How the coastal cities are transforming? The disaster as catalysts of change

Francesca Paola Mondelli, Marta Rabazo Martin, Maria Grazia Cianci

Roma Tre University, Department of Architecture

francescapaola.mondelli@uniroma3.it; marta.rabazomartin@uniroma3.it; mariagrazia.cianci@uniroma3.it

Abstract:
In the current climate crisis, coastal cities face growing risks related to both water scarcity and flooding. Climate change, uncontrolled urbanization, and the inherent vulnerability of coastal areas call for a rethinking of planning strategies. This contribution presents part of the PRIN COSTA|Med research project, which collects international case studies where environmental crises have triggered innovative adaptation strategies. Focusing on two examples—the Dutch Delta Programme and the PATIVEL in Valencia—we explore how planning and design can respond jointly to complex challenges. The goal is to identify shared trajectories and outline integrated guidelines for resilient coastal management, with a focus on the Mediterranean, one of the regions most exposed to sea-level rise.

1. Introduction. Designing with Disasters — Rethinking Coastal Urbanism in the Age of Climate Crisis.

In the 21st century, climate change has ceased to be a distant scenario and has become a structuring force transforming how we live, plan, and imagine our cities. Coastal territories—liminal spaces between land and sea—are among the most affected. The combination of rapid demographic growth, increasing anthropization, and the expansion of urban settlements into ecologically fragile zones has significantly heightened the exposure of coastal cities to natural disasters. These are not merely episodes of exceptional violence, but manifestations of a systemic imbalance in the relationship between human development and natural systems.

Among the various elements at play, water emerges as the central agent of crisis. Its dual character—both scarcity and excess—makes it pivotal to many of the most disruptive phenomena of our time. Prolonged droughts, wildfires, and water shortages reveal the fragility of inland ecosystems, while excessive precipitation and storm surges destabilize cities and coastlines. In parallel, slow-onset phenomena such as sea level rise, salinization, and coastal erosion threaten the long-term viability of urban development along the coasts.

These dynamics compel us to critically reconsider the human-nature relationship. As Neil Smith (2006) famously stated, "there's no such thing as a natural disaster"—what we perceive as disasters are often consequences of political, social, and spatial decisions, such as the occupation of flood-prone areas, the sealing of soil, or the removal of natural buffers like wetlands and dunes. In this sense, disasters are not nature's intrusion into the urban realm, but the return of suppressed ecological processes in territories overbuilt and overregulated.

The relationship between city and nature has never been static—it has evolved through centuries of shifting paradigms, from domination and separation to a more integrated and dynamic vision. Historically, urbanization in coastal territories has exemplified the impulse to control nature: land was reclaimed, estuaries filled, shorelines fixed, and rivers canalized to serve industrial, logistical, and speculative purposes. This anthropocentric model, rooted in the Enlightenment ideal of nature as inert matter to be shaped by human will, has generated a brittle urban ecology incapable of responding to contemporary environmental challenges. As climate change accelerates, sea-level rise, storm surges, and saltwater intrusion are reclaiming spaces once artificially stabilized, exposing the fallacy of this dichotomy. Contemporary scholarship—from Haeckel's early ecology (1866) to Latour's political ecology (2018) and the systemic readings of urban metabolism (D'Arienzo & Younés, 2018)—has argued for a more relational approach, one that recognizes humans as part of, not separate from, ecological processes.

This shift reframes the role of design: cities, and particularly coastal cities, must be understood not as closed systems protected from nature, but as open, adaptive infrastructures embedded within it. The goal is no longer to resist natural dynamics through static barriers, but to accommodate, absorb, and even learn from them—by

shaping urban forms that respond to hydrological rhythms, sediment flows, and climatic variability. In this regard, aesthetics and engineering must converge to support both functional resilience and cultural imagination. As Diana Balmori succinctly states, "We must put the twenty-first-century city in nature rather than put nature in the city; to put a city in nature will mean using engineered systems that function as those in nature and deriving form from them" (Balmori, 2010). This reorientation calls for a fundamental transformation in how we conceive urban life at the edge of water—shifting from opposition to coexistence, from containment to collaboration.

Jeremy Rifkin (2019) highlights the deep incompatibility between carbon-intensive urban models and the planetary limits we now face, calling for a "Green New Deal" of infrastructure capable of decentralizing and decarbonizing urban life. Similarly, landscape architect Kate Orff (2016) argues for a new ecological imagination in urban design—one that moves beyond cosmetic greening toward "living infrastructure" systems that mimic, restore, or collaborate with natural processes. For Orff, resilience is not about resistance, but about dynamic adaptation, cohabitation, and repair.

Such perspectives mark a fundamental shift in how disasters can be understood. Rather than treating them as interruptions, this research proposes to interpret disasters as revelatory episodes—moments that expose systemic weaknesses but also generate possibilities for innovation. This approach advocates for a move away from superficial "greenwashing" toward engineering-informed strategies inspired by natural systems, including sediment cycles, wetland restoration, oyster reef cultivation, and dynamic floodplain design.

Cities such as New York—through the Rebuild by Design initiative (2012)—Mumbai, and Rotterdam have pioneered these ideas, implementing forward-looking strategies that embed risk management into the DNA of urban and coastal planning. Northern European countries have institutionalized long-term resilience policies, but in contrast, the Mediterranean remains one of the world's most vulnerable and underprepared regions. Despite early efforts such as the Barcelona Convention (UNEP/MAP, 1976), many Mediterranean countries still suffer from fragmented governance, lack of integrated planning tools, and reactive emergency management. The flooding event that struck the Valencian coast in October 2024 is a stark reminder of this fragility.

According to recent projections (EEA, 2024), sea levels in the Mediterranean under low-emissions scenarios could lead to extreme flooding events becoming ten times more frequent by 2050—transforming what were once centennial phenomena into regular occurrences. In this context, a crucial question emerges: how can we plan and design coastal territories in a way that is proactive, integrated, and resilient?

This essay responds by developing a multidisciplinary framework that brings together urban design, spatial planning, and environmental systems thinking. At its core lies a curated archive of global case studies documenting how cities have reacted to, learned from, and reimagined themselves through coastal crises. These experiences are not seen merely as emergencies but as generative events—catalysts for transforming the built environment, governance models, and the relationship between land and water.

By drawing lessons from diverse geographies while grounding the analysis in the unique socio-environmental conditions of the Mediterranean, the research aims to define a set of spatial and strategic guidelines. These will serve not only to mitigate risk but also to inspire new design cultures capable of co-evolving with the rhythms of nature. In reframing disasters as design tools, this study advocates for a paradigm of coastal planning rooted in resilience, reciprocity, and long-term thinking.

2. **International References**

In the United States, a series of major climate-related disasters over the past two decades have spurred significant innovation in the fields of urban planning, infrastructure design, and resilience thinking. Among these, Hurricane Katrina in 2005 stands out not only as the costliest natural disaster in the nation's history, but also as a turning point in how vulnerability, inequality, and risk are understood and addressed in urban contexts.

Hurricane Katrina, which struck the Gulf Coast in August 2005, brought winds reaching 175 mph and a storm surge that overwhelmed the levee system, causing catastrophic flooding in New Orleans (Fig.1). The disaster resulted in over 1,800 deaths and displaced more than a million people. The damages exceeded $160 billion, making it the most expensive natural disaster in U.S. history (Graumann et al., 2005). Yet beyond the sheer scale of destruction, Katrina exposed long-standing systemic failures: racial and economic inequalities, aging infrastructure, and institutional fragmentation. Entire neighborhoods—particularly the predominantly Black and low-income Lower Ninth Ward—were submerged for weeks, showing how climate events magnify social vulnerability.

Fig. 1: Aerial view showing a flooded neighborhood adjacent to the 12th Street levee in New Orleans. Source: Vincent Laforet/The New York Times/Redux

The failure of the levee system—long believed to offer adequate protection—was not just a technical collapse but a manifestation of decades of underinvestment, poor planning, and environmental mismanagement (Colten, 2006). The Army Corps of Engineers, which oversaw much of the levee construction, later acknowledged critical design and construction flaws. The emergency response, primarily led by FEMA, was widely criticized for being disorganized and inequitable. In this sense, Katrina was not merely a natural disaster, but a human and political one.

Recovery efforts were uneven. While various plans such as the Unified New Orleans Plan (2007) attempted to guide reconstruction, many were top-down and failed to involve the communities most affected. Some areas of New Orleans have rebounded, but others remain marked by vacancy, slow repopulation, and continued risk. As historian Andy Horowitz has argued (Horowitz, 2020), Katrina should not be seen as an isolated crisis but as part of a "century-long disaster" rooted in the complex intersection of geography, policy, and inequality.

Despite its failures, the Katrina experience catalyzed a national rethinking of resilience and urban design. It helped lay the conceptual and institutional foundations for subsequent initiatives—like Rebuild by Design—that seek to merge ecological insight with participatory governance and long-term planning.

Nevertheless, Katrina sparked national and international conversations on urban resilience, environmental justice, and the ethics of reconstruction. It laid the groundwork for later initiatives, such as Rebuild by Design, that attempt to address climate risks through collaborative, inclusive, and ecologically informed planning. The lessons from New Orleans underscore the importance of designing not just for physical protection, but for social resilience, institutional accountability, and historical memory

The Rebuild by Design program, initiated in response to Hurricane Sandy in 2012, introduced a new design methodology based on interdisciplinary competition, co-design with local communities, and resilient infrastructural strategies (Rebuild by Design, 2014; Gould & Lewis, 2016). One of the most emblematic cases is the intervention in the Hudson Bay area, where the project "The BIG U," proposed by the Bjarke Ingels Group team, envisioned a continuous coastal protection system for Manhattan. This multifunctional belt not only serves as a physical barrier against flooding but also incorporates public spaces, parks, bike paths, and ecological devices that enhance urban quality (BIG Team, 2014; Lang & Rothenberg, 2017). The project stands as a prototype of resilient planning that integrates infrastructural scale with the quality of urban space.

However, Rebuild by Design is not limited to a single intervention. The competition launched in 2013 led to the selection of ten finalist proposals, each addressing specific vulnerabilities along the New Jersey and New York State coasts. Among these, "Living with the Bay" for Long Island, "Hunts Point Lifelines" for the Bronx, and "New Meadowlands" in New Jersey reinterpret riverine and coastal territories with integrated approaches that combine ecology, green infrastructure, and community engagement (Rebuild by Design, 2014; Oppla, 2020; Sanderson et al., 2016). These proposals share a core principle: the goal is not to resist nature but to learn to live with its dynamics.

Rebuild by Design has highlighted the importance of understanding natural systems — watersheds, marine currents, coastal ecosystems — as the foundation for urban management. This awareness has enabled the development of design strategies that not only respond to emergencies but also rebuild the relationship between human settlements and landscapes, promoting a vision of resilience based on adaptability, equity, and co-design (de la Peña et al., 2014; Lang & Rothenberg, 2017).

Another significant methodological contribution comes from the Atlas of Disaster, published in 2021 by Rebuild by Design in collaboration with New Jersey Future (Rebuild by Design & NJ Future, 2021). This document gathers data and narratives on climate disasters that have affected the State of New Jersey, highlighting socioeconomic inequalities, systemic vulnerabilities, and the need for cooperative governance. The atlas serves as a knowledge base to strengthen integrated planning, promoting the use of visual and collaborative tools to engage citizens, administrations, and professionals in the creation of fairer and safer scenarios.

In India, the SOAK project, proposed by Anuradha Mathur and Dilip da Cunha for the metropolis of Mumbai, radically rethinks the relationship between the city and water by proposing a dispersed and capillary model of coexistence with moisture rather than containment. SOAK's approach is based on cartographic and phenomenological observation of the monsoon landscape, where water does not follow a clear line but forms an extended, changeable, and distributed zone. Mumbai is interpreted as an estuary rather than land to be defended: the central idea is not to build barriers against water, but to design spatial conditions to absorb, distribute, and celebrate it. Water is not seen as an enemy but as a generative urban substance (Mathur & da Cunha, 2009).

SOAK's design methodology is distinguished by its exploratory, situated, and phenomenological character, emphasizing graphic and cartographic representations (Fig.2) that merge environmental data, material culture, and design imagination. This is not an abstract theoretical exercise, but a systemic and design-oriented response to a context marked by recurrent disasters such as the monsoon floods that cyclically affect Mumbai. SOAK does not stem from a single catastrophic event but from a critical understanding of the hydrographic landscape and its urban dysfunctions, which are attributable to modern hydraulic management based on containment and channelization. Here, resilience strategies are framed as narrative and spatial scenarios capable of inspiring a

new urban mindset oriented toward coexistence with climate variability and the valorization of water as a generative element of space.

Fig. 2: Drawing from the exhibition SOAK, opened at the NGMA (National Gallery of Modern Art) in Mumbai on June 23, 2009. Source: https://www.mathurdacunha.com/soak

In contrast with Rebuild by Design, which operates in a concrete field made of public competitions, inter-institutional partnerships, and infrastructural implementations, SOAK proposes an exploratory and conceptual design approach. Both projects share the centrality of water as a subject of urban design but differ in methods and language: Rebuild uses masterplans and implementation budgets; SOAK works with mappings, visions, and new territorial grammars.

Far from being a contradiction, this dichotomy offers fertile ground for a theory of urban hydraulic design that combines technical competence, geographical understanding, and symbolic imagination.

3. Europe at Risk

In the global context, the United States and India represent two distinct yet extreme environmental and climatic scenarios. In both contexts, differing socio-economic models—each driving specific patterns of urban growth—have resulted in heightened exposure to climate-related risks, ultimately culminating in large-scale natural disasters.

In Europe, by contrast, despite operating within a smaller geographical and demographic framework, there is a wide range of environmental conditions that have led to varied historical approaches to the relationship between land and sea. Northern European countries—such as the Netherlands, Belgium, Denmark, and the UK—have long faced the challenges of flooding and the delicate balance between human activity and natural systems. In response, these countries have implemented both governance and design strategies aimed at enhancing urban resilience.

Conversely, although Mediterranean countries have a long-standing cultural heritage of living with water, they have been comparatively slower in developing effective climate adaptation strategies, despite some noteworthy examples of adaptation in specific cities and regions. Yet, the Mediterranean remains highly exposed to climate-related risks, particularly in deltaic areas across Italy, France, Spain, Greece, and Egypt (De Lucia et al. 2022). As highlighted by the European Environment Agency (2024), the Mediterranean basin is among the regions most vulnerable to sea-level rise—making it especially at risk of experiencing extreme high water levels up to ten times more frequently across much of Europe by 2050. Coastal areas in this region are increasingly affected by erosion, soil salinization, infrastructure degradation, and declining habitability.

In Europe, flooding events—triggered by a variety of factors—have long been frequent and widespread across the continent (Bevacqua et al., 2019; van de Wal et.al., 2024). The HANZE (Historical Analysis of Natural Hazards in Europe) database (Paprotny et al., 2018) provides an overview of extreme weather events and their impact on European territories between 1870 and 2020. As illustrated in the map (Fig. 3), the number of recorded flood events during this period is surprisingly higher along Mediterranean coastal regions—reaching peaks of up to 45 episodes in the Venetian Lagoon, 39 along the Catalan coast, and 23 in the Comunitat Valenciana—than in other flood-prone northern countries such as Belgium, the Netherlands, or Denmark, where the relationship with water has long shaped spatial planning and territorial governance.

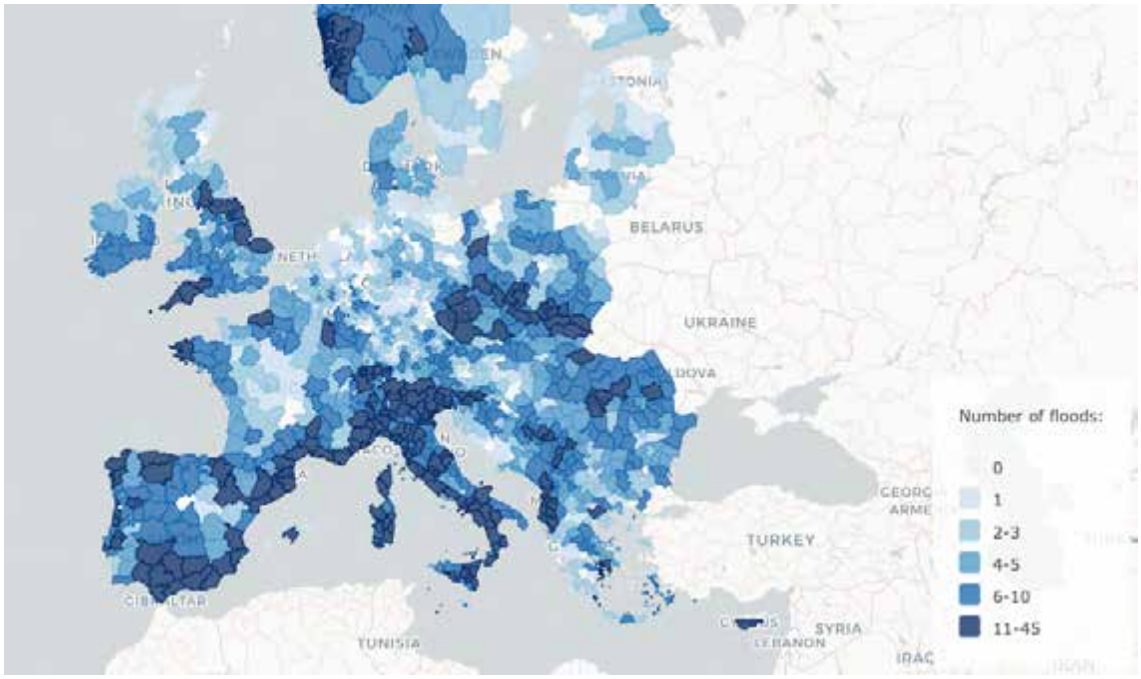

Fig. 3: number of recorded flood events in Europe between 1870-2020. Source: HANZE

However, it is important to note that both the frequency and the intensity of such events determine the actual level of risk for coastal territories. For example, areas like the Po Delta—despite recording a lower number of flood events—are among those most severely affected, with catastrophic impacts in terms of both human lives

and economic losses. This underlines the fact that, albeit with different patterns, the vast majority of European coastlines remain highly exposed to risk.

In territories that have experienced the most severe impacts, large-scale flood defense infrastructures have been implemented since the 20th century. In countries such as the Netherlands and the UK, extensive systems of movable barriers and beach nourishment programs have been deployed. These combined strategies have proven effective, particularly in semi-enclosed geographic contexts—such as bays and lagoons—where engineering solutions tend to have greater impact and efficiency. However, these systems come with high costs—not only for implementation but also for long-term maintenance (van de Wal et al., 2024). Moreover, as natural dynamics evolve—such as further sea-level rise or changes in tidal behavior—these infrastructures may become obsolete or inadequate. It is therefore increasingly evident that the paradigm must shift: rather than continuing to contain seas and rivers, it is human presence, with its settlement pressures and economic activities, that must adapt to natural processes.

Indeed, while climate change is clearly exacerbating existing vulnerabilities, flood events have always occurred across Europe. What has changed in recent decades is the growing urbanization of coastal areas—thereby increasing the exposure and risk to human populations—and the enhanced ability to record and analyze catastrophic events, which has led to a heightened awareness of the issue, including in the Mediterranean basin.

Europe presents a variety of approaches to coastal management and risk adaptation, with differences between northern and Mediterranean countries. While national strategies are more established in some northern contexts, southern regions are beginning to develop their own frameworks, often in response to specific environmental and social challenges. In many cases, it is only in the aftermath of a disaster that political and institutional momentum drives the development of long-term planning and strategic action. In this light, the two case studies presented in this paper—the Netherlands and the region of Valencia in Spain—illustrate parallel trajectories, where major flood events have triggered projects that later informed broader regional strategies.

3.1 Northern Europe: the Netherlands

Among the European countries most advanced in coastal zone management, the Netherlands stands out. The country's physical geography—characterized by the interweaving of the Rhine, Meuse, Scheldt, and Ems River deltas—exposes much of its territory to a constant risk of flooding, exacerbated by the ongoing rise in sea levels. These phenomena pose not only a threat to the resident population but also to the Dutch economy as a whole. As the world's eighteenth-largest economy (International Monetary Fund, 2018), any disruption in the Netherlands would have significant repercussions for the broader European and global economic balance.

This particular territorial condition led the Dutch government to develop flood risk protection strategies much earlier than many other European countries. Of particular interest is the Delta Programme—a modern evolution of the original Delta Plan, launched in response to the catastrophic North Sea flood of 1953, which devastated coastal areas of the Netherlands, the UK, Belgium, and Scotland.

In its initial phases, the Delta Plan focused on the construction of large-scale engineering works aimed at increasing the safety of the country's most low-lying and vulnerable areas. Specifically, the plan entailed the reinforcement of coastal dunes and the construction of a series of massive dams, including the renowned Oosterscheldekering (Eastern Scheldt storm surge barrier, Fig.4). These interventions were carried out between 1958 and 1997 and resulted in 14 major infrastructural works, including dams, sluices, and storm surge barriers. This first phase of the programme is emblematic of the engineering-driven approach typical of the second half of the twentieth century.

Fig. 4: Aerial photo of Oosterscheldekering flood barrier by Frans Lemmens

Today, however, with the increasing risks linked to climate change—coastal erosion, sea level rise, and the growing frequency of extreme weather events—there has been a marked shift toward a more adaptive and resilience-oriented strategy in the Netherlands' coastal management framework.

In 2007, the Dutch government established the Second Delta Commission (the first having been created in the 1950s), chaired by former Prime Minister Cees Veerman. The commission was tasked with assessing the potential impacts of climate change on the Netherlands and providing strategic recommendations for flood risk management. Its findings, compiled in an influential report, have guided national climate adaptation policy ever since.

The report contains twelve key recommendations, addressing a wide range of issues including:
- The structural integrity of dikes and flood defenses in the Netherlands;
- Urban development in areas with high flood risk;
- The administrative, organizational, and financial aspects of implementing flood prevention measures.

Following the adoption of these recommendations, the current Delta Programme was established through the Delta Act, which came into force on January 1, 2012. The Delta Act formally defines the roles of the Delta Commissioner (who manages the programme) and the Delta Fund (which provides its financing). The entire programme operates under the direct responsibility of the Ministry of Infrastructure and Water Management. The Act also mandates that the programme be updated annually, and it is financed through a dedicated annual budget of €1 billion from the Delta Fund.

The Delta Programme represents a long-term adaptation and resilience strategy for the Netherlands (Fig.5), operating across both national and regional levels. Its central goal is to align climate change management with socio-economic development needs. Operationally, this strategy is articulated through several key components: (i) Delta Decisions, which define the overarching national regulatory framework[1]; Delta Plans, which translate these

1 Between 2010 and 2014, five Delta Decisions were developed, forming the foundation for policy and planning over the next 35 years: 1. Delta Decision on Flood Risk Management; 2. Delta Decision on Freshwater Supply; 3. Delta Decision on Spatial

decisions into concrete implementation measures at both national and regional levels.[2]

Adaptive Delta Management
Since its establishment in 2009, the Delta Program has progressively evolved by adopting the so-called Adaptive Delta Management (ADM) approach—an adaptive strategy, capable of evolving in response to climate or socio-economic changes, and an integrated one, designed to address the various dimensions of water management in densely urbanized contexts (Bloemen, 2019).

Given its long-term perspective, the program's goals are intentionally broad to allow for adjustments and updates over time as priorities become clearer. The Delta Committee has proposed three distinct time horizons (scenarios) for achieving the program's objectives:
1. Concrete interventions through 2050;
2. A clear vision through 2100;
3. Long-term recommendations for beyond 2100.

The ADM methodology is critical to the success of the Delta Program:
«we look far ahead to the challenges facing us and, with this knowledge, we take the measures on time that are necessary and affordable at that point. In doing so, we ensure that we can always respond flexibly to new opportunities and new insights. For example by giving rivers more room step by step[3]. Or by strengthening the coast with sand nourishment operations that we can adjust easily when required: more or less nourishment, or in a different location»[4]

In pursuit of an efficient and adaptive model, the Delta Program relies on the Monitoring, Knowledge, Action cycle, which involves continuously assessing whether: (i) the program is on track with its implementation timeline; (ii) new developments or events necessitate updates to the roadmap; (iii) an integrated approach is being maintained; (iv) authorities, institutions, and stakeholders are being sufficiently engaged.

Based on this methodology, an annual assessment of the program is conducted, along with a comprehensive systemic review of the Delta Decisions and Preferred Strategies every six years.

Adaptation; 4. Delta Decision on the Rhine–Meuse Delta; 5. Delta Decision on the IJsselmeer Region

2 1. Delta Plan for Flood Risk Management; 2. Delta Plan for Freshwater Supply; 3. Delta Plan for Spatial Adaptation

3 The *Room for the River* project (lounched in 2007 and largely implemented by 2015) was a key precursor and pilot for the Delta Programme.

4 Deltaprogram.nl

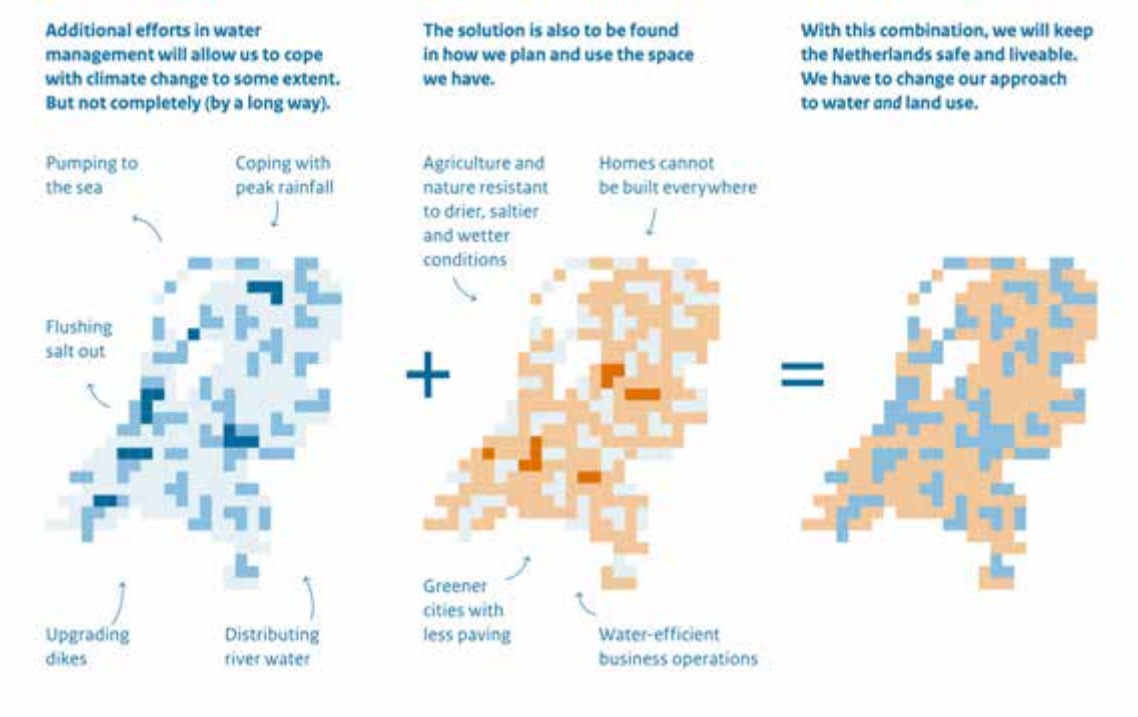

Fig. 5: Delta Program implementing both water management and spatial measures. Source: National Delta Program 2025 outline

Decision Making

The experience of the Delta Program is particularly relevant when it comes to the decision-making process, that is, the sequence of events that led the Netherlands to formally adopt this national strategy. In the early 2000s, although political interest in climate adaptation was steadily growing, no concrete decision had yet been made regarding when and how to move forward with a new, forward-looking approach to climate-related risks.

Once again, it was an emotional and political response to a natural disaster—specifically, the devastation caused by Hurricane Katrina in the United States (see section 2. International References)—that provided the necessary momentum for change in the Netherlands.

The key milestones that led to the institutionalization of the Delta Program can be summarized as follows:

- March 2005: Senator Lemstra introduces a motion urging the government to invest in a proactive strategy to anticipate climate change and rising sea levels.
- May 2005: In response to this motion, the Ministry of Housing, Spatial Planning and the Environment launches the national program Climate Adaptation and Spatial Planning (ARK).
- August 2005: Hurricane Katrina strikes the U.S. Gulf Coast. The catastrophic impact of the storm serves as a wake-up call for the Dutch government, reinforcing the urgency of the ARK program.
- 2006: The Royal Netherlands Meteorological Institute conducts a study to assess the potential impact of sea level rise on Dutch territory.
- 2007: ARK publishes the first National Adaptation Strategy (NAS), identifying flood safety as one of the most pressing issues to address.
- June 2007: The Ministry of Transport, Public Works and Water Management releases the Water Vision report. Among its most important proposals is the establishment of a high-level, independent advisory committee dedicated to long-term planning and climate adaptation.
- September 2007: In line with the Water Vision, the Second Delta Commission is established.
- 2008: The Delta Commission publishes its final report.

• 2009: Climate adaptation policies are consolidated through the creation of the Delta Fund, providing dedicated financial resources.
• 2012: The Delta Act comes into effect, giving full legal authority to the Delta Program.

In the analysis of coastal governance models, the Dutch case is particularly significant as it exemplifies a comprehensive institutional commitment to adaptive and integrated territorial management. This demonstrates that coastal governance in the Netherlands is not confined to sector-specific planning nor delegated solely to local authorities; rather, it is embedded within a national strategy prioritized as essential for the governance of the entire country. From this overarching strategy, regional-level plans and programs subsequently cascade. Specifically, the financial resources allocated annually to the program by the Delta Fund—with a medium-term horizon of seven years, periodically extended—enable operational capacity that goes beyond planning, supporting projects and initiatives at multiple scales.

3.2 Mediterranean Basin: Valencia Region

The urban transformation of Valencia in response to water-related disasters exemplifies a critical shift toward ecological awareness and urban resilience. The pivotal moment came in 1957, when a catastrophic flood of the Turia River inundated the city, causing widespread destruction and significant loss of life. The disaster exposed the inadequacy of existing flood control measures and forced the city to confront its vulnerability to extreme weather events. In response, authorities implemented a monumental hydraulic intervention: the diversion of the river's course to the south of the city. Known as the Plan Sur, this redirection removed the watercourse from the densely populated urban core, significantly reducing the risk of future flooding. Although it followed the technocratic logic of mid-20th-century modernist planning — emphasizing infrastructure and control — it inadvertently created an unprecedented urban opportunity: the potential reuse of the abandoned riverbed within the heart of Valencia (Fig.6).

Fig. 6: Green Infrastructure in the metropolitan area of Valencia. Source: Muñoz Criado, A., 2009

In the aftermath of the diversion, the former riverbed lay dormant, a linear void threading through the city's fabric. Initial proposals envisioned the space as a transport corridor, complete with highways and rail links, aligned with the era's emphasis on motorization and urban expansion. However, these plans soon met with increasing public resistance. During the 1970s, a groundswell of civic activism emerged, mobilized around the idea that this central space should be reserved for public use rather than further sealed by asphalt. Environmental groups, cultural organizations, and ordinary citizens coalesced around the slogan "El río es nuestro y lo queremos verde" ("The river is ours and we want it green"), successfully halting the infrastructure project.

The outcome of this mobilization was the creation of the Turia River Park (Jardín del Turia), a linear urban park that redefined Valencia's relationship with its hydrographic and ecological heritage. Formalized in the local planning framework of the late 1970s, the project reclassified the old riverbed as public green space, with an emphasis on natural character and multifunctionality. From that point forward, the park evolved as a symbol of the city's capacity for adaptive reuse and democratic planning (Galán, 2011a).

Constructed in 18 sectors and stretching more than 8 kilometers from west to east, the Turia Park integrates a wide range of uses and functions. It acts as a major piece of urban green infrastructure, combining recreational spaces, ecological corridors, cultural institutions, sports facilities, and pedestrian and cycling routes (Galán, 2011b; Medina Piles et al., 2010). Its physical configuration is one of its most distinctive features: sunken approximately four meters below street level, it provides an uninterrupted, traffic-free environment that contrasts sharply with the surrounding cityscape.

This recessed design has a dual character. On one hand, it has contributed to some fragmentation, weakening transversal connections and making parts of the park feel visually and physically isolated from the adjacent neighborhoods. On the other hand, it has proven to be a vital asset during extreme meteorological events. The DANA (Depresión Aislada en Niveles Altos) storm of 2024 demonstrated the park's strategic hydrological role. Acting as a massive floodplain, the park absorbed significant volumes of stormwater runoff, mitigating the impact of the torrential rains that overwhelmed other urban and peri-urban drainage systems (Generalitat Valenciana, 2025). In this way, the Turia Park provided an emergency buffer zone and reaffirmed its value as a piece of resilient infrastructure in the face of climate uncertainty.

Beyond its flood mitigation capacity, the Turia Park stands as a landmark example of urban ecological retrofit. It exemplifies how cities can repurpose obsolete or hazardous infrastructures into multifunctional public spaces that promote environmental sustainability, public health, and social equity. The park's genesis and growth reveal the importance of civic participation, flexible planning instruments, and the willingness of institutions to revise earlier technocratic visions in light of evolving ecological and cultural values.

Nevertheless, the park's full potential has yet to be realized. Its integration into broader territorial systems remains an open project. Linkages with the Albufera Natural Park to the south, the Huerta de Valencia agricultural landscape, and the upstream Turia Natural Park are still fragmented or underdeveloped (Muñoz Criado, 2009). These connections are essential for establishing a coherent regional green infrastructure that promotes ecological continuity, habitat connectivity, and integrated mobility.

Ultimately, the Jardín del Turia illustrates how cities can turn crises into opportunities — how a site once defined by risk and destruction can be transformed into a symbol of resilience, community, and sustainable urbanism.

Building on the lessons learned from inland adaptive strategies such as the Turia River Park, the Valencian region has progressively extended its environmental planning efforts toward the coastline — a territory equally vulnerable to both anthropogenic pressure and climate-induced hazards. The Mediterranean littoral of the Comunitat Valenciana is characterized by a sharp juxtaposition between ecological richness and urban expansion, where natural systems such as wetlands, dune fields, and fertile agricultural lands coexist uneasily with tourism-driven development and infrastructural sprawl. Recognizing the critical role of the coast in territorial resilience, the Generalitat Valenciana approved in 2015 the Territorial Action Plan for the Green Infrastructure of the Litoral, commonly known as PATIVEL (Plan de Acción Territorial de la Infraestructura Verde del Litoral) (Jódar-Abellán & Molina Giménez, 2019).

PATIVEL (Fig.7) represents a paradigm shift in Spanish coastal governance. Unlike earlier regulatory tools focused on isolated protected areas, this plan introduces an integrated and supramunicipal perspective aimed at ensuring the continuity and functionality of the coastal green infrastructure system. It does so by defining a coastal protection strip extending 500 meters inland from the shoreline — a distance that can be expanded up to 2,000 meters where necessary to guarantee ecological connectivity with inland natural systems (Jódar-Abellán & Molina Giménez, 2019, pp. 715–716).

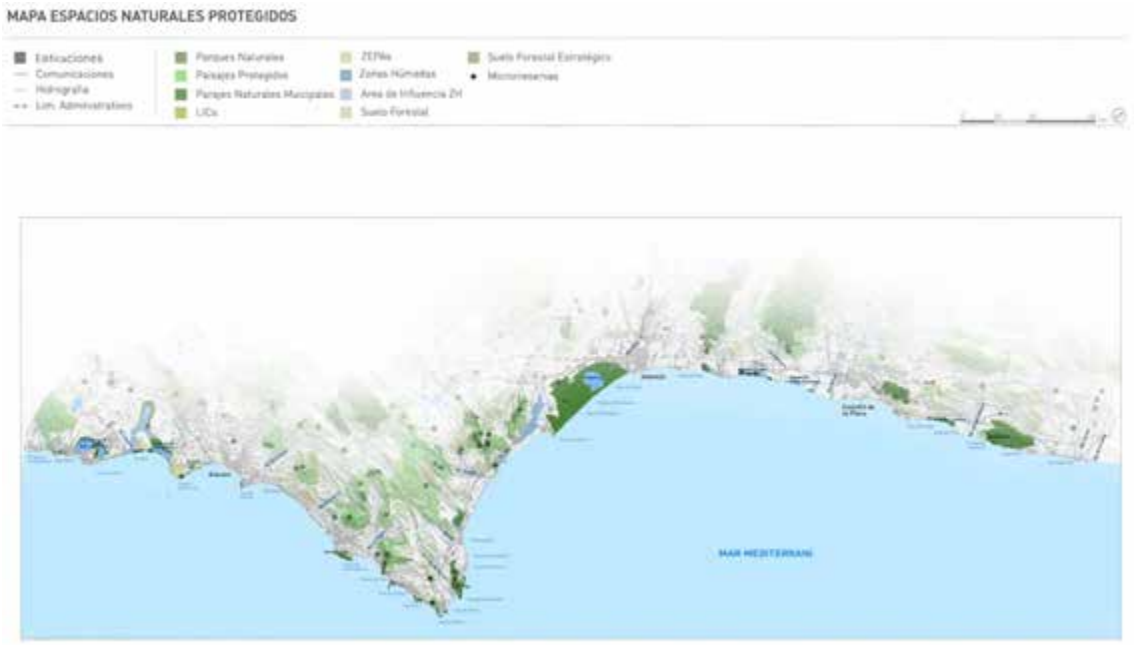

Fig. 7: Map of protected natural areas. Source: Pativel, 2018

This regulatory perimeter includes a wide range of environmental assets: wetlands of international importance (e.g., Albufera and El Hondo), coastal aquifers vital for water security, productive agricultural landscapes such as the Huerta de Valencia, and natural habitats listed under the EU Natura 2000 network. PATIVEL's guiding principle is that these assets should be preserved not only for their intrinsic ecological value but also for their contribution to public well-being, territorial permeability, and disaster risk reduction.

To operationalize this vision, PATIVEL defines five zoning categories based on environmental sensitivity and land-use constraints. These include non-developable coastal areas (ZRP-NA), ecological connectors (ZRC-AG1), regulatory buffers (ZRC-AG2), and areas of common agrarian interest (ZRC-AG3). Through this typological framework, the plan restricts new developments in high-risk or ecologically strategic areas and provides municipalities with a reference model for incorporating green infrastructure into their local planning instruments (Jódar-Abellán & Molina Giménez, 2019, pp. 717–719).

However, as with the Turia Park, the effectiveness of such territorial tools depends on institutional coordination, political commitment, and technical enforcement. One of PATIVEL's most innovative contributions is the creation of the Visor Cartográfico, a digital mapping platform that enables stakeholders — including public officials, professionals, and citizens — to interact with updated geospatial information regarding land classification, zoning restrictions, and environmental constraints. This platform enhances transparency and fosters a culture of participatory governance, echoing the role that civic engagement played in the creation of the Turia River Park (Galán, 2011a).

Despite these advances, the implementation of PATIVEL has faced substantial challenges. In the province of Alicante, for example, political pressures from landowners and local administrations led to a significant reduction — over 50% — of the initially proposed protected areas, raising concerns over potential rollbacks in environmental safeguards and exposing the administration to future claims of patrimonial responsibility for desclassified land (Jódar-Abellán & Molina Giménez, 2019, p. 721).

More importantly, recent events have demonstrated the urgency of PATIVEL's objectives. The DANA storm of October 2024, which caused the overflow of secondary watercourses such as the Poyo stream (Fig. 8) and devastated several peri-urban areas (Torrent, Paiporta, Picanya), illustrated the region's vulnerability not only along major river basins but also across minor drainage networks and urban margins. These territories, often excluded from

major hydrological plans, are precisely the types of zones PATIVEL seeks to regulate through ecological buffer zones and undeveloped corridors. In this sense, the plan functions not only as a regulatory document but as an adaptive framework — one that anticipates the multifunctional role of open spaces in risk mitigation, biodiversity conservation, and climate adaptation (Generalitat Valenciana, 2025).

Fig. 8: The Albufera area of Valencia, before and after the DANA. Source: ESA, Landsat-8 satellite, published by El Independiente

The coastal zone thus mirrors, on a regional scale, many of the tensions and possibilities observed in the case of the Turia Park: the friction between development pressure and landscape preservation; the necessity of cross-scalar governance; and the potential of green infrastructure to serve as both ecological and civic infrastructure. Just as the sunken corridor of the Turia River offered an unexpected but critical role during extreme rainfall events, the preservation of open coastal land — often undervalued — may prove essential in the face of sea-level rise, salinization, and hydrometeorological volatility.

In conclusion, PATIVEL represents a robust, if imperfect, attempt to shift coastal planning paradigms from reactive protection toward proactive resilience. Its integration with wider territorial plans — including the Plan de Acción Territorial del Paisaje, the regional wetland strategy, and local urban development plans — is crucial for its success. Like the Jardín del Turia, it reflects a broader redefinition of landscape not only as an aesthetic or natural element but as a strategic infrastructure for the future of Mediterranean cities.

4. Discussion: comparing pathways

Both the Dutch Delta Programme and the Valencian PATIVEL reflect how environmental disasters can act as pivotal catalysts in transforming spatial planning paradigms. The 1953 North Sea flood and the 1957 Turia River flood exposed systemic vulnerabilities and triggered immediate technical responses. Yet, rather than leading directly to comprehensive strategies, these events initiated a progressive trajectory—from emergency response to pilot projects, and eventually to the formulation of enduring territorial strategies.

The two case studies are particularly interesting to compare due to the temporal proximity of their trajectories, which both began in the 1950s. To facilitate comparison—both in terms of timing and in relation to governance structures and spatial scales—the main points are summarized in Table 1.

Table 1

Dimension	Delta Programme (Netherlands)	PATIVEL (Comunitat Valenciana, Spain)
Triggering Event	(i) **1953** North Sea flood disaster; (ii) renewed focus post **2005** with Hurricane Katrina	**1957** Turia River flood in Valencia; increasing coastal degradation
Precursor Projects	(i) 14 major infrastructural works including *Oosterscheldekering* (between 1958-1997), (ii) *Room for the River* (launched 2007) — spatial adaptation to flood risk	*Jardín del Túria* (post 1957) — river diversion and public park
Programme Launch	**2010** (official Delta Programme)	**2018** (official adoption of PATIVEL)
Key Objectives	Flood protection, freshwater security, climate change adaptation	Protect coastal green infrastructure, regulate urban expansion
Planning Philosophy	Adaptive Delta Management; "living with water"	Territorial ecological planning; limiting development
Geographic Scale	National (entire delta region); subdivided into regional sub-programmes	Regional: entire Valencian coastal strip (~500 km)
Governance Structure	Led by Delta Commissioner; multi-level collaboration (state, local, water boards)	Led by Generalitat Valenciana; coordination with municipalities
Public Participation	Strong participatory approach, co-creation, expert input	Formal consultations; more top-down approach
Legal and Planning Tools	Delta Act, Water Act, Environment and Planning Act; climate stress tests	PATIVEL as a binding Territorial Action Plan; land-use moratoria
Integration with Broader Policies	Linked with housing, agriculture, transport, and energy policies	Integrated with tourism, landscape, and sustainability frameworks
Focus Areas	River basins, coastal areas, urban settlements, agricultural zones	Ecological corridors, tourism zones, vulnerable coastal lands
Implementation Style	Long-term planning cycles (6 years); yearly updates	One-time plan with implementation oversight and revisions

In both contexts, it was the project—not the plan—that first redefined spatial and ecological possibilities. In the Netherlands, the Room for the River initiative (2007) marked a shift from purely technocratic flood defense to spatially integrated adaptation. Similarly, in Valencia, the creation of the Jardín del Túria transformed a flood-prone riverbed into a central green corridor, setting the stage for broader ecological thinking that would eventually underpin PATIVEL.

This trajectory underscores the value of concrete interventions—pilot projects capable of reshaping collective imaginaries and institutional approaches—as necessary precursors to robust, long-term strategies. In the Dutch case, this process was institutionalized through dedicated funding mechanisms like the Delta Fund and a multi-level governance framework. In contrast, PATIVEL's implementation faced fragmented authority and local resistance, particularly in areas like Alicante where political pressures halved the extent of proposed protections.

While the Netherlands and the Comunitat Valenciana differ in geographic, economic, and cultural contexts, they both illustrate a common pattern of adaptive transformation. This shared experience highlights the necessity of proactive planning, informed by past disasters but not dependent on future crises to spur action. As discussed in this paper, flooding has always been part of Europe's coastal and deltaic histories. The real challenge lies in moving from reactive responses to anticipatory governance, recognizing that all such territories remain inherently vulnerable under changing climatic conditions.

5. Conclusions

This contribution presents a section of the PRIN COSTA|Med research project, funded by the Next Generation EU initiative. The broader project focuses on collecting and analyzing international case studies (Fig.9) where climate

change adaptation and sea-level rise strategies have emerged in response to catastrophic events or situations of acute environmental, urban, and social vulnerability. The aim is to identify shared trajectories that can inform the development of guidelines for coastal zone management and adaptation across the Mediterranean—adopting an integrated perspective in which planning and design work together. Strategic visions must guide action, but strategies themselves are also shaped through concrete interventions.

Fig. 9: Location of the different global case studies considered in the PRIN COSTA|Med research project. In red, innovative territorial design initiatives; in blue, completed case studies.Source: Marta Rabazo Martin

The two case studies discussed—the Dutch Delta Programme and the PATIVEL in the Comunitat Valenciana—demonstrate this reciprocal relationship between strategy and project. These experiences are particularly relevant for other coastal territories, even those not yet severely affected by extreme events. As highlighted throughout this paper, the entire Mediterranean basin is exposed to a wide range of risks, with potential impacts on population, economic systems, agriculture, and cultural heritage.

Our intention here was to illustrate the methodological approach of our study and some of the key dimensions used to compare and analyze different experiences. In fact, our comparative research spans over [insert number] global case studies. COSTA|Med promotes a research by design approach—a methodology still relatively underdeveloped in Italy but clearly effective in many of the international contexts we have explored.

Furthermore, the project aims to broaden the focus of impact assessments: from analyzing consequences on populations and infrastructure to considering the vulnerability of cultural heritage and cultural ecosystem services. Raising awareness of these often-overlooked dimensions is essential to grasp the full scope of sea-level rise implications.

Finally, we may need to revise our understanding of what constitutes a "disaster." Rather than framing it solely as a sudden and disruptive event, we should also recognize the slower, progressive transformations of territorial practices and heritage uses—changes already underway in many places. Only by acknowledging these evolving dynamics can we begin to see this new form of "disaster" as a potential driver for change, adaptation, and forward-looking planning strategies.

Acknowledgements:
This contribution is part of the research project PRIN COSTA|Med – Catching Opportunities for Strategic Transformation and Adaptation of Mediterranean Coasts, funded by the Italian Ministry of University and Research, under Italia Domani – National Recovery and Resilience Plan (PNRR) and the European Union – Next Generation EU. Principal Investigator: Prof. Maria Grazia Cianci.

References

Balmori, D. (2010). A Landscape Manifesto. Yale University Press.

Bevacqua, E., Maraun, D., Vousdoukas, M. I., Voukouvalas, E., Vrac, M., Mentaschi, L., and Widmann, M.: Higher probability of compound flooding from precipitation and storm surge in Eu- rope under anthropogenic climate change, Science Advances, 5, eaaw5531, https://doi.org/10.1126/sciadv.aaw5531, 2019

BIG Team. (2014). The BIG U: Rebuild by Design Proposal. Rebuild by Design. https://www.rebuildbydesign.org/project/big-u/

Bloemen, P.J.T.M., Hammer, F., van der Vlist, M.J., Grinwis, P., van Alphen, J. (2019). DMDU into Practice: Adaptive Delta Management in The Netherlands. In: Marchau, V., Walker, W., Bloemen, P., Popper, S. (eds) Decision Making under Deep Uncertainty. Springer, Cham. https://doi.org/10.1007/978-3-030-05252-2_14

Colten, C. E. (2006). An Unnatural Metropolis: Wresting New Orleans from Nature. LSU Press

D'Arienzo, R., & Younés, C. (Eds.). (2018). Synergies Urbaines – Pour un métabolisme collectif des villes. Métis Presses.

de la Peña, D., Jones, D., & Holloway, M. (2014). Designing Resilience: Preparing for Extreme Events. Island Press.

De Lucia M., Anzidei M., Musacchio G., Eva E., Solarino S., (2022). Aumento del livello del mare. Cosa è importante sapere per affrontare I prossimi cambiamenti. SAVEMEDCOASTS2. INGV, Roma.

Delta Commissioner, National Delta Program 2025 Outline, September 2024.

European Environment Agency. (2024). Climate impacts in Europe: Sea level rise and extreme events – CMIP6/SSP scenarios. EEA Report.

Galán, J. J. (2011a). The River Turia Park, Valencia (Part 1). Universitat Politècnica de València.

Galán, J. J. (2011b). The River Turia Park, Valencia (Part 2). Universitat Politècnica de València.

Generalitat Valenciana. (2025). Informe sobre los efectos de la DANA de octubre de 2024 en la Comunidad Valenciana.

Gould, K. A., & Lewis, T. L. (2016). Green Gentrification: Urban Sustainability and the Struggle for Environmental Justice. Routledge.

Graumann, A., et al. (2005). Hurricane Katrina: A Climatological Perspective. NOAA.

Haeckel, E. (1866). Generelle Morphologie der Organismen. Berlin: Georg Reimer.

Horowitz, A. (2020). Katrina: A History, 1915–2015. Harvard University Press.

Jódar-Abellán, A., & Molina Giménez, A. (2019).El Plan de Acción Territorial de la Infraestructura Verde del Litoral (PATIVEL) de la Comunidad Valenciana (España). In Congreso Nacional del Agua: Innovación y Sostenibilidad (pp. 713–722). Universitat d'Alacant.

Lang, R., & Rothenberg, J. (2017). Rebuild by Design: A New Model for Resilient Urban Design. Journal of the American Planning Association, 83(2), 106–119.

Latour, B. (2018). Down to Earth: Politics in the New Climatic Regime. Polity Press.

Mathur, A., & da Cunha, D. (2009). SOAK: Mumbai in an Estuary. National Gallery of Modern Art

Medina Piles, A., et al. (2010). Guía de jardines históricos y parques urbanos de Valencia. Ayuntamiento de Valencia.

Muñoz Criado, A. (2009). Plan de Acción Territorial de la Huerta de Valencia. Generalitat Valenciana.

Oppla. (2020). Nature-Based Solutions Case Study: Rebuild by Design. https://oppla.eu

Orff, K. (2016). Toward an Urban Ecology. Monacelli Press.

Paprotny, D., Morales-Nápoles, O., and Jonkman, S. N.: HANZE: a pan-European database of exposure to natural hazards and dam- aging historical floods since 1870, Earth Syst. Sci. Data, 10, 565– 581, https://doi.org/10.5194/essd-10-565-2018, 2018

Rebuild by Design. (2014). Rebuild by Design: Winning Proposals. https://www.rebuildbydesign.org

Rebuild by Design & New Jersey Future. (2021). Atlas of Disaster: New Jersey. https://www.rebuildbydesign.org/research/atlas-of-disaster

Rifkin, J. (2019). The Green New Deal: Why the Fossil Fuel Civilization Will Collapse, and the Bold Economic Plan to Save Life on Earth. St. Martin's Press.

Sanderson, E. W., Solecki, W. D., Waldman, J. R., & Parris, A. S. (2016). Resilient urban waterfronts. Ecology and Society, 21(4), 41.

Smith, N. (2006). There's no such thing as a natural disaster. In Understanding Katrina: Perspectives from the Social Sciences. Social Science Research Council. https://items.ssrc.org/understanding-katrina/theres-no-such-thing-as-a-natural-disaster.

UNEP/MAP. (1976). Barcelona Convention for the Protection of the Mediterranean Sea Against Pollution. United Nations Environment Programme / Mediterranean Action Plan.

Unified New Orleans Plan (2007). https://abag.ca.gov/sites/default/files/new_orleans-final-plan-april-2007.pdf

van de Wal, R., Melet, A., Bellafiore, D., Camus, P., Ferrarin, C., Oude Essink, G., Haigh, I. D., Lionello, P., Luijendijk, A., Toimil, A., Staneva, J., and Vousdoukas, M.; (2024). Sea Level Rise in Europe: Impacts and consequences, in: Sea Level Rise in Europe: 1st Assessment Report of the Knowledge Hub on Sea Level Rise (SLRE1), edited by: van den Hurk, B., Pinardi, N., Kiefer, T., Larkin, K., Manderscheid, P., and Richter, K., Copernicus Publications, State Planet, 3-slre1, 5, https://doi.org/10.5194/sp-3-slre1-5-2024