but there has been some pushback because then the garbage trucks and fire department trucks would have to go somewhere else. We have tried to find new creative solutions to provide open space but it is difficult.

What are the favorite places that people always visit in the neighborhood? How much time do you spend at the waterfront? Would you use the new park or river walk proposed?

I spend a lot of my time at the waterfront, especially because I live there. The waterfront is just one of many areas that have been developed and provides a space for people to enjoy. A spot opened up right behind my building at Ricker's Slip, South Street, which is very popular. Since its opening, it has become quite crowded, to the extent that there were even wait times to use the exercise machines, which is unusual to see. There just are not a lot of amenities when you build something and it is free and accessible with open space along the wharf then it becomes very popular. Right now, that is my favorite spot.

What are the actions that should (or shouldn't) be carried out? What would you do specifically for your neighborhood? How long has the Riverfront been in this condition?

The Two Bridges waterfront has been in a dilapidated state for many years. It was once an undesirable area with abandoned cars, and high-crime rates, and people generally ignored it. To address this, the city implemented a strategy about 50-60 years ago by constructing a significant amount of low-income and affordable housing along the waterfront, particularly in the Lower East Side. That was because the waterfront used to be an undesirable place, it was docked and it was all industrial. I think within the last 20 years in many cities, including New York, people began to realize the value of waterfront and so they start to develop it. And it put a lot of pressure on existing residents who lived in the area for a long time. They know that no one ever paid any attention to the waterfront and no one ever built any highways, because it was just an industrial area. The perception and significance of the waterfront changed as people realized the benefits of living near the water. New York City went on a campaign to the Federal Government for the waterways to make them more attractive. Then we started to see many waterfront development plans. Ironically, after Hurricane Sandy, there was a surge in housing development along the waterfront, despite scientific knowledge that this area is prone to flooding. Thousands of housing units were constructed, raising concerns about the long-term sustainability and safety of these developments.

What is the role of your business in the territory? What resonance does its activity have on

the territory? Are you in collaboration with other associations?

I am part of a neighborhood-led, resident-only waterfront group focused on the Two Bridges area. The uniqueness of our group is that we are the only group that has resident leaders and we do not have other people involved. We formed this group primarily so that the people who live on the waterfront for 50 years have a voice in what is going on. We formed this group because too often, other organizations and groups speak on our behalf without truly understanding our needs. We do interact with many government agencies and many other groups but we never compromise our own perspective or surrender our voice when participating in larger discussions. It is important and we hope that this will be a model for other communities. Sometimes you need to form a group of residents only. You can interact with the CBO's and directly with government agencies but you need to make sure you have a voice at the table. Now it is a challenge because many of these meetings occur during the day and we have to adjust our schedules and be more flexible, but we always try to make sure that at least one person from our group goes to these meetings and is involved.

Are there activities organized to involve citizens? How do citizenship respond to organized initiatives? What are the relationships with the nearby activities?

I will try to answer as best I can because we are a pretty small community in terms of the area. The Two Bridges community has a relatively small area, with a land shoreline of approximately 0.82 miles at most. We do try to activate the waterfront; we have a number of little activities from small grants coming in. We have a family day to get people involved, and we have an exercise day just to keep people active. We are limited to just about that for events that we can do for our residents. But all of our activities are primarily organized by residents in the area. Obviously, there are other groups involved, and it is not only to make people feel like they are involved, but it also gives them a feeling of stakeholders to steward in their direction. Without such involvement, there is a risk that some individuals may feel discouraged, give up, or disengage from community affairs. Our goal is to empower residents and make them feel that their participation truly matters.

Does the municipality respond to organized initiatives? How is the area perceived by the citizens? What are the potentials of that area? What are the biggest vulnerabilities of it? What social risks is it subjected to?

In Two Bridges we are dealing with several challenges and risks. One major issue is the number of development proposals we are facing. To address this, we have a resident panel in place to oversee and control the development process. However, the current master plan for the area is completely out of scale with our neighborhood, and it is evident to any planner that it does not align with proper planning principles. However, with development pressures, we also face resiliency pressures. This means the developers are able to come in and build their building to code and beyond code so that they can withstand storms. The existing form of docking in place does not have that ability, so it is very difficult to get that for all the buildings. Non-profit-owned buildings, like the one I mentioned, will require significant investment in flood protection measures. So, we not only face threats from developers but also the pressure to implement resiliency measures that directly impact the residents. It is challenging. I know there have been offers for the building that I live in where they come in and say you have a nice spot and we would like to take over this spot. But what you are doing is pushing out the people who live there all of their lives, for 40 to 50 years. There have been discussions about relocating people and pushing them away from the waterfront, but there is a lack of trust in such plans. Moving people away from their homes is not an ideal solution, and past experiences, like the situation in Essex Possey Ward, have shown that promises of returning can take decades to fulfill, coming back 46 years later they got finally their homes. These threats are currently being addressed through community engagement, such as the recent Town Hall meeting, and further discussions are expected. I think our area is extremely unique because we are not only facing development pressures but we are facing the threat of climate change and all of them are very related; all of them are a big hurdle to keep the affordable housing stock in the neighborhood stable.

What are the most significant natural disasters that the coast has suffered and how did the people react? How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

Certainly, the primary concern for Two Bridges, like many other coastal areas, is the impact of climate change. The Mayor just recently proposed a plan to extend the area below the Brooklyn Bridge 500' out into the water to enhance resiliency. Another controversial decision was made to raise the East River Park from 7' to 8'-10' which was a complete departure from the previous plan. There are people who are scared of this plan, who are not sure about it because these types of plans get started and never get finished. Raising the edge of East River Park and Lower Manhattan creates a significant contrast with the lower-lying area of Two Bridges, which sits at an elevation of 7 feet. This leaves the neighborhood vulnerable to tidal inundation, and there does not seem to be a specific plan addressing this issue for Two Bridges. Unless the city intends for Two Bridges to become a floodable area akin to Venice, there needs to be a more comprehensive plan in place to address the vulnerability of the neighborhood. What the Mayor did propose was out of budget because it cost $9 Billion. I do not really see how it is funded strictly from government money. There is a possibility that the city may seek funding from developers, which could increase development pressures on Two Bridges. Developers might argue that constructing buildings in the water is the only viable option to protect existing affordable housing along the shoreline.

What do you think can be done? Of the proposals that have been made, which do you think are most feasible? Which will likely to most effective?

I understand the plans, I mean I am more indepth; I have been attending meetings and studying this for at least a decade. I rather understand the reason for raising the East. The plan for Two-Bridges involves a series of deployable that have never been tried before in the City. It is a first for the City. The plan for the seaport is equally ambitious, costing $9 billion and extending 500 feet into the water. All of these plans are grand and ambitious. It is difficult to determine which ones will work. They are extravagant plans such as what I am calling Seaport City 2.0, which is the extension of the shoreline. I do think the new plan for the East River in some format will get done. I'm hoping that it will take three and a half years if not longer, that is ambitious and I'm not sure if the City has ever done something this massive in scale and costing nearly $ 1.5 billion. I will say that I am pleased the Mayor is making an investment in the Lower East Side because 90% of the area is low-income or affordable housing. We do not often see investment in resiliency measures in low-income neighborhoods. Getting the public to that point where they can accept resiliency matters is a little more difficult. There is a lack of understanding of the procedure to implement these plans and the science behind it, which is a little more difficult. I am happy about it because we have been fighting for this for years. And sometimes when you get it to resiliency and the way to build in the resiliency measures is not always pretty. It requires a lot of community involvement, especially when dealing with a small shoreline. You talk about Manhattan, which was not really built for resiliency, this sort of reconstruction shoreline is a difficult process and it is a very expensive process. I really do not know which one will work the best. They all need to work and I am curious to see how they do that right now and how in 5-7 years the neighborhood will be and survives in terms of pushing people out.

To what extent is 'technology' (e.g., pumping stations, movable barriers) a solution? Are there any good non-technological solutions?

I believe that most of the flood resiliency measures being used are not necessarily new technology, but they are new to New York and to this sort of landscape. I have seen flip-up deployable in other areas, but it becomes more challenging when dealing with limited space and numerous underground wires and pipes. The only way that we are going to find out if it works is during a storm. There is a number of pumping station but there is a whole issue of drainage because once you raise the edge you have to figure out how to get out the water. There are a number of tanks proposed. From a scientific standpoint, I am uncertain how much of this technology is genuinely new, and I imagine that New York borrows from other flood-prone regions in the United States and abroad, particularly in Europe. These areas often face regular flooding. Many people have expressed concerns about the effectiveness of moveable barriers and whether the city will have the necessary manpower to execute these plans in a timely manner. It will require people to be present to roll out and put the barriers in place. These are the challenges we will all have to face. However, I do not think these concerns should be a barrier to taking action. Some individuals may argue that there are better approaches or question the readiness of the Office of Emergency Management (OEM) to handle these measures. I believe it would be beneficial to involve researchers and students in this process, starting now. They can examine these plans and, in 20-30 years, reflect on whether alternative approaches should have been taken. It is a good starting point.

Who are the key actors in bringing about a solution? What do you think is most likely to happen in the next 10 years?

You need a progressive Mayor who believes in resiliency and understands its importance; I think we do have such a Mayor right now. But, more importantly, you need a State and a federal government that believes in that also. I do not think we have the Federal government for that at this point. We will see what happens in two years, in terms of who is in office. If a climate denier becomes President, it will pose significant challenges, as the responsibility to fund these massive projects will fall solely on the State and City. I believe these projects are too immense for the State and City to handle alone. In the next decade, depending on the political leadership, we will see how things unfold. It is surprising that we have to depend on whether the President is a climate denier or not as to whether we are going to protect our City, our State and our Country from Climate Change. It is yet to be seen, I know New York City is committed to it. I have met twenty people in the Office of Recovery and Resiliency who are committed to it. I think the

City, with its $1.4 Billion price tag for the East River and nearly $0.5 Billion for Two-Bridges, has shown a commitment to defending against climate change. Also the other parts (such as in the Rockaways and in Staten Island) are all funded in large part by the City and the Federal Government; all from our past President. Now for the larger projects, it is going to rely on who is President of the United States.

The economy of that area on what is based or could it be based? Can the waterfront redevelopment project be considered a resource? What could be a propelling engine for the improvement of the waterfront? What would be necessary for its rebirth?

It is a challenging situation in an affordable neighborhood because any new development or improvements raise concerns about gentrification. However, I believe that just because you live in a low-affordable neighborhood does not mean you cannot have nice things. There is a way where you can put nice things in a neighborhood without necessarily gentrifying it. We have slowly been doing that with the waterfront, making sure that everything we put there is passive, it is affordable for the people who live there and it is also an attraction for the neighborhood. Just because you rebuild a walkway does not mean the area is going to gentrify. The resiliency efforts undertaken by the City present an opportunity to create family-friendly and neighborhood-oriented spaces along the waterfront. And it is a bottom-up approach, which the City typically does a top-down approach where they decide what they are going to do. Right now we are doing community planning, we are having a series of meetings where we say as residents 'this is what we would like to see along the waterfront in connection with the resiliency projects' and that is important. That is how you prevent the whole gentrification issue. By listening to the residents and involving them in decision-making, we can ensure that the outcome reflects their desires and needs rather than decisions made solely by the City.

What are the vulnerabilities of coastal built heritage? Can the intervention in these areas involve risks of cultural involution or loss of identity of the place? Is the level of physical fragility of coastal settlements high?

We discussed the history of New York City, and you know that there are plans to extend the shoreline along the coast. I understand that the Seaport area is probably the most vulnerable area. I also know Lower Manhattan is considered one of the birthplaces of the nation so I think it is important that we respect that, but I do think it is going to be challenging. What is required to protect the City from coastal storms, tidal inundation and climate change is radical thinking) All of it is radical. People have even said to retreat and let it flood and build marshlands; back to the way, it was originally because a lot of New York City's land is landfill. Whereas the other proposals are opposite, where it is saying 'let's build more landfill' and New York City has always done that. I do not have a definitive answer to this dilemma. It's a question that requires further consideration and thoughtful discussion.

What could be the vulnerabilities to which users are subjected to flooding? Can the new interventions lead to risks of social exclusions? How to avoid gentrification?

To address gentrification, I believe that rezoning plays a crucial role. If we want to talk about this area we talk about the scale. I think what a lot of people don't realize about and maybe they are realizing it now is rezoning. One of the things we are doing as a community-led group is applying to rezone our Two-Bridges waterfront. One thing that people did not realize and I think was probably amplified when the Mayor announced Seaport City 2.0 was that there are underwater lots property around the edge that were developable. An important aspect of our proposal is mapping the underwater lots along the edge as parkland. This is crucial for the community to understand because if these lots are not designated as parkland and the proposal goes through, there is a risk of potential building construction. If we get this mapped as parkland, then the only thing that they can do is build more parkland and open space, which would be great. To avoid gentrification you really need to involve the community in every step of the process. There are successful models for that. Resiliency planning provides an opportunity for community involvement. You bring people in, they know what their experience was during Sandy and other storms, and they are able to express that they want some type of flood protection, but they are also able to give some input as to what should go there or what that protection should look like. I think those are key methods to avoid the threat of gentrification.

What do you think of the new design strategies for New York City? Which are the key factors to design a good waterfront? Who are the key actors in bringing about a solution? Considering that when we build something, something else is destroyed. In creating these new strategies, what do you think can be lost?

Community involvement is indeed crucial, and it is commendable that the city is making big and bold moves. Raising the East River Park may be controversial, but it is yet to be seen if that is the best plan. Sometimes, when the city changes its approach and presents a new plan, it can catch people off guard. However, it is important for individuals to step back and evaluate whether the new plan is actually better. Does this work? Does this protect human lives?' I think somehow that gets lost when people get upset or about the way people are doing things. In the end, is this a better plan than what was presented before? With Seaport City I think that is a tough stretch. I really do not know with our current climate how feasible that is and the timetable for doing that stretches into the 2050s until it is completely done. Therefore, we are not really talking about something that can be done in a decade or anything below that, 2050 is closer to what people think. You lose a lot of the neighborhood because you are creating new neighborhoods, you create a whole shoreline, you create landfill. Regarding the three proposed areas, namely Lower Manhattan, East River Park and Two-Bridges, it is important to recognize that those are three different areas. One area will create a new park so you lose whatever history you had in that park. You have to destroy that entire park, dig it up, so all of those memories that people have and all that connection that people had of the people who used that park for 50 years is all going to be changed. I think that social identity is going to be lost, but what people will be saying is 'we are saving your life'; so there is a trade-off with that. For Two-Bridges the waterfront wasn't the nicest place, at all. There might be some history there but it is not some place you walked at night. Therefore, I think people for the most part are happy to see that it is developed to a certain extent. I know people who have complained that other parts of the City are nicer (Battery Park, Brooklyn Bridge Park), so people say they go there. But when we talk about new development in the Two-Bridges waterfront people get very nervous. We all say we want a better waterfront like those other parks, but when we say that we are ready to make your park nice, everyone seems unsure. So the key is let the people get involved in how it is designed.

Do you think revitalizing the waterfront is a good use of public funds? If not, then in your opinion, what could be a better option?

I think it is an excellent use of public funds. Our waterfront is important and is a defining feature of New York City. We are an island and our waterfronts are horrible for the most part, especially in our particular neighborhood. Therefore, I do think it is an extremely valuable investment. In terms of overall City dollars, I wish they would put more into it. If you look into other cities like Chicago, they are all doing stuff along the waterfront. The drawback to that is some of the poorer Cities are along the waterfront because they were industrial and the people have been there all of their lives. However, the place was never developed and now they are forgotten. Our connection to water is important and our understanding that we are a waterfront city is important. I do not think we spend enough for this size city. I think you could quadruple the budget for these waterfront projects. I do not think it is a waste of money at all.

What do you think New York City should do considering the large amount of money made available to solve this problem?

I think the Mayor announced that they will have an overall Masterplan for this. I thought the Office of Recovery and Resiliency (ORR) was going to do that, but I don't know if that ORR Masterplan focused so much on overall planning for the city. I think it focused on regenerating a city and how to build resiliency. I think there really needs to be a masterplan to talk about the city as a whole and it needs to cover short, medium and long term. One to two years, what will we do in five years and what about thirty years and one hundred years? I think the City is moving towards that but this is all new for everybody. No one thought that New York City could flood like it did, no one could imagine that. Therefore, the City is trying to regenerate itself and we are still relatively young in that process. A lot of the technologies and solutions are untested. I think we are still walking, baby steps, trying to figure this process out. I do not think we are done by any means; it will be interesting to see what happens. I am looking forward to it; I hope I see these things in my lifetime.

Which are the best strategies to mitigate the social vulnerabilities? What can be the threshold of integration between the existing settlement system and the proposed technologies solutions?

I think it goes back to the same theme that I have been talking about and that is community involvement. There is going to be some development along the waterfront and there are going to be massive resiliency projects. What we do not want is to use these resiliency projects as an excuse to build a new development. We want to use them to protect our neighborhoods and we want to use them to protect against climate change. To protect the neighborhood for the people who live there from being moved or forced out. If you make a neighborhood safer and if it has the top of the line resiliency measures in place, then developers are going to look to that and say 'Hey this is the waterfront and now it's safe to build our buildings there'. So let us see if we can find spots to build a luxury house along the waterfront. Rezoning is key; Community involvement means making sure folks are involved in the design. Putting in protection measures for the existing residents and I am talking about permanent affordability, not just 20 or 30 years. Because 20 or 30 years go by quickly and you do not realize it, I have been here in the same building for 22 years, it doesn't seem like it, and the existing contractor who was in our building expired so they could have gone the market way selling. We worked out an agreement so it does not go that way. But it still loops into another 20 or 30-year cycle. I have attended numerous community meetings, actively listening to people and forming my own opinions. I remember the first few meetings they did not want to call anything a wall. And they did not use the word "wall". It was banned from meetings 'and if anyone uses the word – wall, hit them'. Therefore, I used wall on purpose just to irritate them and people did not know what a berm was. All of a sudden we had to educate them, so all of our local leaders, about terms that the City was using and some areas in Europe and other places. We did not know what wall was or a berm or deployable. In other cities, the process of constructing a wall may be straightforward, where you simply get it done and find a way. However, in our City, everything comes with inflated costs, uncertainty regarding effectiveness, and the risk of companies going bankrupt after a few years, leaving behind unfinished structures. Initially, we had the challenging task of educating people about these solutions. Some residents found the 20' or 30' high berms visually unappealing, questioning why we were placing them next to low-income housing. It is important to note that low-income housing is not situated near the waterfront, but the community still had concerns about the presence of walls or berms. Over time, the community arrived at a more acceptable solution that resembled gradual walls, blending with the changing landscape and reducing the wall-like appearance. However, the Two-Bridges area posed additional complexity. The original proposal suggested erecting 8' to 10' walls along the water, but many deemed this idea unreasonable.. There were people who argued that we need to put measures wherever we can to make sure we are protected. No, we are not putting up a giant 10' wall along the waterfront where you cannot see the water and you have the FDR on top so now you have what looks like a prison. Concrete walls were seen as an easy and inexpensive option. In response, we advocated for a more flexible approach, considering that flooding occurs 99% of the time. Instead of permanent walls, we aimed for deployable solutions. We envisioned the flood protection structures to be dual-use, serving as playgrounds or community spaces during normal conditions, and flipping up for storm protection. The playground features would remain intact, serving as flood protection during times of need. This approach was designed for the prevailing "Blue Sky" conditions, as the majority of the time is flood-free. We are talking about the East River right now, because the it does have space. There has been a shift in the plan, as the initial approach involved allowing the water to rise over the edge, but it has now been flipped to raising the edge itself. There are some community members who support this change as it eliminates the need for a wall near public housing areas. However, there are some members who do not want it because for whatever reason they think the old plan was better. In East River Park a significant portion of the waterfront housing consists of publicly funded units, and residents have expressed their preference for not having a wall outside their windows. Some individuals suggest scrapping the existing plans altogether and proposing alternatives like decking over the FDR (Franklin D. Roosevelt) Drive. However, it is essential to recognize the extensive planning and engineering fees that the city has already invested, amounting to $49 million, without the project even commencing. Introducing a new plan, such as decking over the FDR, would require an additional $50 million expenditure. Moreover, there are federal spend-down deadlines to meet, and community outreach remains a crucial aspect. Considering these challenges, it would be quite demanding to pursue a complete overhaul at this stage. In the East River area where they do have space, there is a severe division between people who believe it should be done or it should go back to the old plan. It is yet to be seen if the community will ever get a consensus on that and if the City is allowed to move with it.

What could be the new views for the neighborhood? How do you imagine the future of New York City waterfront?

I believe the Rebuild by Design process, in which I was involved from the beginning, was a valuable initiative. I think what was missing after the entire process, because ultimately it was to get federal funding; that was the ultimate goal. They did not get the community involved. We were talking about concepts of a design but we were not getting into the actual designs. So when Rebuild by Design came out, and Two-Bridges is a perfect example, they proposed flip-down panels for the FDR. It is nice, but it is impossible to make them flip down from the FDR from an engineering standpoint. In addition, you got involved with the State Department of Transportation (DOT) and it was not something that is feasible. That portion of it was missed from the public because everyone who got involved thought we were going to get flip-down panels once the money got awarded and then we learned that was not going to happen. Therefore, I think that portion needs to be worked on. However, I imagine it involves engaging people more directly in the concept. It is important to exercise caution with concepts because people may attend meetings with the expectation that a particular solution will be implemented. Subsequently, they may express confusion or disappointment when they realize that certain ideas, such as building a dome over Manhattan, are financially unfeasible, costing $87 billion.

Senior Technical Director of AKRF, INC as Environmental Planning and Engineering Consultation for BIG U and Lower East Side

What are the biggest vulnerabilities of the New York City ecosystem? How serious are the rising sea levels for NYC? Which areas are most vulnerable? Is this a problem to address immediately?

The rising sea levels pose a significant concern for New York City. In the past century, we've had about 12 inches of sea level rise, but during the Bloomberg administration, that city began recognizing the future risks and accelerating the implementation of strategies, particular after Hurricane Sandy. The areas most vulnerable are certainly those around Jamaica Bay, lower Queens and Brooklyn; these are historically beaches and waterfront communities, where houses are not built to code or to current codes and their residents, especially in these areas can be severely impacted not only by storms, but sea level rise is going to be their biggest threat. If you live in an area with a beach in it, you know Howard Beach, Rockaway Beach, etc. If you live somewhere with the word Heights in it (Brooklyn Heights or Dyker Heights) then you are probably pretty safe. There are areas in Southern Brooklyn, Red Hook and Gowanus Bay that are also susceptible and Staten Island of course. There are relatively narrow areas of the coast of the other major boroughs that could be impacted by sea level rise itself but in a lot of areas that are not inhabited by homes, it is often parkland or roadways, whereas around Jamaica Bay it is mostly residential areas. Addressing the issue of sea level rise is immediate in some areas, but overall, it is crucial to study the problem and develop feasible strategies for the entire city. One of the challenges lies in the mix of privately and publicly owned properties, making it difficult to enforce uniform improvements or changes. When one property raises its park or installs barriers but neighboring properties do not, it compromises the overall effectiveness of the system. Therefore, the city needs to establish an authority capable of enforcing policies and decisions to address this issue effectively. For the East Side Costal Resiliency project, sea level rise is something that we have accounted for in our flood protection features. But last year we actually made a significant design change to address future vulnerability of East River Park, so our project originally was designed to provide flood protection for 100-year storm with 30 inches of sea level rise and the ability to adapt for an additional 24 inches of sea level rise. So what we have viewed as a hundred year window. However the area between our flood protection and shore, which was mostly parkland, was going to remain at its existing elevation. So through studying we identify that within 50-80 years, with see level rise, then that parkland would be inundated with a simply high tide or especially if it was a spring tide or some sort of king tide. So the decision was made to actually proactively raise the park and address long term vulnerability to sea level rise alone, not just coastal storms, while maintaining the basis for the project which is for a hundred year coastal storm tide.

What are the greatest resources and what are the biggest obstacles of the proposals that have been made? which do you think are most feasible? Which will likely to most effective?

For the East Side Coastal Resiliency project, the obvious greatest resource is the available park; East River Park is quite large and it provided us the foundation to build the flood protection without impacting the neighborhood significantly. This compartment was identified early on in the Rebuild by Design process due to its potential for implementing the big berm and securing available capital. The city has committed a substantial amount of funding, surpassing federal funding, to make the project as effective as possible. The biggest obstacles faced are the absence of a clear authority in the city that can make high-level decisions and the competing interests and requirements of different departments involved, such as the Department of Transportation (DOT), the Department of Parks (DOP), and the Department of Environmental Protection (DEP). Each of those has sometimes competing interests and requirements. So trying to make designs that can address all of their needs has been a real challenge. Regenerating the waterfront park, we have to address the impacts to DEP amount of sewer infrastructure within that park. We are building adjacent to a major highway, the DOT has concerns about the impacts that we could have on the highway. Who is going to maintain that base facility once they are built, the City has never had them. Therefore, they have to maintain facilities for what we build into the city infrastructure and they've never had a facility like this. Again, we don't have an agency that is a Resiliency Agency and the responsibility would be to maintain, operate, inspect and also repair. Perhaps as additional compartments of the Big U are built and additional resiliency projects are built in Jamaica Bay or Rockaway or Red Hook then hopefully the city will identify and create an agency as an umbrella view of that. However, our biggest obstacle that I have found is that this is the first project of this nature in the City and it's difficult to get a full understanding and commitment to it. Therefore, for a century, they have been maintaining, inspecting and operating bridges; they have a very specific way of doing it. They know they have an inventory and understand how to do it and anything that you try to add to that inventory that is out of the ordinary becomes a challenge, so we are trying to do things that fit their requirement. Of the proposals that were made for this area, for instance, the big bench or at least park features, in New York City there's the Department of Parks and they have a very specific and strict standards of what a bench, a light-fixture or playground equipment should look like. If you do not have a community organization such as Brooklyn Bridge Park or Friends of Brooklyn Bridge Park or the Prospect Park Alliance, the Central Park Alliance, you cannot use anything in the park, because that is not a park standard for they have the funds and, again, replacement parts. So these other parks in New York City that have new features, because they are founded through fund raising and private donations and it doesn't fall on the Park's Department to maintain that, it is still a New York City park, but the funds come from outside. We do not have that situation in East River Park. It is in a low incoming neighborhood, it is not a high profile park, it is mostly used for active recreation, like baseball and soccer, but it is not a destination park like the Highline or Brooklyn Bridge Park. So that has been a struggle, there is this vision for what the park could look like, but then you know, we are constrained in what we can actually achieve because of the park standards. Therefore, we did studies of the big bench and the flip-ups and all these things. What it comes down to for our project is that the most faceable things are those things that have been proven to work in Texas and in Louisiana. Therefore, you know, flip-up gates, the City was not comfortable with in trying something new. They needed to ensure that the Federal Emergency Management Agency (FEMA) was going to accredit the system. That means revising the flood maps, right behind the system, because of the federal funding which was originally going to be a huge portion of the funding for the project. A condition of getting the $350 millions from the federal government was that FEMA accredits the system. So using experimental flood protection features was not something that was approved. So ultimately the challenge for the designers, for the urban designer's architects was then taking features that are standard, a concrete wall or steel floodgate and trying to enhance that in a way to make it fit more in the vision the educational or recreational goals of what the Big U was. We can provide flood protection but the system needs to, you know these people are going to be living with this every day when there is no floods, so how do we make can make it as the original vision.

Are there any good technological and natural solutions? Who are the key actors in bringing about a solution?

In terms of technology, this project is specifically designed to be non high-tech. Everything is manually operated and everything except for two very small features, operated from the hydraulic pump. Otherwise all the gates are to be closed by people that are swinging gates closed or rolling gates closed; the tide gates just close on their own. This reduces the operations requirements and the concerns about maintaining a system that, again, flooding may not happen for another forty years and it may not ever happen again. The Department of Transportation (DOT), being the primary actor, expressed strong concerns about the potential increase in operational and maintenance costs associated with a more technologically advanced system. Therefore, they requested us to find solutions, and we did, that would require some additional planning and staffing when there is a storm event to make sure that people are out there closing to the gates. It has a slightly increased duration of impact on the city because we are crossing many roadways; so those roadways, obviously, when the gates closed the roadways gets closed. We are integrating a portion of flood protection at the VA Medical Center, which is between 23th and 25th street. They built a floodwall and they built their gate system, which is a pop-up gate. So they feel comfortable, they also have pump stations to address any infiltration. Whether we can get FEMA to accredit those pop-up gates is still an open question. FEMA has not accredited a system with those gates. They have been tested in benign conditions to show how they work. I am not aware of any actual floods where they have been used but I think the people who manufactured it stand behind it. I think that is going to play a much bigger role in the Lower Manhattan, the Two Bridges Project. There is a lot of space underneath the viaduct, where putting wall or putting these giant steel gates which we have in our project is just not feasible, so pop-up gates are most likely not going to be used there. There are also the NYU Langone has another sort of style of pop-up gates. There is the other style of pop-up, press gates, which we call bottom-hinged gates that water comes in, it makes the gate float and come up. At NYU they also have a version that is a vertical gate, the water comes in and the wall starts to rise. That vertical gate is an excellent solution for certain conditions. I definitely think for parks, for roadways might be a different problem or issues, one of the concerns for any of these gates are on an activated roadway if the gates come up during or are activated with heavy rainfalls and even if the water comes up an inch or two it could damage cars. One concern with activated roadways is the potential damage to vehicles if the gates come up during heavy rainfall, even with slight water elevation. The hazard to vehicles, along with the increased cost, were significant factors in the decision to opt for a low-tech approach. Pumping stations are also considered a viable solution, especially at the VA Medical Center where they have low-lying areas. These stations can help supplement the barriers by addressing water overtopping in specific conditions, such as surpassing storm event expectations or higher sea level rise than predicted.

In which way we could consider the Big U both a social and a resiliency project for flood protection? What do you think could be the most important aspect between flooding security and social integration?

An important consideration is the long-term impact of sea level rise. If we solely focus on constructing a barrier without addressing issues along the shoreline where people live, work, and engage in recreational activities, there will come a point where the barrier must remain closed constantly to prevent flooding from spring tides or high tides. By only addressing one condition, we neglect the ongoing challenge of sea level rise. To effectively address sea level rise, additional financial resources in the form of millions or billions of dollars would be required. Of course, here in New York the concerns with the people who live immediately adjacent to it, but since this is an important estuary and ecology. Therefore, even if you put a gate, no matter how big you put that gate, the fresh water that would normally flush out of the harbor is going to be restrained. It's like pouring water through a strainer, it slows down, so you are going to get issues with increasing salinity and impacts on what habitat and a sea life that you would expect.

What kind of maintenance does the Big U need? Whose could be the possible investors? How do you think this project could influence citizens' behavior?

I think only when you start to recognizing and experiencing the scope of the problem and the cost, you can well estimate because of buildings in this urban environment are complexity and part of the utility system with the roadways and the highways. In addition, there are the costs of materials in construction and labor. You cannot really appreciate it until you do it; you have been studying this for four years but the budget can change, for instance, our project of 2.5 miles of coast is 1.4 billion dollars, but the City has several hundred miles of coast. Perhaps a project built in Battery Park City, in some areas where there is a more concentrated wealth, maybe they would be interested in helping to fund that project. Here, they are scared about their impacts and something happening again in the future, but they are not a visible group for resiliency. There is a visibility for NGO's and other charitable organizations to help in other ways not for the resiliency. Unfortunately, until something changes, Federal, State, and municipal funding, is the only place you are going to get the investment.

Every time we build something, something else is destroyed. In creating these new strategies, what do you think can be lost? How is the project evolving? Has it changed along the way and why?

The project has indeed evolved over time. We spent the first several years and a large amount of the design and investigation effort trying to implement the bridging berm, big berm vision within East River Park, which called for a line of flood protection along the highway with an earthen berm to hide the wall from within the park. So when you are in the park you would feel like you were in a park, you would be connected to the river and see planted in green areas but if you were on the highway or if you live in the NYCHA apartments until you were higher up, your experience would be a wall. So there was certainly a disconnection being created, visually, between the community and the park. The highway (for example), the FDR already creates a physical disconnection and we are trying to address that with new bridges and access points. And so the evolution of the project to raise the park then maintains the existing visible connection between the park and the community because now we are removing that wall. It enhances the visibility of park from outside this area. For instance, if you are in Domino Park, in Brooklyn, Williamsburg, if you look across the river, that is our project area. If you went there now and looked, you would not even see there is a park there, you would just see cars driving on the highway, maybe the trunks and branches of some trees. You can see flat land with a couple of small buildings. Therefore, by raising the park and adding topographic features it will become much more visibly and visually clear that it is a green space, that it is more welcoming, and it is not just something for the people using the fields. We have been doing a lot of work to try to increase the usable open green space that is between the fields; converting some of the fields so that they are more like the great lawn in Central Park. They are not fenced off, so when a game is not being played it is a grass area, people can use it and the kids can play. We are adding new playgrounds and new facilities. We want to really improve it and address some of the concerns the people have who live there and want to use the park. They wanted more playgrounds for their kids; they wanted more areas where families can gather. So that is a real improvement while providing flood protection; it addresses 100% of the goal of the Big Vision to provide flood protection, but 99.9% of the other time when there is not a flood that it is a usable space. When we move out of East River Park, I think the historical identity of that park is in many ways connected with the historical identity of the public housing because the park was built at the same time as the public housing, which was the mid-20th century. The Park itself is not a Homestead or Vox Park, it is not a modern park, it is not a historical park, but it has a very close identity to that neighborhood. So yes, certain people have expressed concerns. There are areas of the park that maybe they have been visiting their whole life, they love it, and they are scared to see it go. But that is where the importance of messaging that the park will be an improvement and there will be new features, new trees, that when they are full-grown it will be an improvement.

How could the BIG U purpose be actually designed? How is the project connected to the overall experience of the BIG group in Copenhagen?

For the studies, visuals, planning and overall work carried out by the Big team here in New York, they are personally reviewed by Bjark Ingels. He was the visionary behind the Big U and he is still personally involved in any of the work that they do. The team consists of architects, urban designers, and planners, landscape architects and other diverse professionals based in New York. But in order to actually implement this project, it requires a huge team of coastal, structural, and geotechnical engineers, bridge engineers, building designers, a huge team, and it has been a growing experience and challenging to implement a vision as closely to that vision as possible, as we talked before, while working with the City.

The project was temporarily halted by the Department to conduct a Value Engineering study. There were concerns about constructability impacts to traffic and the highway because of the alignment of the flood protection and the decision was made to change the design. So the design was changed to elevate the park, which is a strategy that has been proposed and implemented in other cities. Boston has a very similar strategy where they elevate, what they call, harbor walks, esplanades and other means to provide the flood protection at the face of their harbor, which would be our river. And it allowed us to expand the limits of the work that we were doing within the park. We are replacing aged buildings that had not been maintained and do not meet current standards for facilities for the public, add additional playgrounds, additional topographic features. We had a bridging berm, it was really a flat park, but we had elevated areas in the back of the park; now by raising the park, we have areas that are high by the highway and low by the river, or areas that are high by the river and low by the highway. It is a much more varied terrain. I personally feel it is an improvement in the design (the value-engineered recommendation). Yes, it resulted in a delay and there was some confusion in the community about why decisions were made and how they were made and what ultimately the description of the project was now, but it is the same project; it is just that the design was changed and expanded a bit. The design change was not the entire project, it was the area South of East River and the area North of East River Park remained unchanged. The project still includes exposed floodwalls and floodgates, with numerous gates crossing streets, roads, and parks. The challenge lies in planning the construction process to minimize impacts and ensuring the continued usage of the parks in the same manner as before. The community's feedback was taken into account, and their desire for no changes in certain parks, such as playgrounds and baseball fields, was respected and incorporated into the design. We have 18 gates, 14 of them are north of the park, crossing streets, roads and parks multiple times.

What could be considered the main components of the project? Under social and technological aspect?

In terms of social aspects, as mentioned with East River Park, especially the improvement of the usage of the park and the inclusion of new facilities and additional ones, consists mainly of fields with planned pathways and limited gathering areas. The project seeks to create more gathering spaces and enhance the overall social experience, making it a community-building opportunity. This emphasis on social integration is considered one of the most important aspects alongside flood protection.

The main technological aspect in the project is educational, which is the ability for people to understand not only the storms but also the sea level rise. The main component of the project, while it is a flood protection project, a majority of the work that is going to be done is park redevelopment. While it is a resiliency project and that goal and the requirements of the resiliency have always been addressed and respected. Ultimately, a lot of the workers and a lot of the community focused and facing elements have been about designing park space for, not only the people that live there now, but the people who will live there in the future. When you think of BIG U and flood protection that was, sort of, the impetus for creating it, but actually when you think of it, it is connectivity to the park and improvement to the park is the main thing. It is at least equally important if not more important I mean. Regarding technology, the approach is to make it as un-technological as possible. This approach presents an opportunity for education, as tried and tested methods often prove to be the best due to reduced risks, concerns about funding, and the potential for performance or failure. For instance, the project addresses concerns about the gates' functionality by ensuring that they are manually operated and physically locked, minimizing reliance on automated systems like actuators or hydraulic motors.

What could be a threshold of integration between the vulnerable settlement and innovative mitigating solutions?

The project has undergone a shift from high-tech solutions to low-tech improvement solutions due to various factors, including funding limitations, construction considerations, design modifications, community input, and community concerns. Community concerns were another reason why the flip-down gates were eliminated because people did not want something that "may not work". The city had the same concern about the kind of maintenance using with the chosen solutions. It is generally things that have been addressed and implemented by flood protection authorities and the corps of engineers, visual inspections, regular maintenance, regular enclosures of the gates, making sure the hinges work and the rollers work, and that the locking mechanisms are in place. The maintenance requirements for the floodwall itself are minimal, as concrete is a highly resilient material unless subjected to extreme events beyond the design parameters or significant physical impacts such as a large ship collision. Under normal circumstances, minor issues such as cracking and spalling are expected to be minimal and manageable.

The project team designed three main kinds of protection options for the Big U: flip-down panels, the big bench and the berms. How do they work?

The flood-down panels were initially considered as an innovative solution, where they could serve both as a shade structure and as flood protection. However, due to concerns regarding cost, performance, and maintenance, this idea was ultimately discarded. The "big bench" is essentially a low-level floodwall that has seeding integrated within it, which seems like it could be (used), in an area where flood heights are at elevations that are not too significantly above the existing grades. It is essentially taking a simple floodwall and making it into a bench. It functions just like any other wall. In our areas, when we are talking benches, we tried to envision a bench where something came up it. But our flood elevations were just too high and it did not become feasible. Berms, we have earthen levees which are standard flood or retaining systems for dams and reservoirs, in our original design we used some earthen levees in just a pyramidal shape with a specially designed clay core. However, take up a lot of space and in our park where you need a lot of flat space for baseball fields and other things, it did not really work that well. So the berms are really a landscaping feature, we have a flood wall, we have a berm in front of it to mask the wall itself and to create usable slopes and greenery, or pathways down from the bridges and we should cross the highway at a higher elevation. They provide some protection to break waves from the floodwall itself however, it will be more of a landscaping feature.

What kind of materials will you use to build the berms and how do undulating berms help in retaining and slowing down water? How did you estimate the dimension of these technologies?

The sizing and grading of the berms have been carefully considered to meet the specific needs of the park. Each sports field has a maximum allowable slope. There is space and pathways where we have a park that the target is to be universally accessible, which means that there is no slope on a pathway that exceeds 20% or 1-to-5 (grade), which is considered an improvement on what, in the United States, is considered as ADA accessible, which is 1-to-12 slope. Therefore, 1-to-20 is much more slope-wise that were to be planted or landscaped in any way of 1-to-3 because that is the maximum slope at which you can use a lawnmower. Therefore, there are very practical reasons for the sizes and the grading of the berms. Furthermore, the elevations of the highest berms are designed to align with the bridges that pass over the highway. This approach ensures a seamless transition from the bridge to the park, providing a more integrated and enjoyable experience for park visitors. Rather than a bridge simply landing within the park, the bridge becomes an integral part of the park itself, enhancing the overall park-like atmosphere.

How do you imagine the future of the New York City waterfront? Can you explain better how will Humanhattan works?

A learning experience from this project and especially after the changes in design is the engagement of people who are most impacted by the flooding and by the interventions. This involvement might be introduced as critical to ensuring that the design addresses both those types of concerns and the buy-in or the feeling that they have value and interest in the project. They have a stake in the outcome and the result is critical. There was a lapse there when the change was happening when the study internally within the city, constructability, value, and the approach are not disconnected there with the community which we are working to rectify. It is understandable that there may have been a disconnect during the design changes, but it is positive that the city and project team have recognized the importance of rectifying this and learning from the experience. The city has recognized that. Therefore, I think that they have learned an important lesson. Moving forward that integration of the people and the solution is going to be more appreciated.

Author profile

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The vulnerabilities of coastal settlement systems are inextricably linked to the experience of individuals and communities in dealing with natural disasters and hazards within the built environment. In addition to catastrophic weather events and the inherent characteristics of sites, vulnerability also relates to human actions that affect the delicate climatic balance. In this scenario, the book is the culmination of field research activities carried out in an international context as follows: New York City, in The South Bronx and Lower Manhattan areas, invested by major processes of waterfront regeneration to address flooding and post-disaster mitigation in the built environment. The research investigated the issue of technological innovation by relating it to the demand for integration and hybridization of appropriate solutions in vulnerable contexts. The book focuses on the appropriateness of technologies as the outcome of a shared process among waterfront regeneration actors aimed at climate change mitigation and coping with flooding. By focusing on the performance of coastal settlement systems, their adaptability, and by deploying state-of-the-art participatory approaches, it was possible to establish thresholds of integration between innovative technological mitigation solutions and the vulnerable built environment for waterfront regeneration. These results lead conservation and transformation actions toward the appropriateness of technologies in the built environment. The method enables the construction of a Reticular and Integrated Model, which leads decision-making processes to improve the quality of the waterfront built environment and the lives of its inhabitants. The goal is to act on the rapid process of propagation of technological solutions, mitigating the dichotomy between nature and culture, and acting on the modern sense of human society, which is often subjected to economic pressures dictated by the speed of evolution of the built environment and innovation progress. Through the principle of integration and the ability to functionally connect the elements of a system to each other, the book proposes an approach to waterfront regeneration choices that recalls the Hybrid City model. The regeneration modes proposed to address the consequences of climate change and the vulnerabilities that coastal settlement systems and communities encounter in adapting to this new climate era.

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