DELTA INTERVENTIONS

DESIGN AND ENGINEERING IN URBAN WATER LANDSCAPES

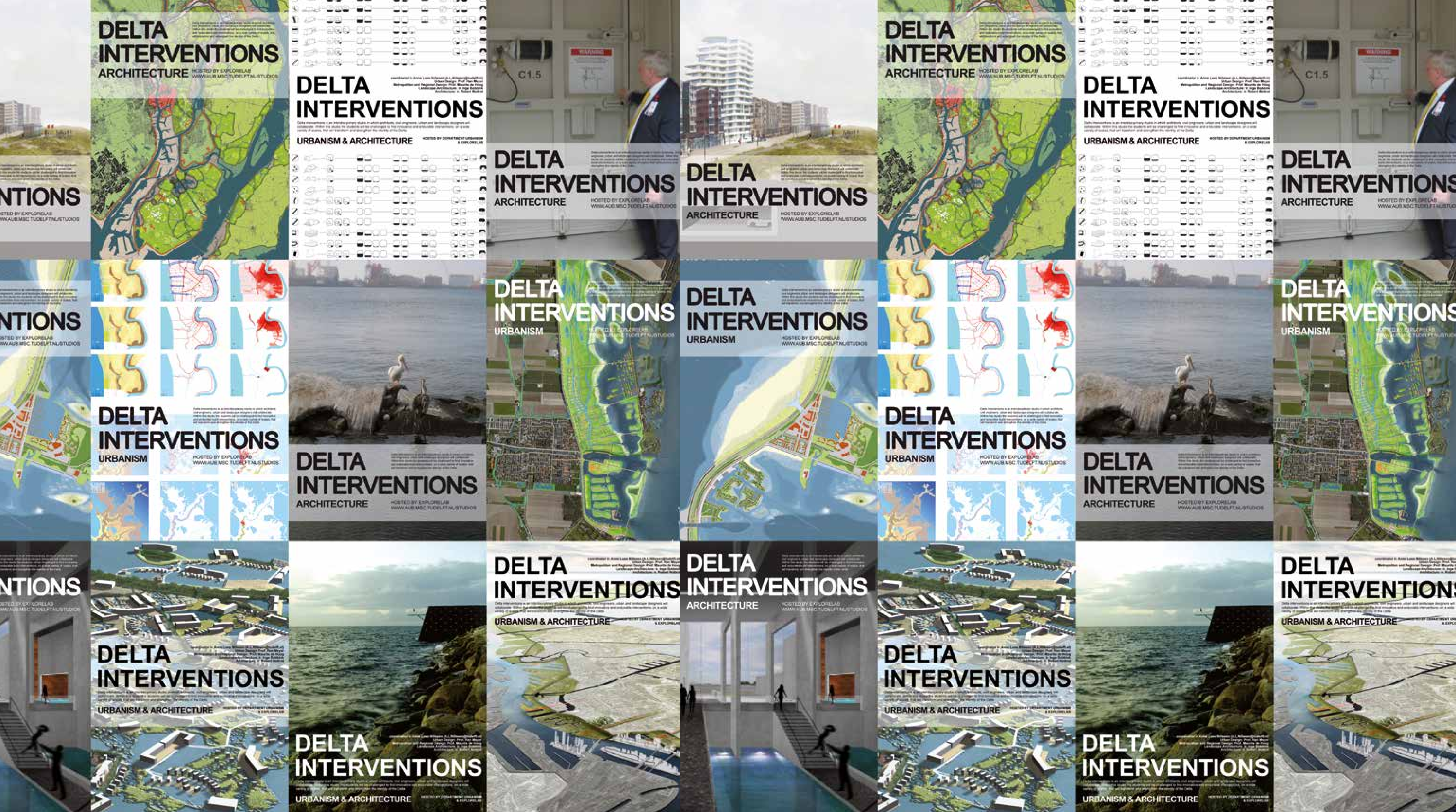
Anne Loes Nillesen
Baukje Kothuis
Han Meyer
Frits Palmboom

Front cover: Vision for the Rijnmond-Drechtsteden region in the Southwest Dutch Delta, which entails a new approach to flood risk management primarily based on reducing the consequences of floods. Central in the design are the adaptive polders (shown in yellowish green).

These polders have an adaptive structure: the levees enclosing them are resistant to overtopping. Combined inlets and outlets together with newly formed creeks allow water to enter at regular water levels. Restoring tidal flow through the Haringvliet creates a new type of natural delta environment in the polders, creating a new condition for a new, adaptive form of the built environment, comprising amphibious or flood-proofed buildings in many forms (red blocks).

A withdrawal strategy is proposed for several very deep polders. There is only room for limited development outside the levees – in the southern part of Eiland van Dordrecht, for example, and the very low-lying polders in the center of Voorne-Putten. However, in these areas typical delta habitats can be developed naturally. In the low-lying dike ring areas in the north and east (blue-green; levees marked as red-brown lines), efforts focus on reducing the probability of flooding with extensive reinforcement of levees.

Front cover image: Robert de Kort



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This book presents a selection of research-by-design projects developed in the Delta Interventions Studio at the Delft University of Technology, including a short overview of all graduation projects from 2009-2015, and reflections by senior scholars. We hope this book will inspire others working on delta issues and designing interventions.

The Dutch Delta is known for its extensive flood protection system, which permits residents to live in a safe and attractive environment. The Dutch expertise in 'designing with water' has become an important field of study as well as an export product. Due to climate change, the Netherlands will face new water management challenges, requiring additional measures to reduce flood risk. In this light, the 2005 International Architecture Biennale Rotterdam and the 2007 Dutch Delta program both focused on addressing long-term water-related issues; this put 'designing with water' high on the agenda for spatial planners and architects.

At the time, in design projects water was often used as a generic term, and (although there were exceptions) many designs were made without a basic knowledge of how water behaves, or the conditions created by the water. As an example, designers would propose and visualize a spatially attractive bypass for a river; however, when civil engineers investigated the proposal, they would inform the designers that water would not naturally flow there, and that the project would not reduce flood risk. The process would leave designers frustrated because engineers had 'killed their baby', and leave engineers irritated that designers did not take the basic laws of physics into consideration. It was in this context that the multi-disciplinary Delta Interventions Studio was founded.

The studio projects vary in scale from buildings and multifunctional flood defenses, to neighborhoods and urban areas, to complete regions. A number of international cases are also included. The projects vary from detailed designs, to strategic plans and policy proposals. The studio emphasizes the link to practice, and results have often been shared with practitioners and policy makers. This way the research-by-design performed by the students contributes to the debate on flood risk management, as well as proposing concrete solutions.

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DELTA INTERVENTIONS

DESIGN AND ENGINEERING IN URBAN WATER LANDSCAPES

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Henk Ovink

DELTA INTERVENTIONS: IMPROVING FLOOD RISK RESILIENCE BY DESIGN

PREFACE

Urban deltas are hit hard by climate change impacts. Rapid urbanization combined with increasing flood risk pose serious threats to the viability and the stability of our deltas, our regions, and our communities. The natural vulnerability of delta areas is interdependent with flood related urban threats. This not only showcases their vulnerability, but also provides a clear opportunity for integrated design and planning approaches, and innovative solutions for urbanizing deltas.

Deltas and coastal areas are among the most urbanized and urbanizing places worldwide. Water is key for agricultural production as well as energy production; and it is essential for the economy, and social and cultural wellbeing. Deltas, flood plains, and coastal zones are therefore characterized by high economic and social activity. All advantages come together in deltas, and make them home of the largest metropolises on earth. Recent projections even show that, by 2050, not only will 75 percent of the world's population live in cities, but also that more than 70 percent of them will live in urbanized deltas (CDC volume #3, C40).

The great opportunities deltas offer are also the root of the challenges delta cities face. Rapid land-use change, changes to the water system and rapid (often uncontrolled) city growth put huge pressures on urban systems, societies and citizens, on both the economy and the environment. Climate change makes urban deltas even more vulnerable, due to their low-lying position. Rising sea levels already threaten the economic and physical viability of low-lying areas, and these levels will only continue to rise. Additionally, the frequency and intensity of extreme weather events will increase, resulting in more floods and droughts in delta areas. Not for nothing did the 2015 World Economic Forum (WEF) Risks Report place water crises as the number one global risk. The viability of delta countries is at risk even before the deltas begin to become submerged.

Global urbanization produces growth, prosperity, emancipation, cultural activity and development opportunities, but these positive effects could be reversed if we do not make our deltas more resilient. Adapting to and mitigating the threats urbanized deltas face is extremely urgent because large numbers of people are at risk, as well as key infrastructure and assets. Taking into account sea level rise and floods, Hallegatte et al. (2013) predicted the following 10 cities as the most vulnerable urban deltas in 2050 (measured as a percentage of GDP): Guangzhou, Mumbai, Kolkata, Guayaquil, Shenzhen, Miami, Tianjin, New York-Newark, Ho Chi Minh City, and New Orleans.

To make our deltas more resilient, we must do more than focus only on the effects of climate change and adaptation measures such as improving flood defense systems. Human interventions in river and delta systems, such as damming and channelization, also affect how these water systems function. Urban water must be seen in the context of the rural hinterland and the river basin; together these ensure the quality and safety of the entire ecosystem, and guarantee the quantity and quality of water in the delta. Water quality determines both economic and societal prosperity; and water quantity determines the risks - caused by either too much or too little water – defining our societies' vulnerability. Making deltas more resilient is not about 'fixing' climate change; it is about moving towards a systems approach where long-term comprehensive design strategies are connected to short-term (preferably innovative) interventions.

Urban water management is at the heart of how cities develop. Therefore spatial planning and design have become increasingly important. The 2015 WEF Risks Report concludes with the warning that failures of urban planning and the failure to adapt to climate change will increase the vulnerabilities of communities across the world in the next decade. A comprehensive, integrated approach is needed, one which combines the defense and the development of cities, adding value for all based on the principles of safety and quality of life, the environment, and the economy. To improve community resilience, adaptation plans must be connected to local needs and include all stakeholders. This implies moving or sharing responsibilities from central government to local authorities, private institutions, and citizens; using approaches and processes that are truly inclusive and collaborative.

The need for comprehensive investments in response to climate change provides unique opportunities to combine and integrate spatial, economic and social needs and demands. An increasing number of deltas are already sharing knowledge and lessons learned in the effort to improve resiliency and adaptation strategies. This book showcases dozens of projects, examples of how comprehensive designs can improve the resilience of deltas globally.

Henk Ovink, *Special Envoy for International Water Affairs, Kingdom of The Netherlands*

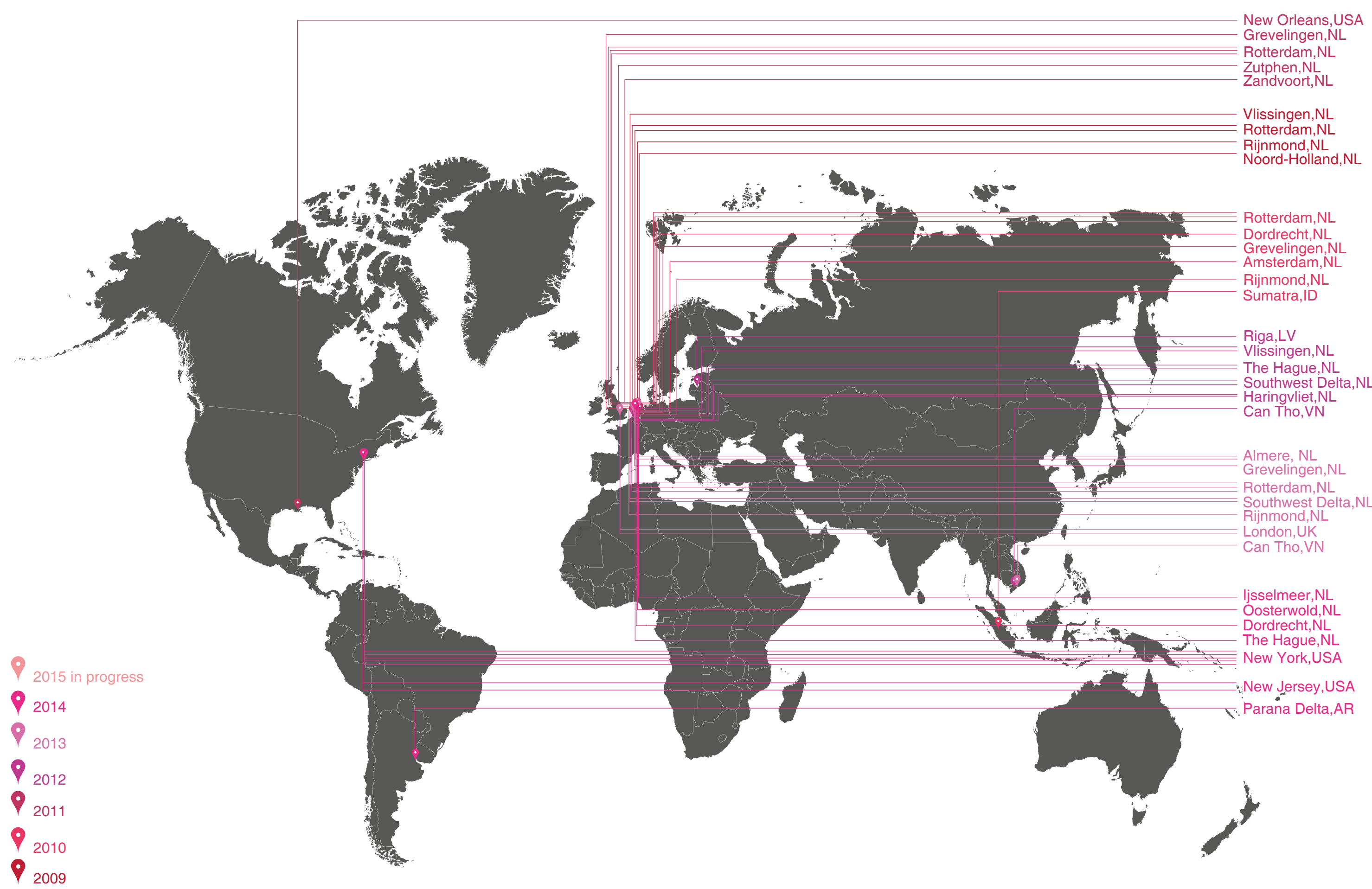

Figure 1.
Location map of
projects in this book.

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Anne Loes Nillesen

INTRODUCING DELTA INTERVENTIONS STUDIO'S

GENERAL INTRODUCTION

The Dutch Delta is known for its extensive flood risk protection system, which permits residents to live in a safe and attractive environment. Because of this experience, developed over many years, the Dutch 'designing with water' has become an important field of study as well as an export product.

Due to climate change, the Netherlands is expected to face additional water management challenges in the future, requiring additional flood risk protection. The 2005 Flood Biennale (the International Architecture Biennale Rotterdam) and the second Dutch Delta program, which started in 2007, both focused on addressing water related issues over the long term. This put designing with water high on the agenda for spatial planners and architects. At the time, in design projects 'water' was often used as a generic term, and (although there were good exceptions), many designs were made without a basic knowledge of how water behaves, or the conditions created by the water.

In the worst case, designers would, for example, propose and visualize a spatially attractive bypass for a river; however, when civil engineers investigated the proposal, they would inform the designer that water would not naturally flow there, and that the project would not reduce flood risk. The process would leave the designer frustrated because the engineer had 'killed their baby', and leave the engineer irritated that the designer did not take the basic laws of physics into consideration. Since then, a lot has improved, but it was in this context that the Climate Adaptation Lab was founded at the Delft University of Technology in 2008. (In 2011 this became the Delta Interventions Studio).

The TU Delft Climate Adaptation Lab was a joint architecture and civil engineering MSc graduation studio, which took climate change as a guiding principle for designs. It specifically addressed the water-related consequences of climate change such as rising sea levels, increasing peak river discharges and more extreme rainfall.

Quantifying and understanding the physical and functional aspects of water formed an important basis for the interdisciplinary approach applied in the studio: How much water are we talking about (now and in the future)? How much does this fluctuate, in which seasons, and with what force? Are we dealing with polluted, salt or fresh water? How does the water function: as a transportation network, an ecological reserve, a tool for recreation, a supplier of agricultural and drinking water, as an urban barrier or connector, or as a qualitative aspect of the landscape?

The Climate Adaptation Lab ran for 5 consecutive cycles. In each of these a wide range of buildings and structures were designed, each of them focusing on water as a threat or opportunity. Most student projects focused on designing flood proof buildings that can deal with the floods or runoff issues expected in the context of climate change. In addition, a series of projects explored the multifunctional use of a building as a part of a flood defense structure, such as a barrier, dike or dune. Some projects focused on additional aspects of water such as water quality, possibilities for tidal energy, or merely the qualitative influence of fluctuating water levels on the surrounding landscape.

Of course, the relation between design and water is much more complex than just the relation between a building and the water surrounding it, especially in the context of a delta. In delta areas interventions are often strongly dependant on policies with regard to water management and local conditions, all of which are inter-related to potentials for land use, ecology, and urban and economic development. Building on fundamental principles of designing with water on the local building scale, in 2011 the studio extended its scope to designing in the context of the complex system of the Dutch Delta.

To illustrate this shift, the studio was now hosted by the Department of Urbanism and continued under a new name: Delta Interventions. The scope of the studio widened; in addition to architecture and civil engineering students, urbanism, landscape and policy students were invited to join in an interdisciplinary team that could together unravel the integral complexity of the Dutch Delta. To do this, it was necessary to analyze past developments and relations within the Delta to determine existing relations and predict and steer future development.

The studio projects vary in scale from buildings or structures, to neighborhoods and urban areas, to complete regions. The projects vary from detailed designs, to strategic plans and policy proposals. Linking to practice is an important focus point of the studio and results have often been shared with practitioners and policy makers. This way the research-by-design performed by the students became a valuable contribution and reflection on the Dutch debate on flood risk management in general and a specific contribution to the Dutch Delta Program.

The body of knowledge developed within the studio based on the Dutch Delta has formed the basis for exploring the applicability of Dutch approaches and interventions in other delta areas. The studio supported some of the university's research projects abroad, such as the New York 'Rebuild-by-Design' competition and the research for 'Flood Proofing Texas'. In both cases, the studio provided a second explorative research-by-design track. In this track, students had the opportunity to focus on various other deltas, doing projects in urbanized deltas in New Orleans, Argentina, Vietnam, Indonesia and India.

This book presents a selection of the wide range of design projects that have been developed in the Delta Interventions Studio over the past eight years. It is with great pride and joy that I look back on my period as the founder, coordinator and one of the teachers of the studio. I hope this book will inspire others who work and design on delta issues and interventions. I would like to thank all the participants, teachers and contributors of the studio for their commitment and contribution to this wonderful result.

ONE | THE ROTTERDAM - RIJNMOND REGION

Anne Loes Nillesen

THE RIJNMOND DRECHTSTEDEN

INTRODUCTION

The Rijnmond Drechtsteden is an urbanized part of the Rhine Meuse Scheldt Delta in the west of the Netherlands. The two main urban centers are the cities of Rotterdam and Dordrecht, both of whose historic city centers are on the riverfront. The Rijnmond region contains the constantly expanding Rotterdam port area, which is the main economic center of the region. The Drechtsteden also includes many smaller urban centers that together form an important water-oriented urban region.

The area faces flood risks both from the sea from potential storm surges as well as inland from peak river discharges. The Netherlands has always had a strong tradition of protecting their land from flooding. After the major 1953 flood, the national Delta Program was established to reduce flood risk in the region and prevent similar events in the future. The featured Delta Works raised the protection level of the existing dike rings and created a law (the Delta Law), which legislated the acceptable risks. As a consequence, a system of closed or closable dams was established to protect against storm surge (Deltacommissie 1961).

The region's flood risk has increased, since its economic importance has grown at the same time as climate change will lead to higher expected storm surge levels and increased peak river discharges. In 2007, a second Delta Program was established to provide a long term strategy to make sure the Netherlands remains a safe and attractive place to live and invest in.

This Delta Program started in the Rijnmond region by exploring possible strategies. Four so-called 'cornerstones' for future project development were developed; they were not intended as preferred strategies, but rather as conceptual directions within the context of all possible strategies (Deltacommissie 2008).

The first cornerstone is the 'open delta'. Following this approach, all of the constructed Delta Work dams would be removed, restoring the natural open connection between the sea and rivers for ecological benefit; flood risk protection would be achieved by reinforcing the dikes of the dike-rings within the area.

The second cornerstone is a 'closed delta'. In this approach, all the now open but closable barriers which protect against storm surge would be permanently closed, in order to further reduce the flood risk. Within the closed system, the dikes could then remain as they are or even be lowered; this would permit existing relations between urban waterfronts and the river to be maintained or even improved. Of course, replacing the open but closable barriers by dams or sluices would impact the accessibility of part of the Port of Rotterdam.

The third cornerstone is 'open but closable delta'. This approach would further extend the current flood risk protection network by adding closable barriers at the inland side of the urbanized Rijnmond Drechtsteden region, the part which is dominated by the rivers. This would protect the most urbanized and economically important part of the region from both storm surges from the sea as well as from peak river discharges from the east. This would minimize the necessity of dike reinforcement within the area protected by this system of barriers. However, calculations showed that despite the cumulative effect of all the separate barriers, dike reinforcement would still be needed within the protected area.

The fourth cornerstone is 'business as usual'. In this approach, the current protection system would be maintained and upgraded, in order to provide protection from future flood risk.

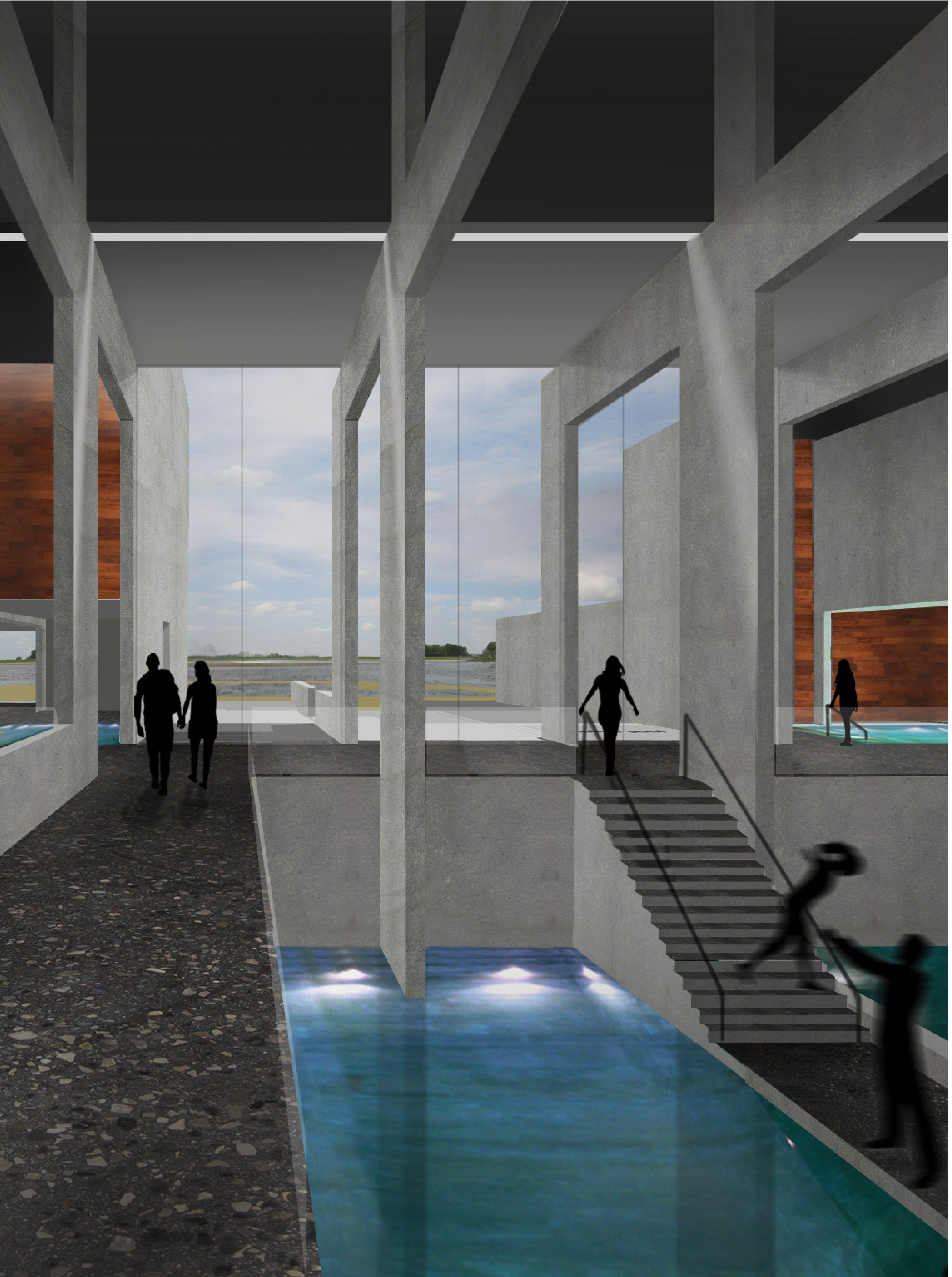
These different strategies would result in different conditions in the Delta and have a strong impact on the spatial composition and socio-economic potential of the Rijnmond-Drechtsteden region. These different approaches and different results appeal to the imagination – and made this an interesting topic for the Climate Adaptation Lab and Delta Interventions Studio to investigate.

An open system that reintroduces the tidal movement and sediment transport into the rivers and estuaries implies the need to reinforce levees. This resulted in projects that applied the experience of fluctuating water levels and that included water as a natural element in the environment, for example, designing tidal parks along the riverfront or designing buildings or neighborhoods in the flood plain that react to changing water levels. Other projects focused on reinforcing existing levees and including them in integral design projects that combine the need for urban redevelopment with the reinforcement of local dikes or by designing multifunctional flood defenses.

A closed system would create the opportunity to develop cities close to the water, developing their relationship with the water; this would make the barriers which currently separate the urban fabric from the river obsolete. This resulted in a range of projects which redesigned the current embankment zones.

The open but closable system would require new barriers. A variety of projects addressed the design of these new barriers, in particular multifunctional flood defenses. These would function both as a flood barrier and as a public building; students from the Department of Civil Engineering & Geosciences and the Department of Architecture & the Built Envorinment cooperated in joint projects.

Extending the current strategy ('business as usual') led to a range of projects that reshape the current dike rings to permit more water storage in the estuaries. Inspiration was found in the historic growth patterns of the dike rings, which grew gradually over time and often consist of multiple (parallel) lines of flood defense. Former inland defense lines were reestablished in these projects, and the current flood protection lines were breached in order to create additional storage capacity. This resulted in new flood plains, where flood proof buildings and neighborhoods were developed.



Anna Dijk

WATERSLOT IN HET SPUI

MULTIFUNCTIONAL SPA AND BARRIER BUILDING

Year: 2010
Location: Spijkenisse, Netherlands

First mentor: Anne Loes Nillesen
Second mentor: Ann Karina Lassen
Third mentor: Ties Rijcken

In 2008, the Dutch government presented the 'Rhine Estuary Closable but Open' water management plan as a potential strategy for future flood risk protection. The plan proposes four new barriers to protect highly urbanized areas in the Rotterdam Rijnmond region against the increasing flood risk associated with climate change.

This project proposes a multifunctional design for one of those barrier buildings. The hydraulic structure, a movable water barrier, can close in the event of high flood water. Beside its primary civil engineering function, the building will serve as a recreational hub for the region, anchored in the surrounding landscape. A few elements from its context are chosen to shape the building, communicating the building's essential quality to the visitor: The different flood risk on both sides of the building; its function as both a building and a piece of civil engineering; its location on the border between an urban area and the countryside; and the different water conditions at the site.

The building design reflects these dualities by showing two faces. On the outside, the structure is expressed as a megastructure with the ability to withstand the forces of the water. It thus confirms to the old-school way of controlling floodwater with large engineering projects. On the inside of the gate where the structure meets the urban landscape, the design is broken down to a human scale, allowing visitors to make contact with the water. On this side, one can experience and enjoy the fluctuating water levels, the reflections, and the different ways of reaching the water.

The secondary function of the structure relates to water-based tourism and recreation; this reinforces the building's iconic character as a 21st-century water project. These functions are informed by the building's location at the edge of an urban area. In the Netherlands, day tourists from urban and suburban areas often enjoy the water or the countryside by bike or boat. This makes the barrier building an attractive recreational destination. The building contains a day spa with a hotel, restaurants, cafes, a sailing center with boat rental, an information center, a pedestrian and cycling bridge and a rooftop panorama deck offering views in both directions.

On the outside, the large concrete protection wall presents different textures leaving nature to create varying patterns and colors over time through the growth of algae and mosses. Rainwater is captured in these textures and trickles down through recessed vertical lines. Small horizontal panorama windows offer visitors occasional views, yet nature inhabits this side of the structure.

In the interior of the building, the structural forces required to withstand the river water are visible through the exposed concrete structures. The construction is used to articulate the large central spaces. Visitors are made aware of the different forces on the two sides of the building by the changing rhythm and spacing of the shear walls. By increasing openness opposite the flood wall, the structure shows the reduced flood risk on this side of the building, allowing greater proximity to the water. Stepped and inclined terraces which partially and temporally inundate indicate the tides, high waters and flood levels. This shows the different water levels that are expected at the location and makes them immediately visible to visitors, evoking questions about the natural conditions of the landscape.

Figure 2.
(left page) Interior view spa, towards the open backside of the building.

Figure 3.
Cross-section of the barrier building.

Figure 4.
Exterior view flood proof front side of the building.

Figure 5.
Building facade at the more open backside.

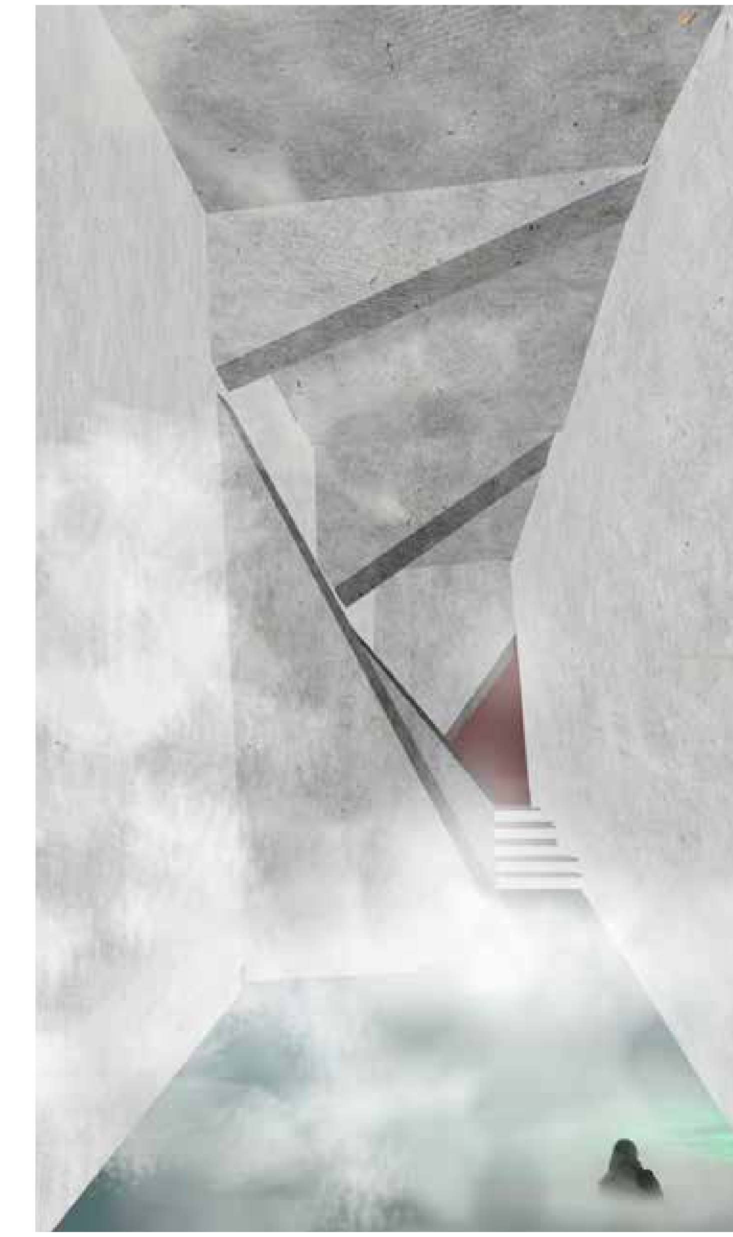
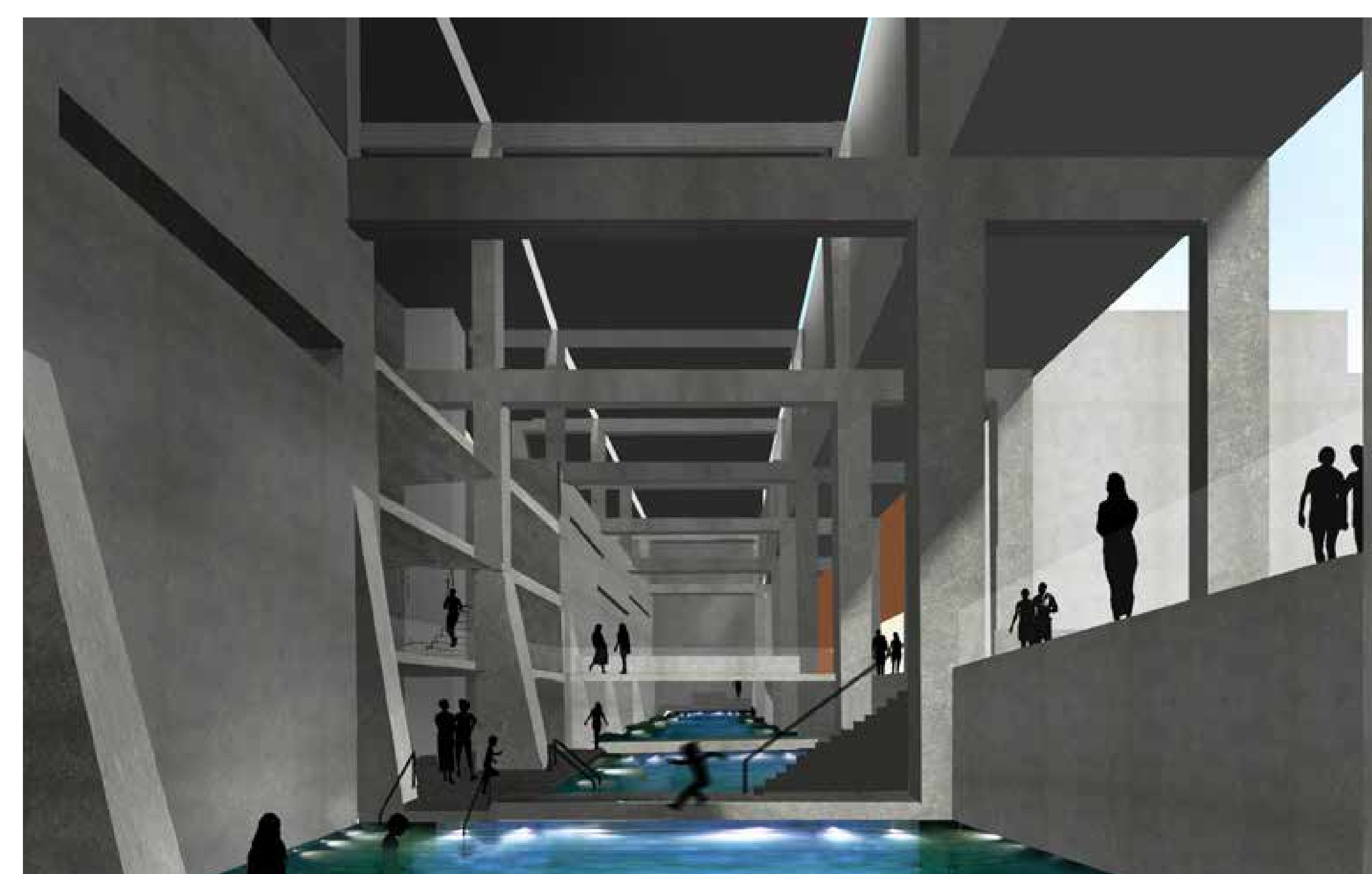
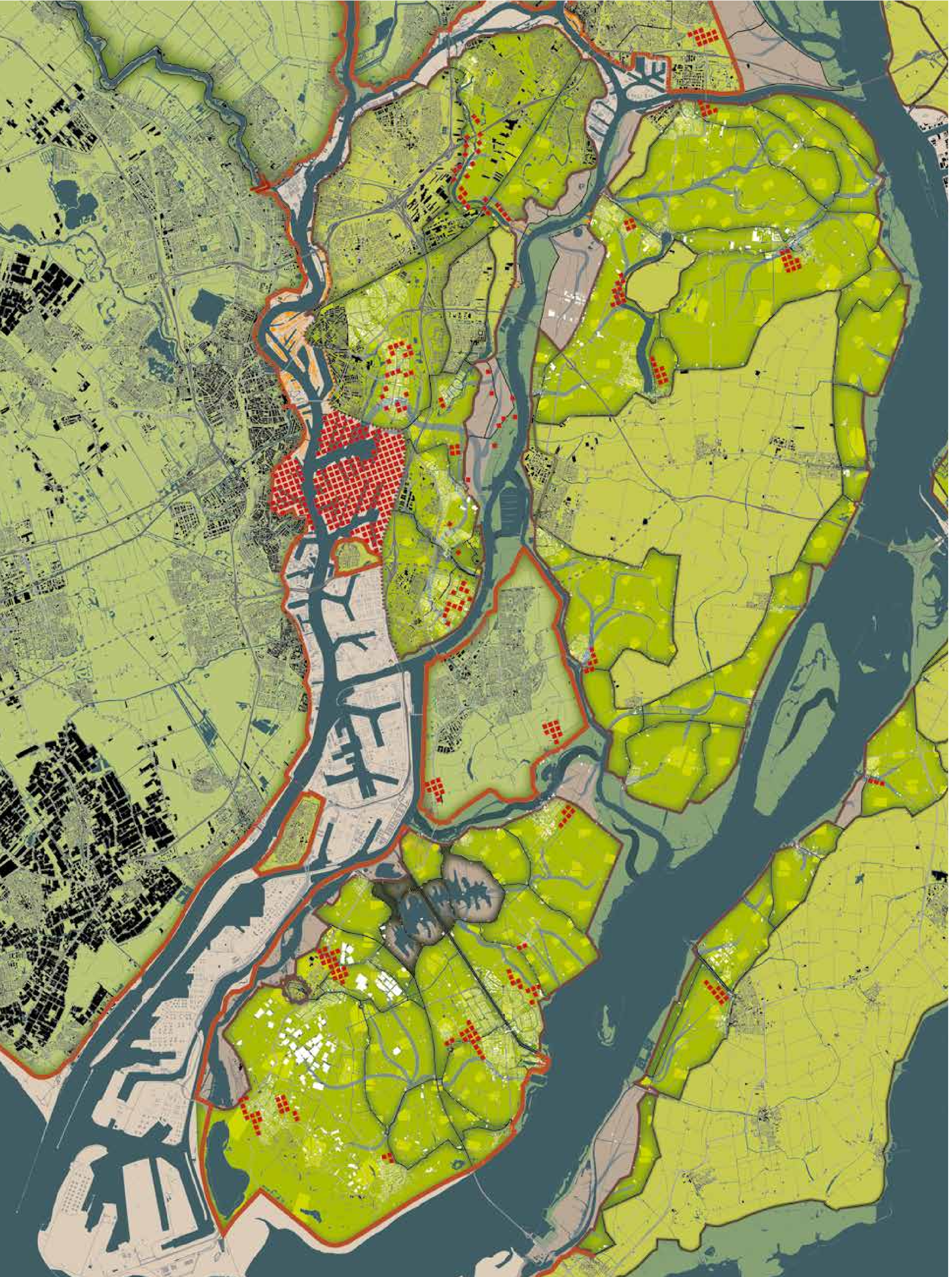


Figure 6.
Figure 7.
Figure 8.
Interior view of the spa building.

ROTTERDAM-RIJNMOND





Robert de Kort

PREPARE FOR IMPACT!

CLIMATE CHANGE ADAPTION AND SPATIAL QUALITY IN THE URBAN DELTA

Year: 2012
Location: Hoogvliet, Netherlands

First mentor: Anne Loes Nillesen
Second mentor: Verena Balz

Technological and policy innovation can inspire new approaches to urban and regional design. For decades, the Dutch flood defence strategy focused on the levee as the ultimate line of defence against flooding. Now that we are facing new flood-risk management challenges brought on by climate change, this strategy has been reconsidered. Work has been under way as part of the Dutch Delta Programme on the transition to a new risk approach, which considers both flood prevention (minimize the probability of a flood) and flood consequence reduction (limit the potential loss of assets and potential loss of life). This graduation project explores the spatial aspects and spatial potentials of a flood risk strategy that is based on large scale flood consequence reduction interventions. The applicability of this flood-risk approach is presented in a spatial strategy and vision in the most densely populated and varied part of the Dutch Rhine-Meuse delta, the Rijnmond-Drechtsteden region. The region is also one of the hotspots in the strategy making process under the Dutch Delta Programme.

When it comes to the materialization of flood consequence reduction strategies, we can draw upon a number of inspiring new design applications from the Netherlands and other countries. In a series of case studies performed in cities including Hamburg, Tokyo, Melbourne and Dordrecht, the properties and utilization of ten types of flood-risk interventions were researched. These were then categorized and applied to a local design for Rijnmond-Drechtsteden. From the case studies, it became apparent that interventions based on probability reduction and interventions based on flood consequence reduction are often combined in the same area. The actual suitability of an intervention for a specific situation depends on the economic value of the protected hinterland and the structure of the local landscape, together with the flood extent and the inundation depth. Most interventions are situated in public space, where smart forms of multiple land use can have a positive impact on local spatial quality.

Risk-management theories also provide good starting points for a stronger focus on flood consequence reduction (e.g., Zevenbergen, Klinke & Renn). As a result of climate change, the frequency of extremely high water levels – and hence the flood probability – are becoming harder and harder to predict. Yet the consequences of a flood can be mitigated regardless of this, by influencing how and where people live, where economic activity takes place and strengthening the community's resilience.

The structure of the landscape and other physical characteristics were leading in this project's design of the flood-risk strategy for Rijnmond-Drechtsteden. Many of the region's southern dyke-rings have their own secondary system of regional levees. They are the products of a historical land-reclamation process around islands formed by sea clay. Unlike the northern and eastern dyke-rings in the region, where the soil is rich in peat, these areas are unlikely to suffer much subsidence in the future. A high level of subsidence makes an area less suitable for flood consequence reduction interventions, because the potential depth of local floodwater increases over time as the ground sinks. The characteristics of the 'occupation layer' (population density, urban character, functions) are also considered, as the findings in the case studies included an analysis of the different measures employed in different types of urban area.

Implementing the two approaches to flood-risk management and the associated interventions creates new opportunities in terms of spatial quality. In this study the focus was put on the regeneration of existing urban areas, another major challenge in the coming decades specifically for the Rotterdam area. Through a GIS analysis combining and scoring factors as maximum flood depth, density, accessibility and level of amenities, residential districts suitable for adaptation were selected. These are indicated by hexagons on the strategy map, with the different colours indicating the type of urban environment concerned.

Central in the design are the polders shown in yellowish green on the strategy map. These have an adaptive structure: the dykes enclosing them have been made resistant to overtopping, while combined inlets and outlets (red circles) allow the ingress of water under regular water levels. The restoration of tidal flows to the Haringvliet should create a new type of natural delta environment, allowing the establishment of unique adaptive living environments. In the event a flood, the water can evacuate back into the inlets and rivers through the outlets. A withdrawal strategy is proposed for several very deep compartments. There is only room for limited development outside the levees – in the southern part of Eiland van Dordrecht, for example, and the very low-lying polders in the centre of Voorne-Putten. Here, too, there is plenty of room for natural development of typical delta habitats. In the heavily urbanized dyke ring areas, most with peaty soil, efforts focus on flood probability reduction with extensive levees. These areas include the dike-rings to the north and east; South-Holland South, Krimpenerwaard, Alblasserwaard, parts of IJsselmonde and the northern section of Eiland van Dordrecht.

A series of draft designs reveal how the new flood defence strategies will be applied at local level. The situation for rural and suburban areas is shown in more detail in a design for the Albrandswaard district, which includes Hoogvliet, a typical post-war centre of urban growth. Here, flood-impact reduction interventions are applied in neighbourhoods earmarked for substantial regeneration. Elsewhere in Albrandswaard, new links are created between the Oude Maas waterway and the Waalhaven dock in the port of Rotterdam. As a result, a polder landscape is transformed into a natural delta environment. In this area, there is scope for new building forms, with clusters of amphibious houses next to the newly formed mudflats and salt marshes affording residents panoramic views of a dynamic natural scene full of birds and unique vegetation.

The redesign of the southern section of Hoogvliet is also developed out of a new relationship with the water. Here, a so-called 'green-blue network' is created and linked up to the Oude Maas, so that people in Hoogvliet can experience the daily rhythm of the tide. Possible ways of adapting the existing large-scale housing complexes in the area were researched, with options including dryproofing the ground floor or incorporating it into a new artificial mound or dam.

The new waterways in Hoogvliet are lined by either urban quays or, to create a more gentle relationship with the water, by homes integrated into a row of artificial dunes. The locality and the buildings within it are adapted to cope with flooding up to a defined maximum depth, so that the area suffers a minimum of damage and life can return to normal as quickly as possible afterwards. Under normal circumstances, these interventions will establish a new relationship between the local community, the region and all of Rijnmond-Drechtsteden, and the water around them and the nature it creates, as well as offering new recreational opportunities and improved spatial quality.

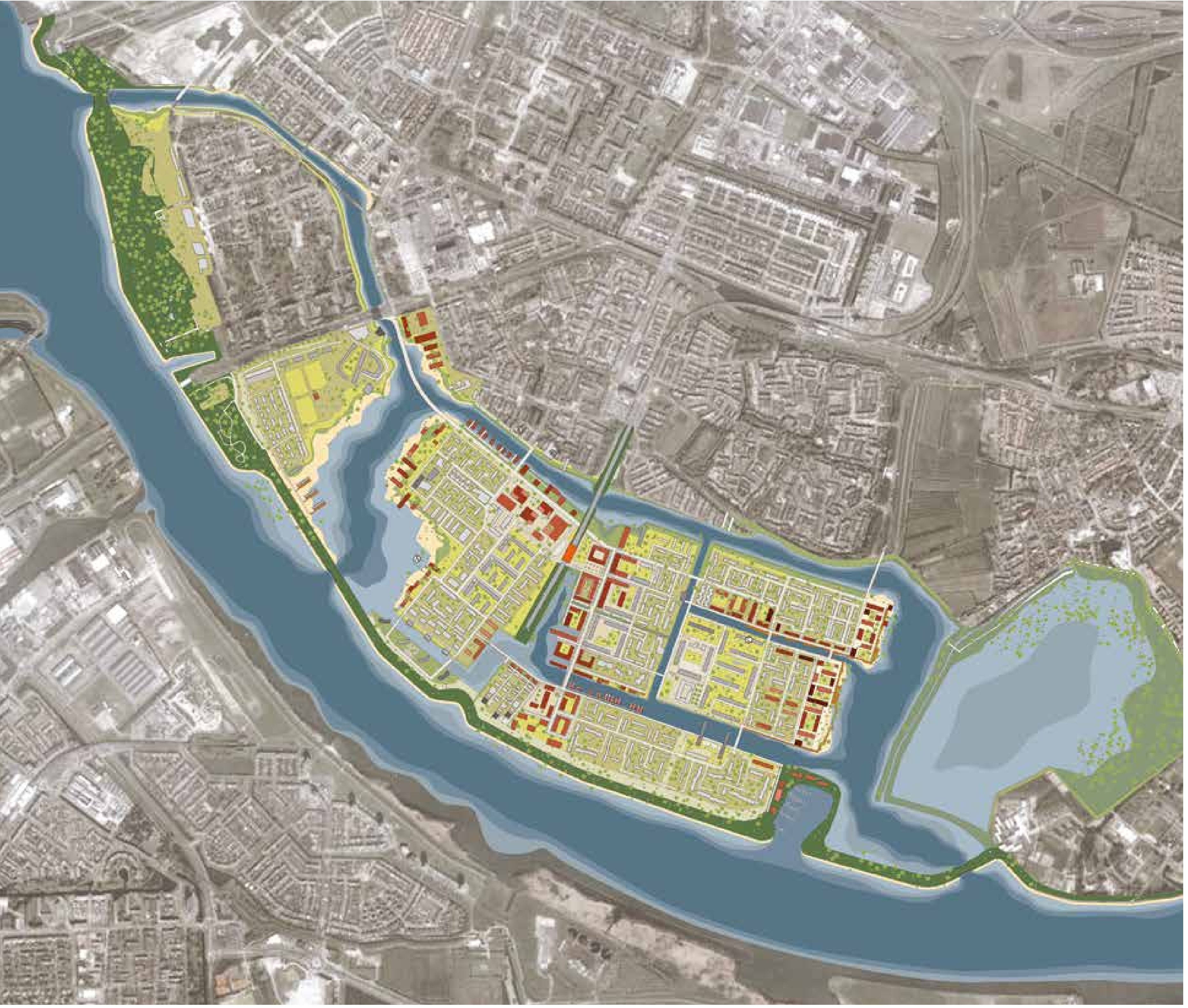


Figure 9.
Adaptive design for Hoogvliet.

Figure 10.
Redesign for one of Hoogvliet's new quays, during regular low tide (left) and high water levels (right).

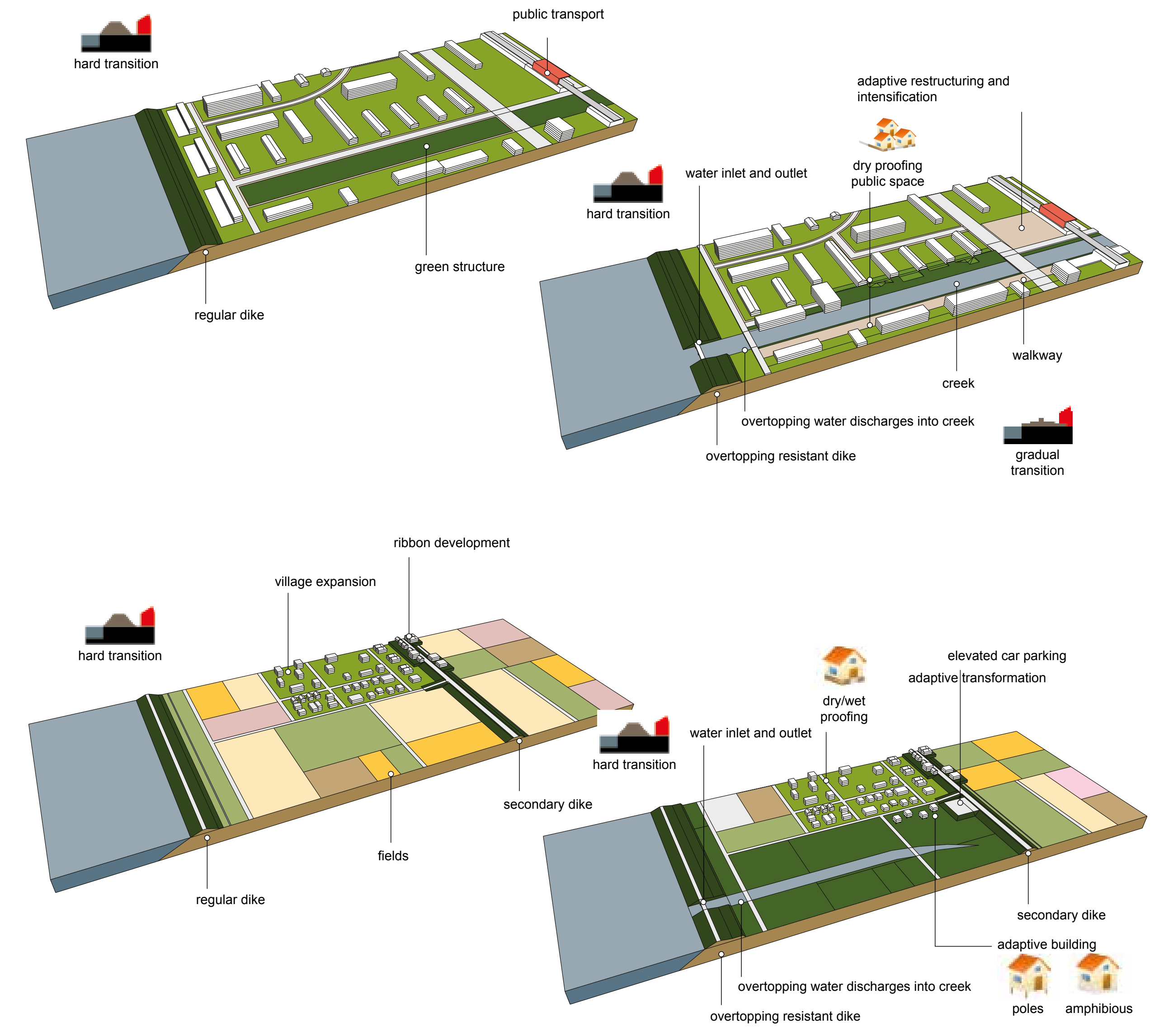


Figure 11.
Sketch design of adaptive polders, in suburban context (upper) and rural context (lower), in existing situation (left) and design proposal state (right).

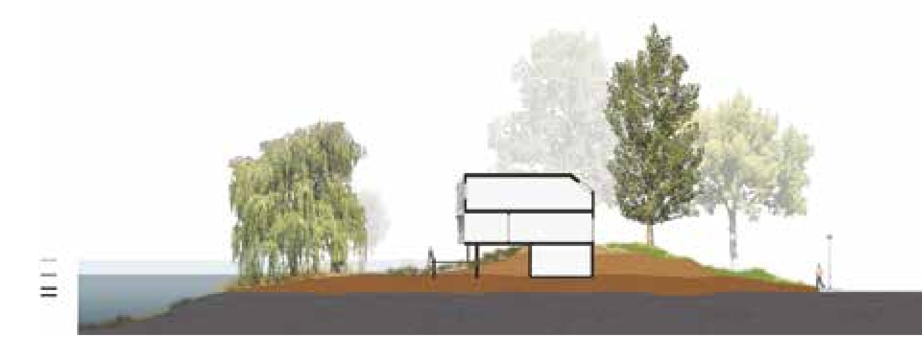
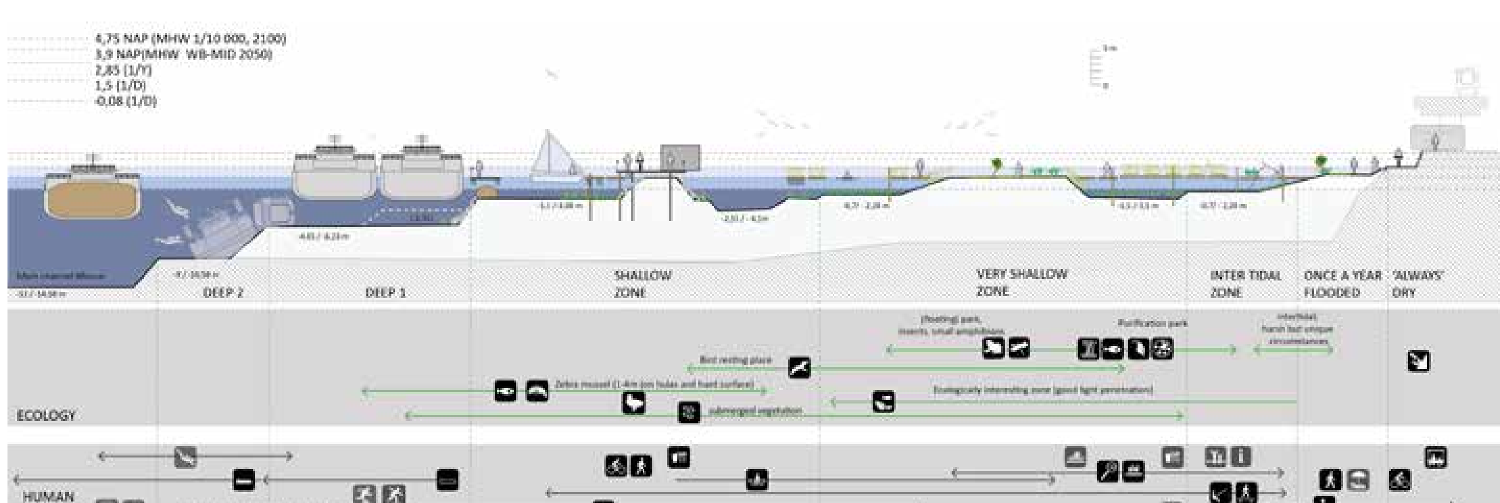


Figure 12.
Cross-section of the Hoogvliet design: new relation of the existing development with public space and tidal waters.

Figure 13.
Cross-section of the Hoogvliet design: new relation of the new developments with public space and tidal waters

Figure 15.
Bird's eye perspective of Maashaven., Rotterdam.

Figure 16.
Cross-section.



Karlijn Kokhuis

THE CONNECTING WATERSCAPE

Year: 2013
Location: Rotterdam, Netherlands

First mentor: Peter van Veelen
Second mentor: Steffen Nijhuis

In Rotterdam, as in many northern European cities, the traditionally dominant relation between city and river has disappeared with changes in industry and trade. Now, instead of serving a central function, the Rotterdam harbor divides successful neighborhoods from deprived ones. The former urban harbor area is short of recreational public space, which makes it difficult to attract starters and young families to these neighborhoods in need of transformation.

This project applies a public space design to strengthen the relation between city and river, at the same time connecting districts which are currently disconnected. The transformation of harbor basins into public space depends in large part on the design of crucial spaces at the edge of the harbor. This project proposes an adaptive redevelopment plan which considers both future effects of climate change and possible socio-economic developments.

Reconnecting districts also requires a good local slow-traffic network, a strong local identity, and programming that appeals to (potential) residents. The spatial claims of watermanagement, industry, recreation and ecology must be integrated and even strengthen each other. Though the municipality has proposed floating neighborhoods for this area, these are rejected in the design proposal because this would have a privatizing effect, whereas it is precisely the open public space that will bring quality to this location.

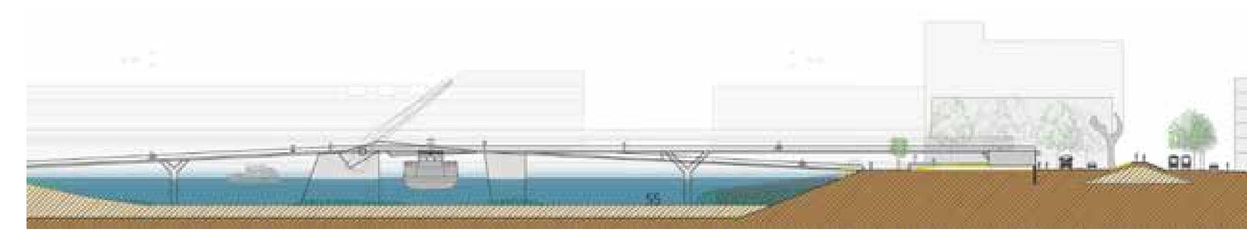


Figure 17.
Cross-section pedestrian and bicycle bridge.

Figure 18.
Brielse kades.

Josephine van der Klauw

COMMUNITY CENTER AFRIKAANDERWIJK

WATER STORAGE AS A SOCIAL CONNECTION

Just behind the 'up and coming' district 'Kop van Zuid', lies the Rotterdam quarter 'Afrikaanderwijk'. Not only does this multicultural neighborhood contend with social difficulties, it also has to contend with increasing flood problems caused by heavy rainfall runoff. To address both of these aspects in a combined solution, a lively community center was designed. In this place, sport, music, and theater share the stage with a skateboard park, which also functions as water storage area.

The community center and the skateboard park are situated on the commuter route between the *Kop van Zuid* and the *Afrikaanderplein*. By positioning the structures on and over the levee that largely separates these divergent communities, the design creates a bridge, both literally and figuratively. The visible draining gullies which are included in the design provide another connection to flooding and flood risk. These gullies catch rainwater and transport it to an underground storage. From there, the water can be re-used: for example to irrigate the community garden's rooftop garden.

Year: 2010
Location: Rotterdam, Netherlands

First mentor: Anne Loes Nillesen
Second mentor: Ann Karina Lassen

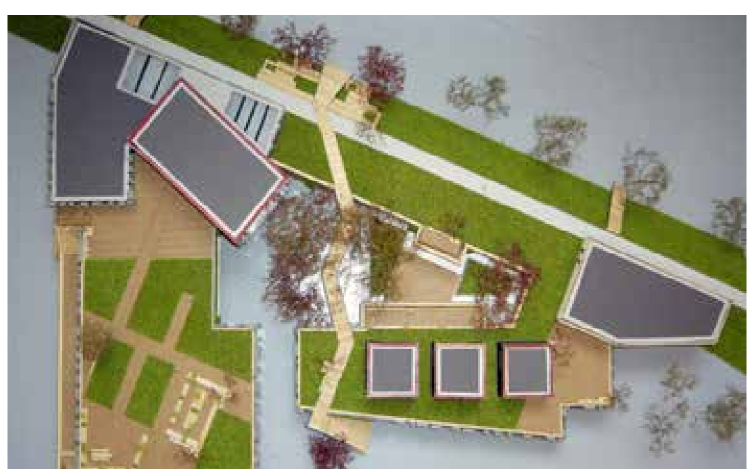


Figure 19.
(top left) Top view of the building, showing the levee diagonal in the top and the courtyard in the middle.

Figure 20.
(top right) Interior view of the theatre room towards the courtyard.

Figure 21.
Cross-section of the building and inner courtyard

Juriaan Calis

SOCIAL SUSTAINABILITY

AFRIKAANDERWIJK

Recent increases of heavy rainfall events have created capacity problems for the existing sewer system in the Rotterdam neighborhood of Afrikaanderwijk. This project investigates the possibility of collecting rainwater and storing and deploying it instead of draining it through sewers. This would keep the relatively clean rainwater separate from the dirty wastewater in the sewers.

The rainwater will be stored in an apartment block that includes a swimming pool. The building design combines the typology of the Dutch building block with the technology and climate system of a greenhouse. The indoor garden will function as the social and natural heart of the building. Water and energy can be stored in large water basins and used for heating and cooling the apartments, flushing toilets and creating a green oasis within the building block.

Year: 2010
Location: Rotterdam, Netherlands

First mentor: Thorsten Schuetze
Second mentor: Ann Karina Lassen
Third mentor: Anne Loes Nillesen

Figure 22.
Interior view of the inner courtyard

Figure 23.
Cross-section of the building.

Claudia Heimensen

WATER WONEN

GO WITH THE FLOW

As a result of climate change, architecture has to adapt to water level fluctuations. Delta areas, such as Rotterdam, require water-resistant designs for waterfront developments. The concept of *Water Wonen* is to connect the city to the water, bring the living space close to the water, where people can experience the tides, while being safe from the water. This water-proof building lets water in the outdoor space at the lowest level of the building during high tides or extreme water levels. The rest of the year, the outdoor space can be used to enjoy the proximity of the river.

From inside the dwelling, the occupants experience the differences in water levels directly, with rising tides and high water directly influencing their way of life. Each individual dwelling has two differently oriented apartments, creating both a water- and a city-apartment. Robust materials such as concrete, wood, and steel have been selected based on the design of the Port of Rotterdam.

Year: 2010
Location: Rotterdam, Netherlands

First mentor: Anne Loes Nillesen
Second mentor: Ann Karina Lassen

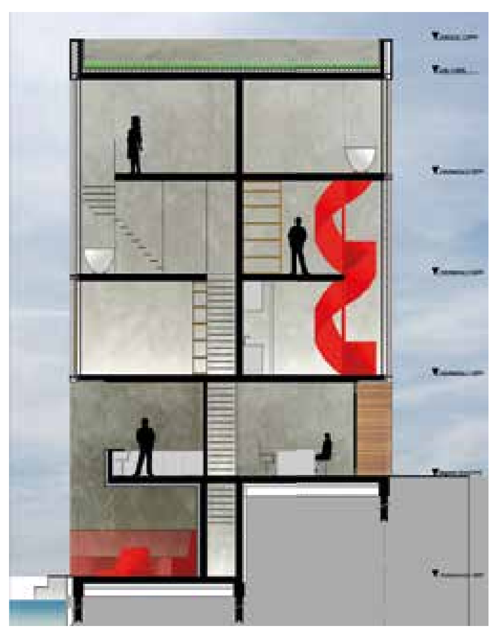


Figure 24.
Figure 25.
Cross-section of the building showing the internal organisation of the two dwellings.

Figure 26.
Facade view: Flood proof outdoor spaces seen from the riverside.

Isabelle Putseys

STRATEGY AND VISION

THE RHINE-SCHELDT DELTA AND RIJNMOND

Cities located in deltas have to adapt to the effects of climate change, and are being forced to seek new urban development strategies. The traditional design of Dutch flood defenses puts flood prevention first and foremost. However, as levees and quays continue to rise as a result of this policy, more and more barriers are placed between the water and the city and between the city and its harbor. Bearing these problems in mind, changing insights towards flood safety lead us to a new strategy in spatial development. This strategy returns diversity and dynamics to the urban delta landscape and transforms the delta from a resistant and fixed region to one that is resilient and adaptive.

We applied this strategy in Deltapark A15, a redevelopment project in the south of Rotterdam. This region has two 'backbones', one infrastructural, the other natural. The A15 motorway is the major infrastructural element; as far as nature, the green-blue landscapes are currently fragmented and deprived of meaning. Deltapark A15 consolidates the scattered natural fragments along the highway, giving them value, and producing a new centrality where residents will find a revitalized urban space with leisure activities, attractive housing, and open green areas. The development is linked to the water by five different dike designs:

- *Delta Living*, a soft dike design, with low density housing, gardens and floating houses;
- *Dike City*, a built dike design with heritage dike houses, marshlands and a beach;
- *Rotterdam Marina*, a hard hedge design with high quality houses, leisure activities, public spaces, and water sports;
- *Bio Eco Park*, an infrastructural dike design, with a water treatment facility, special business development, and a new metro station; and
- *Dunes on the Road*, a natural barrier design, which serves as a sound barrier along the motorway, as well as offering a scenic overlook.

Year: 2009
Location: Rotterdam, Netherlands

First mentor: Han Meyer
Second mentor: Willem Hermans
Third mentor: Henco Bekkering

Co-researchers: Antonio Alba Ruiz, Matei Bogoescu, Remi van Durme, Valentina Grimaldi, Anna Sans Orriols, Patrizia Sulis.

Figure 27.
Rotterdam Rijnmond DeltaPark A15 area.

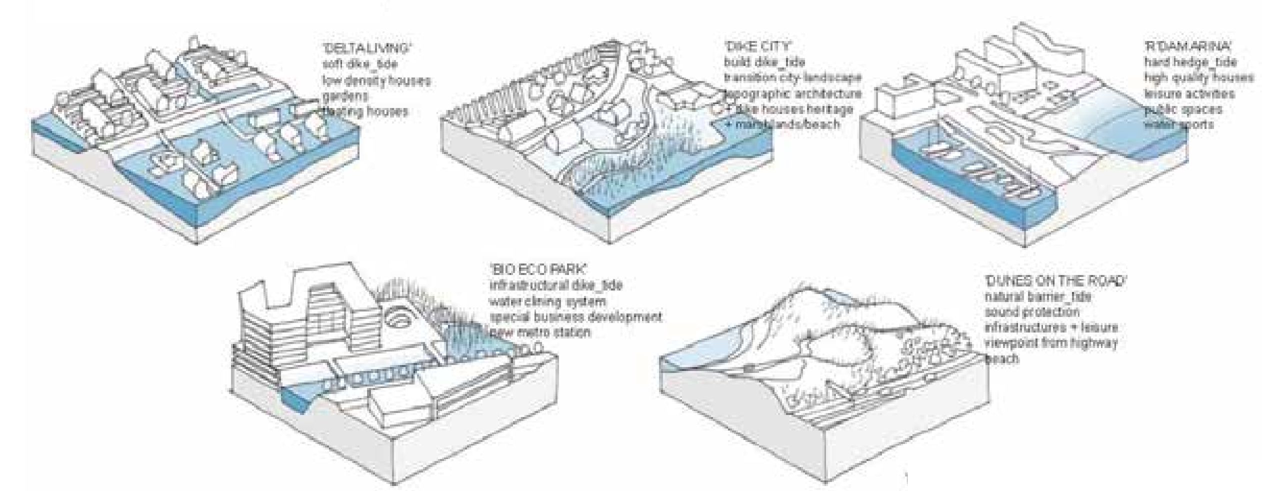
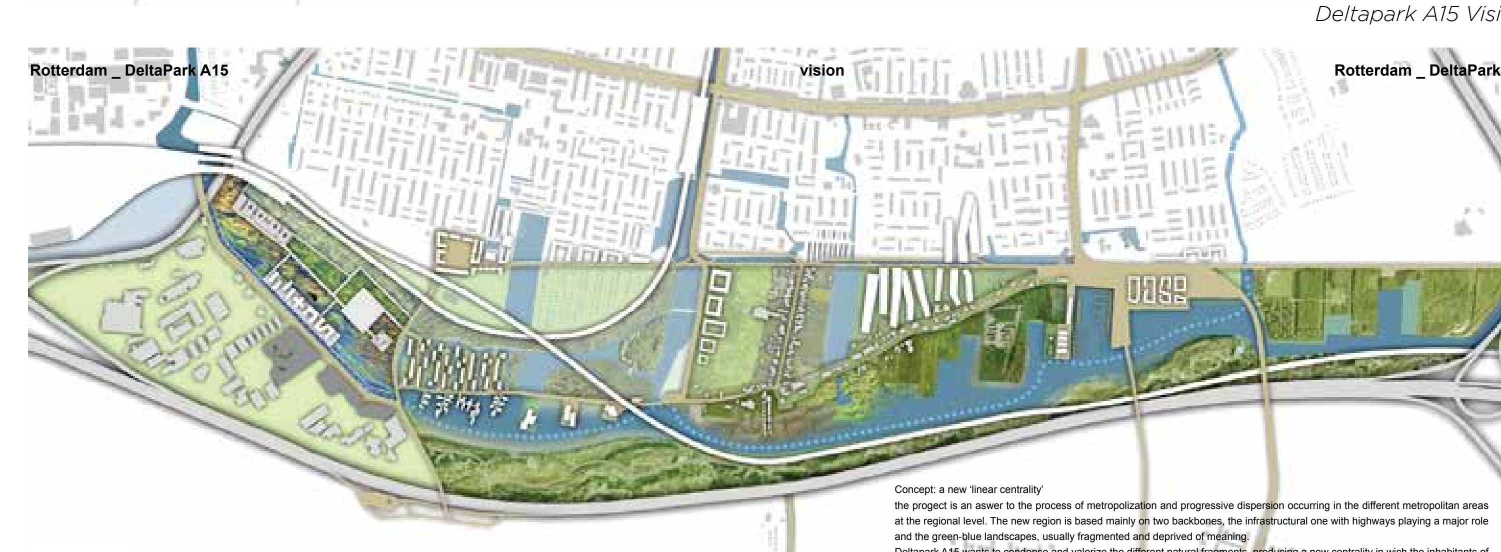


Figure 28.
Five dike designs:
- Delta Living
- Dike City
- Rotterdam Marina
- Bio Eco Park
- Dunes on the Road.

Figure 29.
Deltapark A15 Vision.



Justina Ragaišyte

URBAN SPACES CONVERTED INTO PUBLIC SPACES

REGENERATION OF URBAN AREAS ALONG THE RIVER ROTTE

Apart from shopping hours, the streets along the Rotte River in the city center of Rotterdam are empty and the nearby water is ignored. The urban spaces along this river could be converted into public places, recreating a lost link between city and water. The goal of this project is to increase the connection to the water as the basis for improving this particular part of Rotterdam's city center.

The design is based on a system of various pedestrian routes and different public places that are connected by the water. The main urban design tools will include softening the edge between water and space along the river by building various stepped terraces, extending the activity of ground floor facilities through outdoor space towards the water, and creating reasons for visitors to stay in the area by introducing various sitting options and possibilities to enjoy the views. By focusing on human scale interventions along the waterfront, this design would positively influence the entire district.

Year: 2014
Location: Rotterdam, Netherlands

Mentors:
Maurice Harteveld
Machiel van Dorst

Figure 30.
New design for the Rotte, seen from the Hoogstraat.

Figure 31.
Stepped water quay.

Sjors Verhaar

OLYMPIC GAMES

DESIGNING A MULTIFUNCTIONAL STADIUM

The Netherlands wants to be the host of the Olympic Games in 2028. During this event, the Netherlands would be at the center of the world's attention. This makes it the ideal opportunity to promote our country and demonstrate what we are known for worldwide: water management and hydraulic constructions.

To demonstrate this knowledge, this project proposes a floating Olympic Stadium as the centerpiece of the Olympic Games of 2028. The design of the building will be iconic and will also address the funding question. Investments for Olympic facilities are often huge and a point of national debate. By designing a multifunctional and flexible structure, it will become profitable, as it can be used over a longer period. When desired, it can be floated somewhere else in the world. For example, it could be deployed for the next Olympic Games!

To create optimal multi-functionality, we could change fields for different types of sports by floating them in and out of the stadium. The different sized fields can be positioned at different heights appropriate to each different event, by using a submarine technique. This will enable spectators to experience every event from close by for the optimal experience.

Year: 2009
Location: Rotterdam, Netherlands

Mentor:
Anne Loes Nillesen

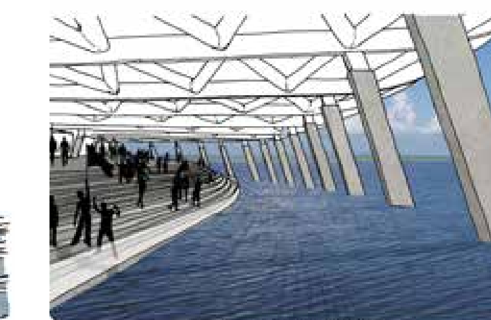
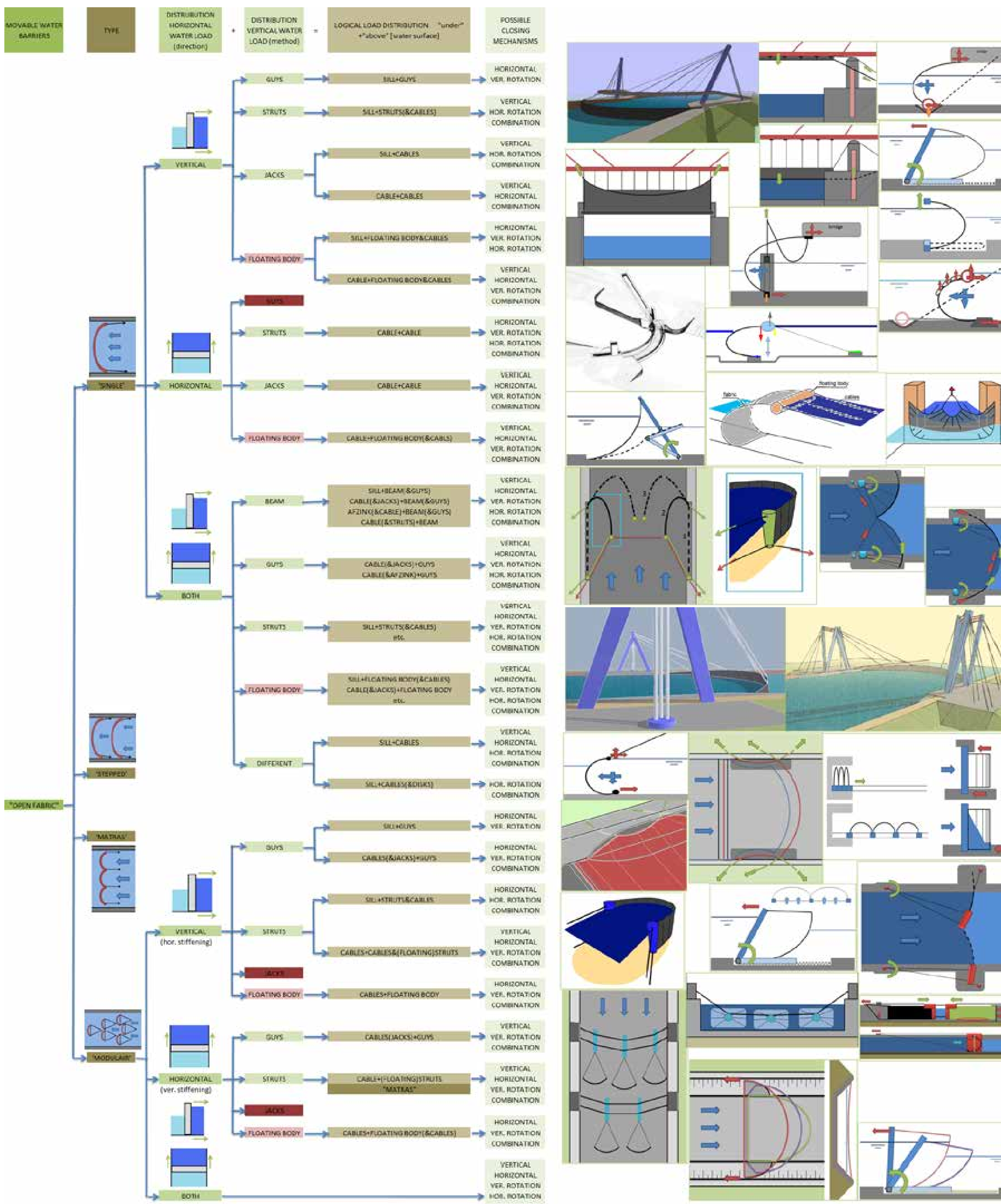


Figure 32.
(right) Impression of the building positioned in the City of Rotterdam.

Figure 33.
Figure 34. .
(far right) Different exterior space of the stadium depending on different water levels.

Figure 35.
Model showing a cross-section of the building.

Figure 36.
Tree diagram of open fabric movable water barriers.



Floris van der Ziel

MOVEABLE WATER BARRIER FOR THE 21ST CENTURY

A USUALLY-OPEN-OCCASIONALLY-CLOSED WATER SYSTEM

Year: 2009
Location: Rotterdam and Dordrecht, Netherlands

First mentor: Ad van der Toorn
Second mentor: Arie Romeijn

The second Delta-committee (2008) foresees difficulty in resolving flood safety issues for Rotterdam and Dordrecht if high river runoffs are still running through the New Waterway within 50 years. One of the proposals is a 'Usually Open, Occasionally Closed' (UOOC) Rhine mouth. (Or in Dutch: 'Afsluitbaar Open Rijnmond'). This concept for the water-system around Rotterdam and the Drecht-cities diverts the river water towards the southern part of the delta. Four large movable water barriers, in the main waterways and navigation channels, are required within the current UOOC concept. This plan calls for an innovative barrier design.

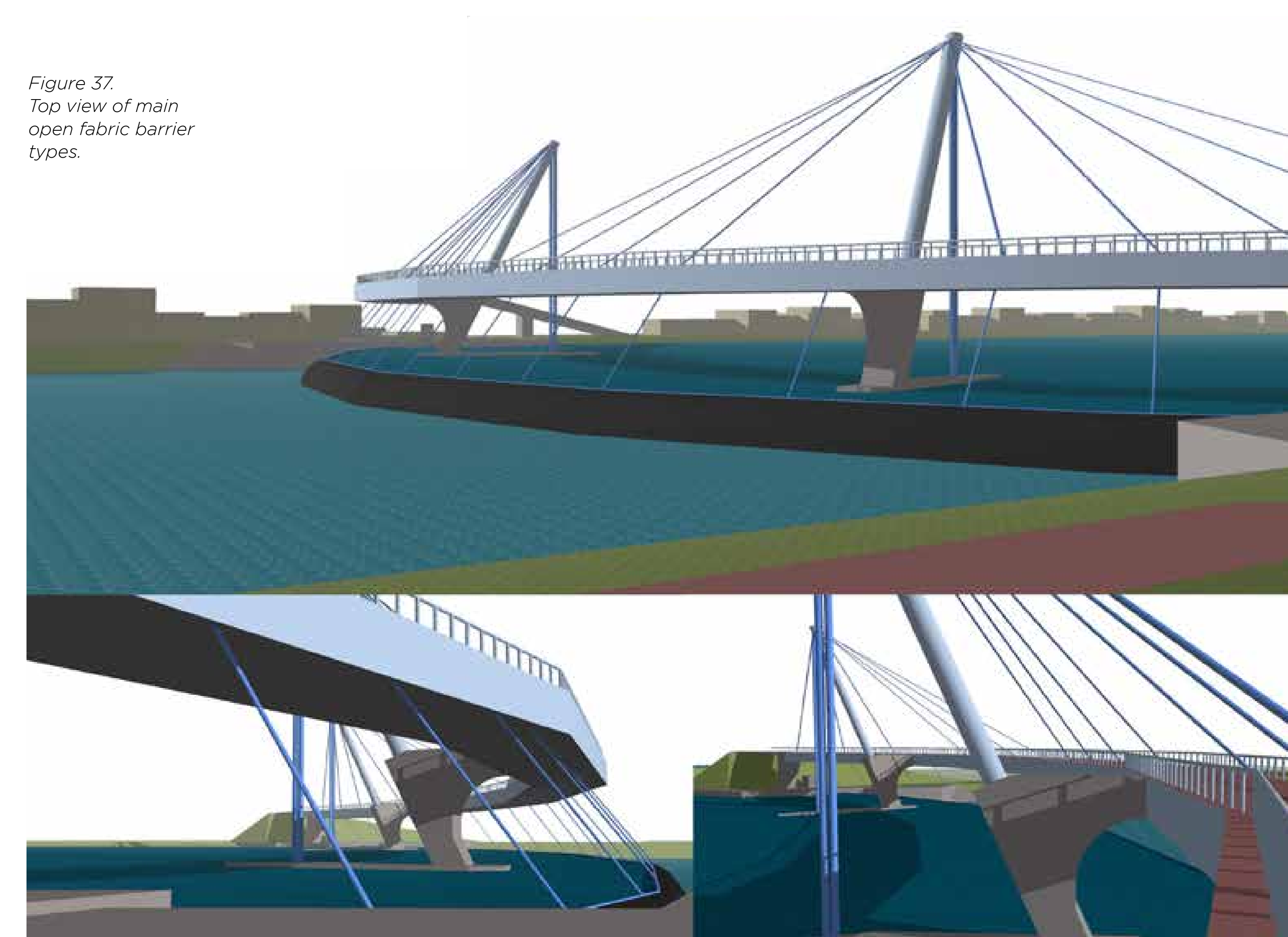
The lifetime of a civil structure is determined by social and ecological aspects, rather than technical ones. Beyond the technical design, more flexible, adaptive designs are needed, which consider the functional life time of the structure. Moreover, hydraulic structures like water barriers are mainly mono-functional, whereas multi-functional structures could increase benefits and social acceptance.

This project takes an integral approach, combining civil engineering and architecture, and applying specific knowledge about synthetic materials, to develop a new type of moveable water barrier. We explore the possibilities of applying light weight and low maintenance synthetic materials, as well as combining functions and designing with functional life time in mind. The result is a moveable parachute water barrier.

The parachute (made of rubberized nylon) hangs beneath the bridge. The bridge diverts about 50% of the water pressure, and the remaining pressure is diverted by the parachute, attached by a cable that runs through the bottom of the parachute and which is clamped to the two bridge abutments. Combining the parachute with the bridge lowers the cost of the parachute barrier because a relatively small parachute is required. The parachute forms a single gate that is more than 200m wide. Not only is this unique for a moveable water barrier, but it is also cost efficient.

Because of the low maintenance cost of the fabric, this barrier is 30% cheaper than a conventional water barrier with a steel gate. In addition, depreciation is reduced, since the main investment – the barrier structure – can be altered each time the fabric needs to be replaced (this makes the technical life time about 25 years instead of 50). Given the uncertainties associated with sea-level rise, flexibility becomes a more important issue, and an adaptive barrier such as this can address that need.

Figure 37.
Top view of main open fabric barrier types.




K

Han Meyer

SOUTHWEST DELTA: SPACE FOR 'CONTROLLED DYNAMICS'

INTRODUCTION

The Southwest Delta is perhaps the most dynamic region in the low-lying Dutch Delta, both in terms of the dynamics of the relationship between water and land, and in terms of the dynamics of urban and economic growth and their consequences for land-use.

The dynamics of the water-land relationship increased at the time when the main stream of the Rhine shifted from the 'Old Rhine' to the Lek, Waal and Merwede rivers, around a thousand years ago. This resulted in a process of transformation, in which a coast with a few small estuaries from the Maas and Scheldt changed into a landscape of large tidal outlets between islands, sand bars, peninsulas, salt marshes and mud flats. The configuration of this archipelago changed frequently, partly due to the storms and floods that washed away large pieces of land, and partly due to sedimentation, which led to the formation of new deposits. Human interventions, such as land reclamation, the damming of creeks, and salt extraction (achieved by cutting away the layer of salt-saturated peat), contributed to these changing dynamics between water and land. The map of the Southwest Delta changed constantly and therefore had to be re-drawn a number of times every century.

The changed course of the main stream of the Rhine was also the most important driver of the process of urbanisation that occurred in and around the Southwest Delta. Cities such as Dordrecht, Rotterdam, Antwerp and many others were able to develop relatively safely behind the coast, while remaining easily accessible from the sea and with links to the hinterland via the rivers.

By the mid-twentieth century, both types of dynamic were increasingly being perceived as problematic, and attempts were made to regulate and control both the land-water process and the process of urbanisation. After the disastrous storm of February 1953, which flooded a large part of the Southwest Delta and claimed the lives of more than 1800 people, the Delta Works were executed to provide better flood protection for the landscape and urban areas. The same period also saw the development of a national spatial planning policy that aimed to steer urban development more effectively. The rapid development of the region around Rotterdam and The Hague was viewed with particular concern. It was feared that a densely populated metropolis would emerge, characterized by overcrowding, congestion and social inequalities. The government introduced a policy of decentralisation that resulted in new centres of urban growth, such as Hoogvliet, Spijkenisse and Hellevoetsluis.

What is the situation today, half a century after the introduction of the Delta Works and the pro-decentralisation spatial planning policy? The Delta Works have led not only to greater security, but also to a drastic change in the natural environment and its various ecosystems. The construction of a storm barrier in the Eastern Scheldt (completed in 1982) was the first major adjustment to the Delta Plan, leading to the retention of tidal salt water in this inlet. Since then, pleas for the re-establishment of tidal reserves, areas of brackish water and gradual gradients of land and water elsewhere in the region have resulted in numerous initiatives.

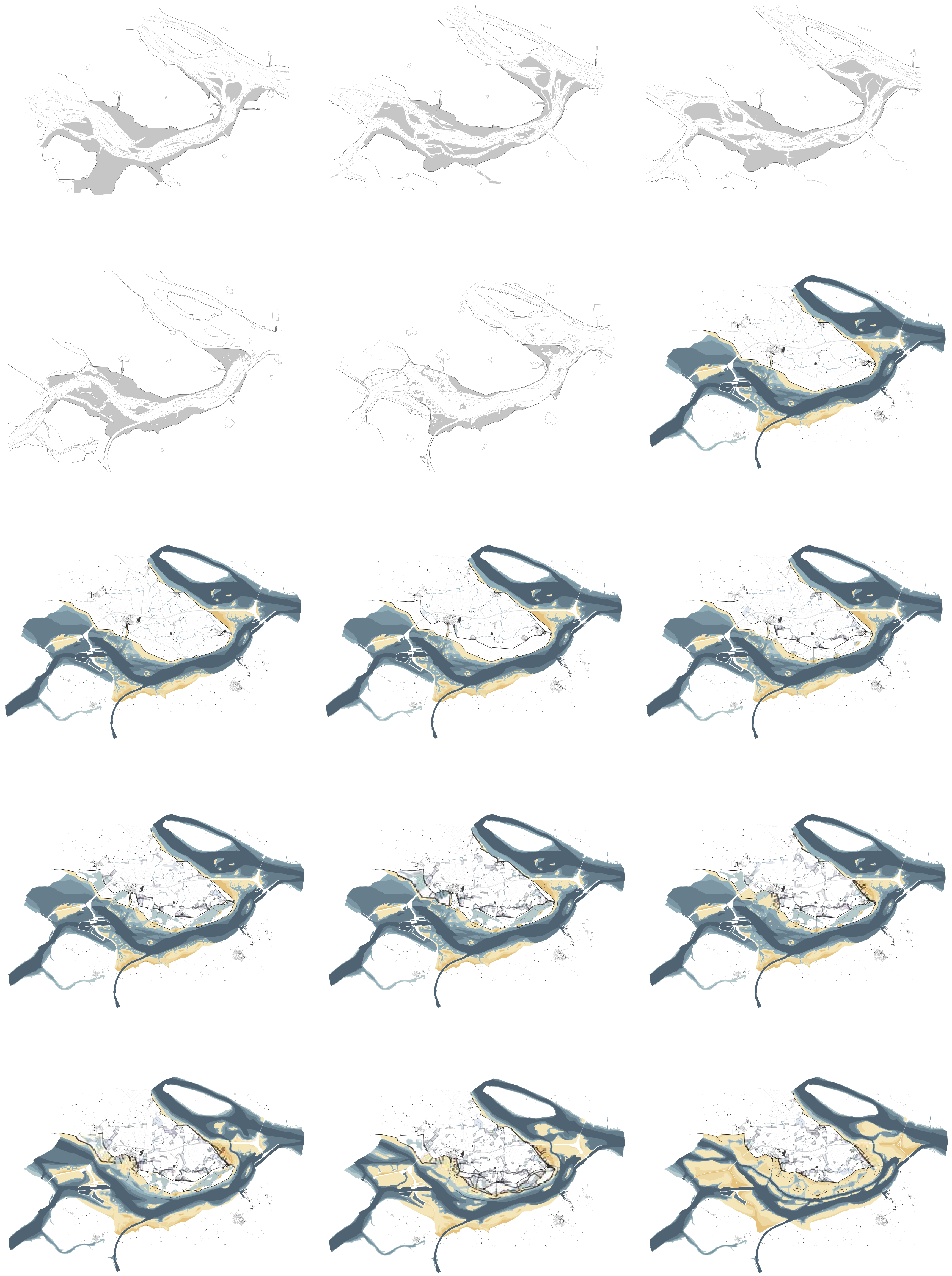
There have also been various changes in relation to urban growth. Over the last decade, resistance to metropolitization has turned full circle into arguments for metropolitization. Rather than encouraging an even distribution of urban growth over the entire Southwest region, greater value is now attached to strengthening, on the one hand, the 'green-blue' character of the Southwest Delta itself, and on the other, the 'horseshoe' of towns and businesses around this delta.

Such changes do not occur automatically; new spatial design challenges have emerged, and the question remains how sub-regions of the Southwest Delta can be related to the larger whole in future.

Regarding the highly urbanized Rotterdam-Dordrecht region, the question is how a new relationship can be achieved between the 'delta condition' and flood security. The main arteries of the rivers run directly along and straight through the most urbanized areas in this region. On the one hand, this creates fantastic opportunities for new urban waterfronts, which can capitalize upon the disappearance of harbor activities from many waterside locations in these cities. On the other hand, it is these waterside locations that are most exposed to the danger of flooding. The design-driven challenge here is to develop new, attractive urban environments in combination with the lowest possible risk of flooding. This means looking not only at the locations in question, but also at the water system of the Southwest Delta as a whole. It is a question of whether lowering the flood risk should be addressed on a sub-regional basis, or whether there should eventually be a joint solution for the entire area along the banks of the Nieuwe Maas, Nieuwe Waterweg, Noord and Boven-Merwede rivers.

There are also design-driven challenges concerning the 'green-blue heart' of the delta: How can we strengthen the natural dynamics while maintaining as low a risk of flooding as possible? At the same time, how can we create new economic prospects for this blue-green heart – for the agrarian sector, leisure and tourism, but also for port activities, shipping and energy production?

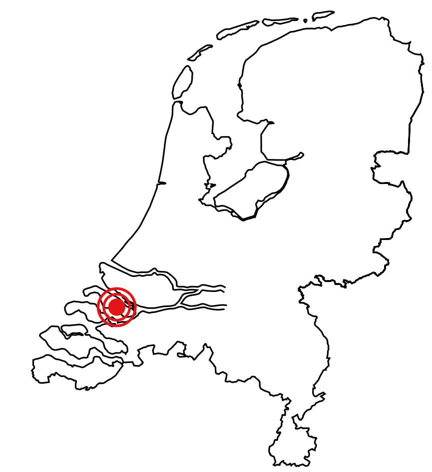
Designing the Southwest Delta in the 21st century is like tinkering with a running engine: the mechanic must constantly pay attention to the smallest parts, while simultaneously keeping an overview of the engine as a whole.



Nathan den Besten

TOWARDS AN OPEN DELTA

RESEARCH & DESIGN FOR SUSTAINABLE URBAN LANDSCAPES



Year: 2012
Location: Krammer Volkerak, Netherlands

First mentor: Han Meyer
Second mentor: Inge Bobbink

The Dutch Southwest Delta is a combination of human intervention and natural dynamics. Reclaiming sandbars and founding cities along the ring dikes characterized the urbanization of the delta. The Delta Works provided safety from flooding, by building dams and levees that closed off sea arms; ever since, the dynamics in the delta have been limited, with major implications for nature, water balance, and soil hydrology. The current 'closed-off delta' can only evoke memories of the former dynamics. Using research by design, this project aims for a future in which these dynamics are restored, at the same time sketching a transforming and attractive urban landscape and residential area in an 'open Southwest Delta'.

The continuously returning theme is to restore the relation between city and landscape with the water - working on different scales and levels. First, restoring the natural dynamics offers opportunities to restore the historical identity of the cities in the region, re-establishing their relation with the water in a tidal zone. Historical research shows that the urban development and form of these harbor cities was not actually oriented towards the water but more towards the polder landscape. In the current project, the design therefore outlines a way to create a clearly visible relation between the restored tidal area, the levee, and the church ring with its main street, while also reinstating the harbor square in the cities Oude Tonge and Ooltgensplaat. Secondly, the area offers great potential for living in a rural environment with many recreational opportunities connected to the water. By developing so-called terps (earthen mounds or knolls), the design provides a means to realize permanent residences in the tidal zone that are still safe from flooding. Finally, this design creates opportunities to improve the water management in the polders by restoring and expanding the original creek structure in the area.

Research-by-design is characterized by pen sketches. Drawing these is part of the search for an integral solution for the urban and rural layers of the planning area, as well as the cultural and natural layers. The possibility of an 'open Southwest Delta' offers many opportunities to create value by integrating these elements.

This project presents a series of images which show the step by step development of Room for the River: gradually restoring the tidal ebb and flow, the subsequent regulated inundations of the polders, creating a natural flood defense, and, finally, achieving a restored 'open delta'. The project concludes with a more concrete elaboration of the city of Oude Tonge as a harbor town with a clear connection to the water. Although this research-by-design project concentrates on the Krammer-Volkerak area, it can serve as a representative case study for the entire Dutch Southwest Delta, as an example for further projects aiming to restore the historical relation of harbor cities with the water.

Figure 38.
(left) Transition from an intertidal area in 1850 to an open delta in 2100.

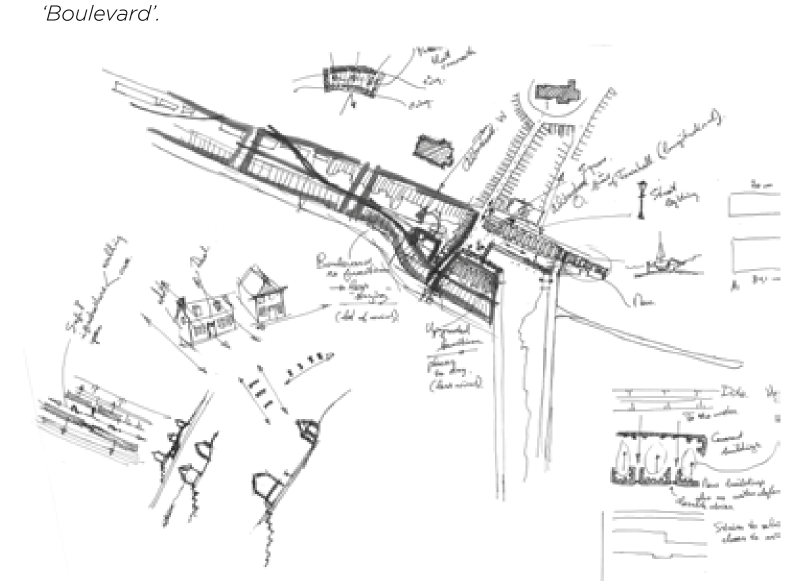


Figure 39.
Pen sketch 'Boulevard'.

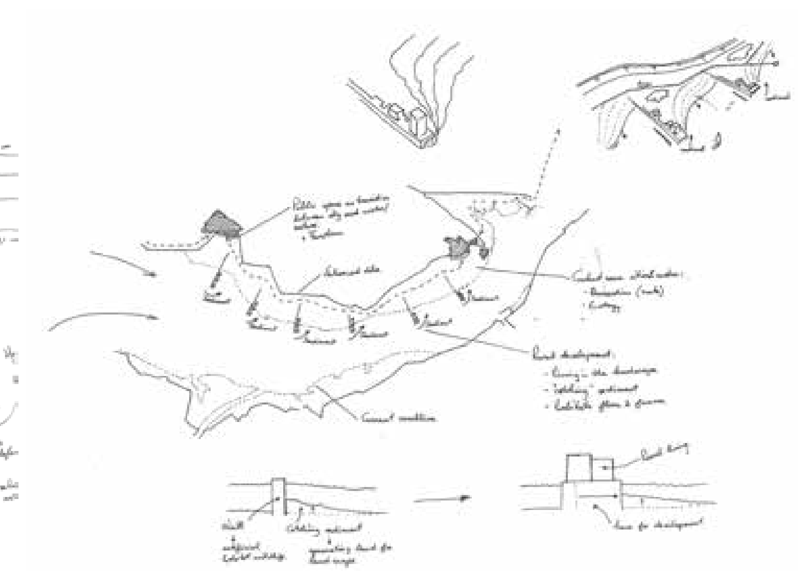


Figure 40.
Pen sketch 'Transition area's'.

Figure 41.
Impression: towards
an Open Delta.

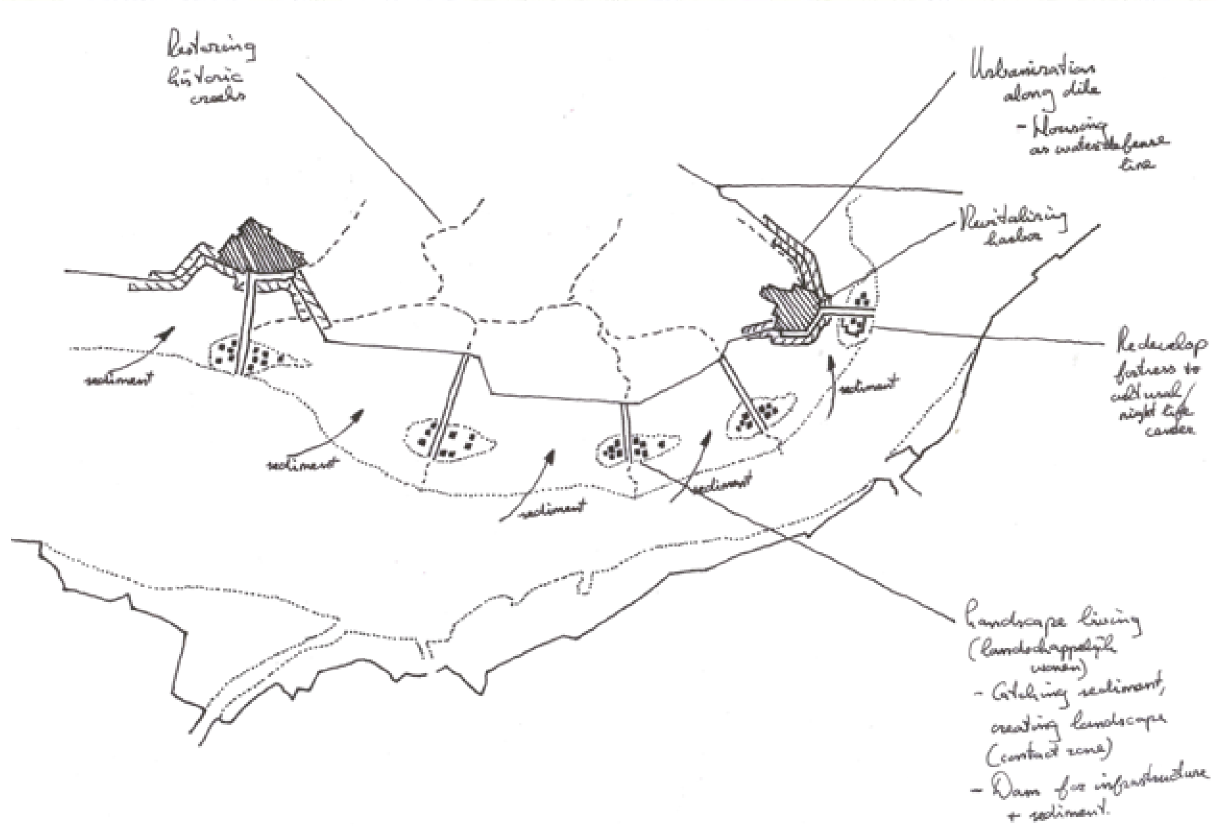


Figure 42.
Pen sketch
'Restoring historic
creek and Landscape
living'.

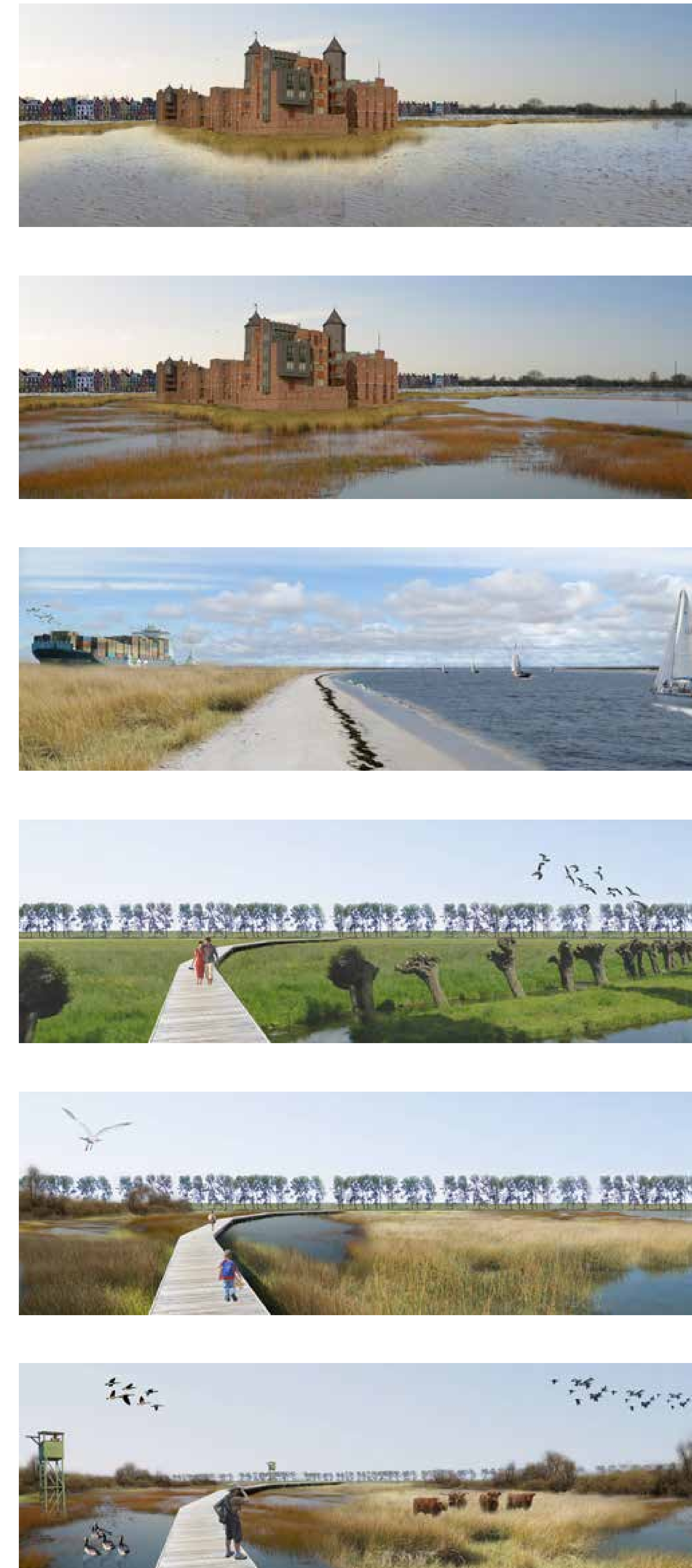


Figure 43.
Impressions of the
open delta: Castle,
Shipping Lane, and
Creek in various
seasons.

Figure 44.
Scale-model of the Nature Activity Center building.

Rene Postel

CLIM(B)NEY

A NATURE ACTIVITY CENTER IN NATURE RESERVE THE BIESBOSCH

Year: 2010
Location: The Biesbosch, Netherlands

First mentor: Anne Loes Nillesen
Second mentor: Ann Karina Lassen

The Biesbosch nature reserve, where this activity centre is to be built, is one of the richest natural environments in the Netherlands thanks to its diversity of flora and fauna. To ensure that it also provides human visitors with space to relax and breathe, the national nature conservation agency Staatsbosbeheer has been looking for ways to ease the tensions between responsible management and the effective use of such areas. For this nature activity center (NAC), the agency wanted a sustainable design that would highlight both the experience of the building as well as the surrounding wildlife and water.

The building sits among various different types of habitat, including overgrown 'wilderness, osier beds, reed beds and mudflats that flood from time to time. The visitor's 'nature experience' begins before they even reach the building. Access is via a wooden walkway, its natural material creating a natural link between the environment and the activity centre, which is also clad with wood. With time, just as nature adapts to the changing seasons, the hardwood exterior will fade and weather.

The tower of the NAC serves a dual purpose: it is both a lookout and a ventilation stack. When the windows on the ground floor are opened, an adjustable grille at the top of the 'chimney' ensures that the building is ventilated naturally. Its cooling strategy is thus based on the controllable throughput of air. Because this passive form of climate control consumes no fossil fuels – no machinery is involved – it helps reduce the center's ecological footprint. Moreover, the arrangement provides just enough ventilation for comfort in the winter and a cooling breeze in the summer.

Unlike the way up to most lookouts, climbing the tower is an activity in itself. Visitors make a short stop at each landing, where they can take in the view of the natural surroundings outside. They will also notice that the temperature drops as they climb higher. This provides a tangible reminder of the climate control system, in an educational way.

Staatsbosbeheer is considering removing the levee that protects the area in which the NAC is to be located. This would place it in a tidal zone, with water levels fluctuating by as much 30 centimeters. The mudflats around it would sometimes be exposed, sometimes flooded, enhancing the variety of the nature experience even more. The building itself is to be constructed just above the highest waterline, so that it will not flood. But even it should flood, that would not be a disaster. The kayak section, where the water would 'enter' the building, has a sunken floor that allows you to look just above the water surface, while in the restaurant you will find yourself at water level. Because the center is encircled by water and is fitted with full-length windows, sunlight is reflected deep inside the building to provide passive energy.

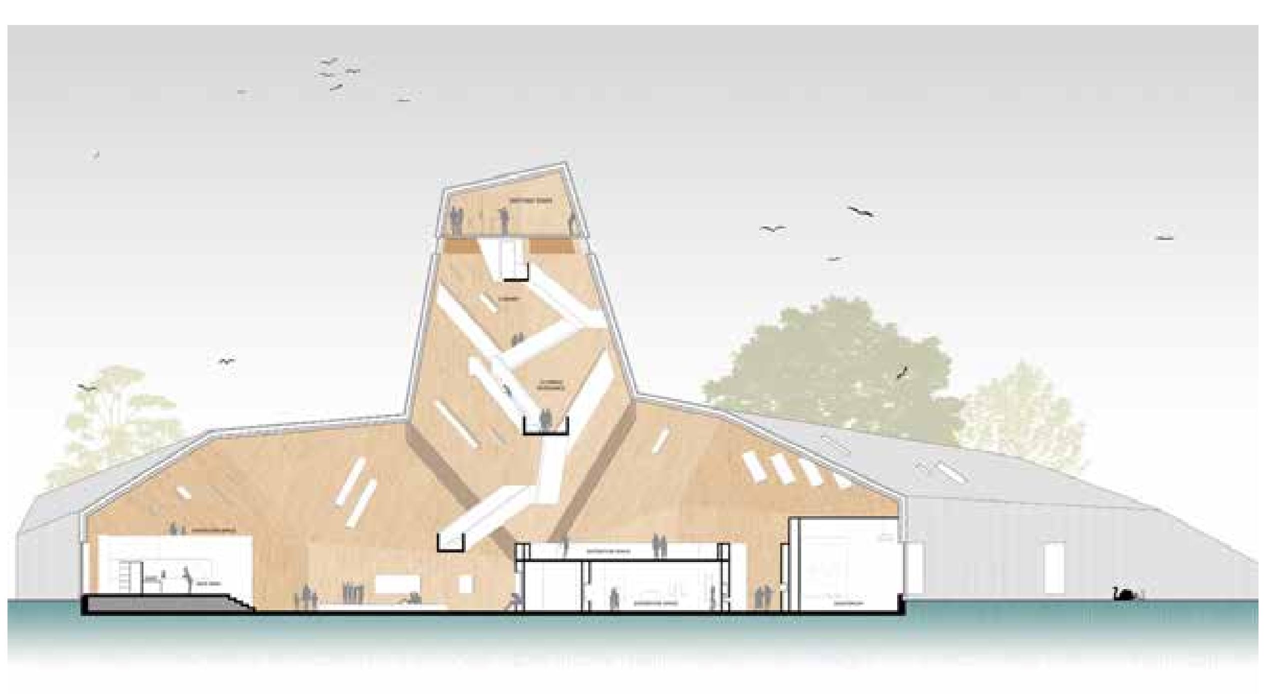


Figure 45.
Cross-section showing the lookout/chimney.

Figure 46.
Impression of approach to the Nature Activity Center building.

Talya ten Brink

COASTAL CONDITIONS

RESPONDING TO THE PARTIAL OPENING OF THE HARINGVLIET SLUICE

Year: 2014
Location: Haringvliet Sluice, Netherlands

Mentors:
Steffen Nijhuis
Daan Zandbelt

Since the Netherlands decided to restore connections between river and sea, the fate of the Haringvliet Sluice near Rotterdam, which was designed in the 1950s as a closed structure, has come under discussion. One scenario places an island outside the more open sluice to block higher waves and storm surge, and to limit saltwater intake in the river. This project explores a design for this scenario that considers site-specific geomorphological and urban processes.

First, the cultural and ecological needs of the region were determined. The layout of housing, commercial facilities, and transportation infrastructure is based on urban planning principles. At the same time, the island and lagoon system will be developed interdependently. To construct the island, the area will be anchored with a concrete spine and riprap in erosion-prone areas to create a concave curve. Sand from stable and non-ecologically sensitive areas will be sprayed over the spine, and aided accretion will gradually create a lagoon ecosystem in the surrounding Rijnmond area.

On the island, design details, such as walk-overs and dune parks within the housing areas, highlight the interaction between natural and artificial forms, as well as remnants of the island construction process. The proposal includes an annual re-evaluation to ensure maximal functioning and an integration of healthy urban and ecosystem processes. This project demonstrates how landscape architecture can work with both site-specific geomorphological processes and urban processes to address national environmental and coastal issues.

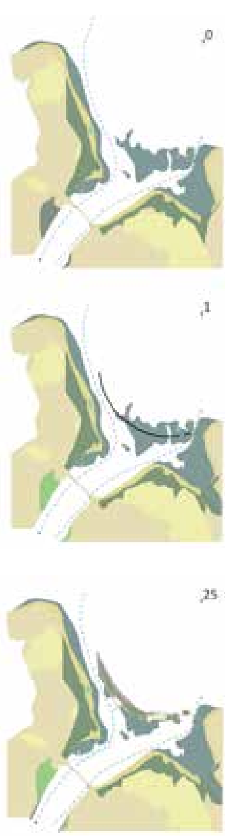


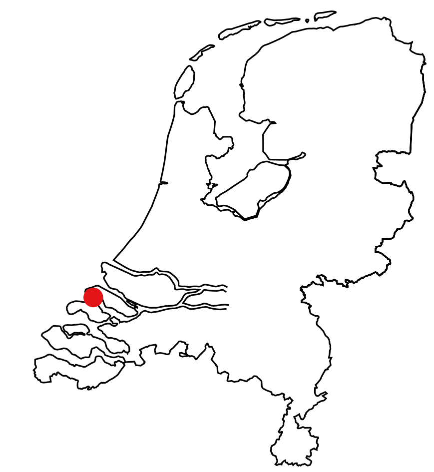
Figure 47.
Change of the landscape over time.

Figure 48.
Top view of proposed Haringvliet Sluice.

Christiaan Rijsewijk

GO WITH THE FLOW

ECOLOGICAL AND TIDAL EXPERIENCE MUSEUM AT LAKE GREVELINGEN



Year: 2010
Location: Lake Grevelingen, Netherlands

First mentor: Anne Loes Nillesen
Second mentor: Ann Karina Lassen

The Grevelingenmeer (Lake Grevelingen) is one of the largest brackish water lakes of Europe and famous for its unique ecosystem. However, the lake is becoming ever more saline. The water quality is deteriorating, putting the ecosystem under increased pressure. For these reasons, there are plans to return the tide to the Grevelingenmeer. This project aims to create awareness of the ebb and flow of the tides. In addition, the building and its exhibitions are both designed to explain more about the ecosystem on, around, and in the surrounding waters.

The building presents an extended sloping route, with different levels. Each level has its own characteristics, and these differences in level allow visitors to experience the tide. At high tide, water flows through parts of the structure. The different water levels at ebb and flow influence the route that is taken through the building. And finally, the building houses an aquarium as its core. The aquarium is part of a tidal power station, which generates renewable energy and makes the building self-supporting.

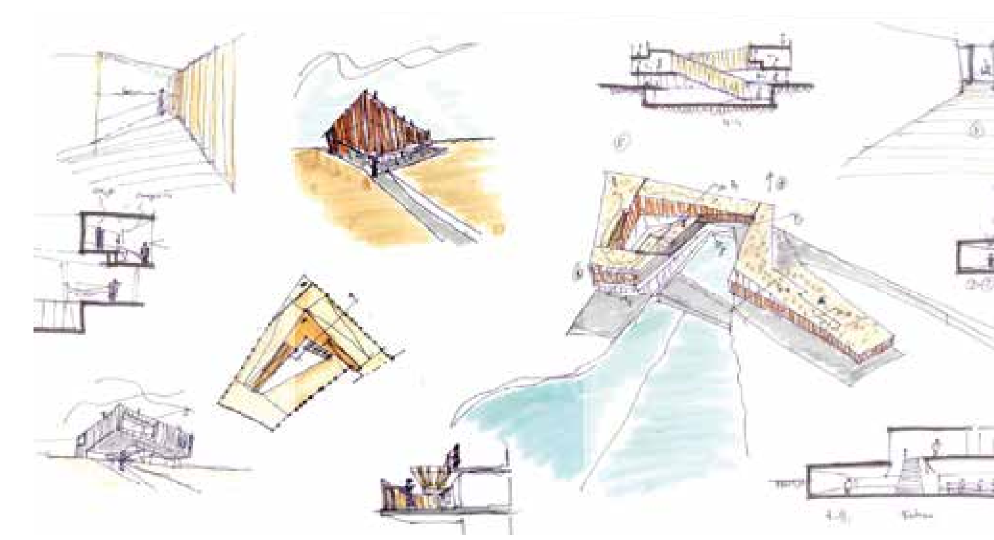


Figure 49.
Design sketches.

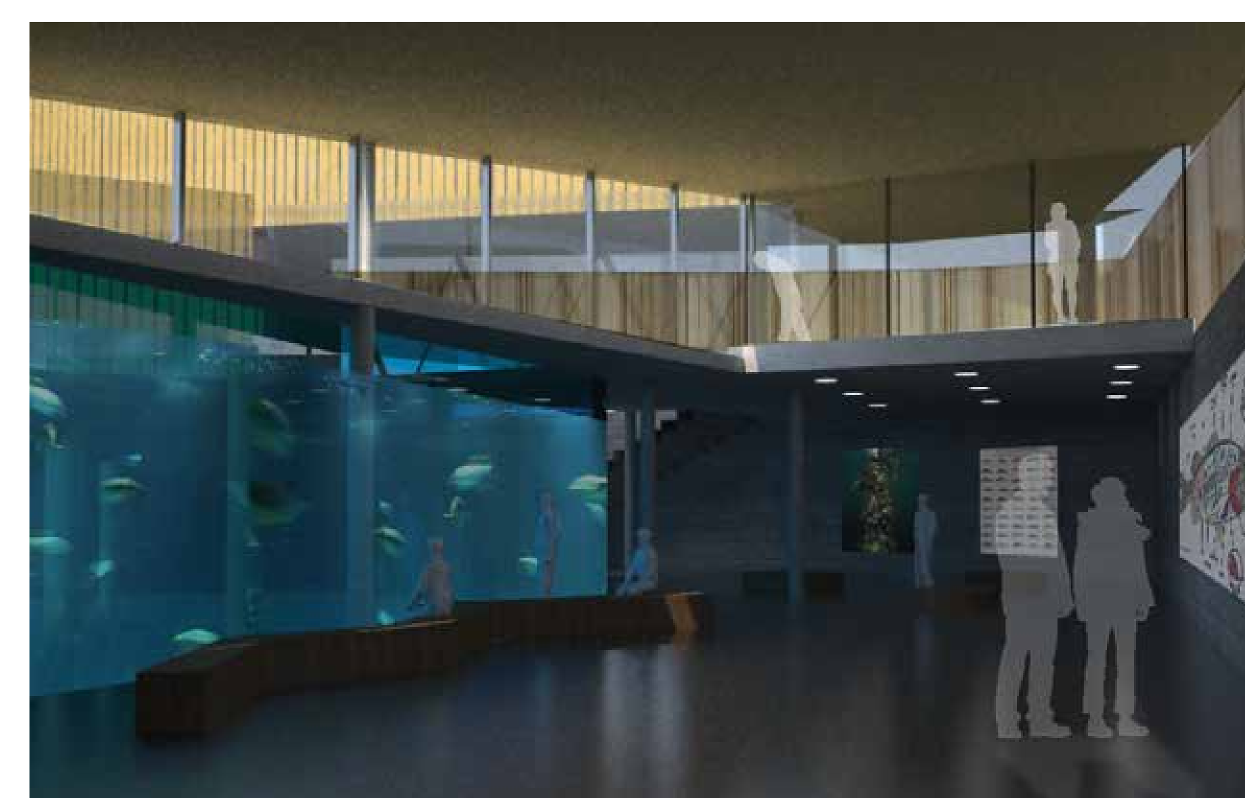
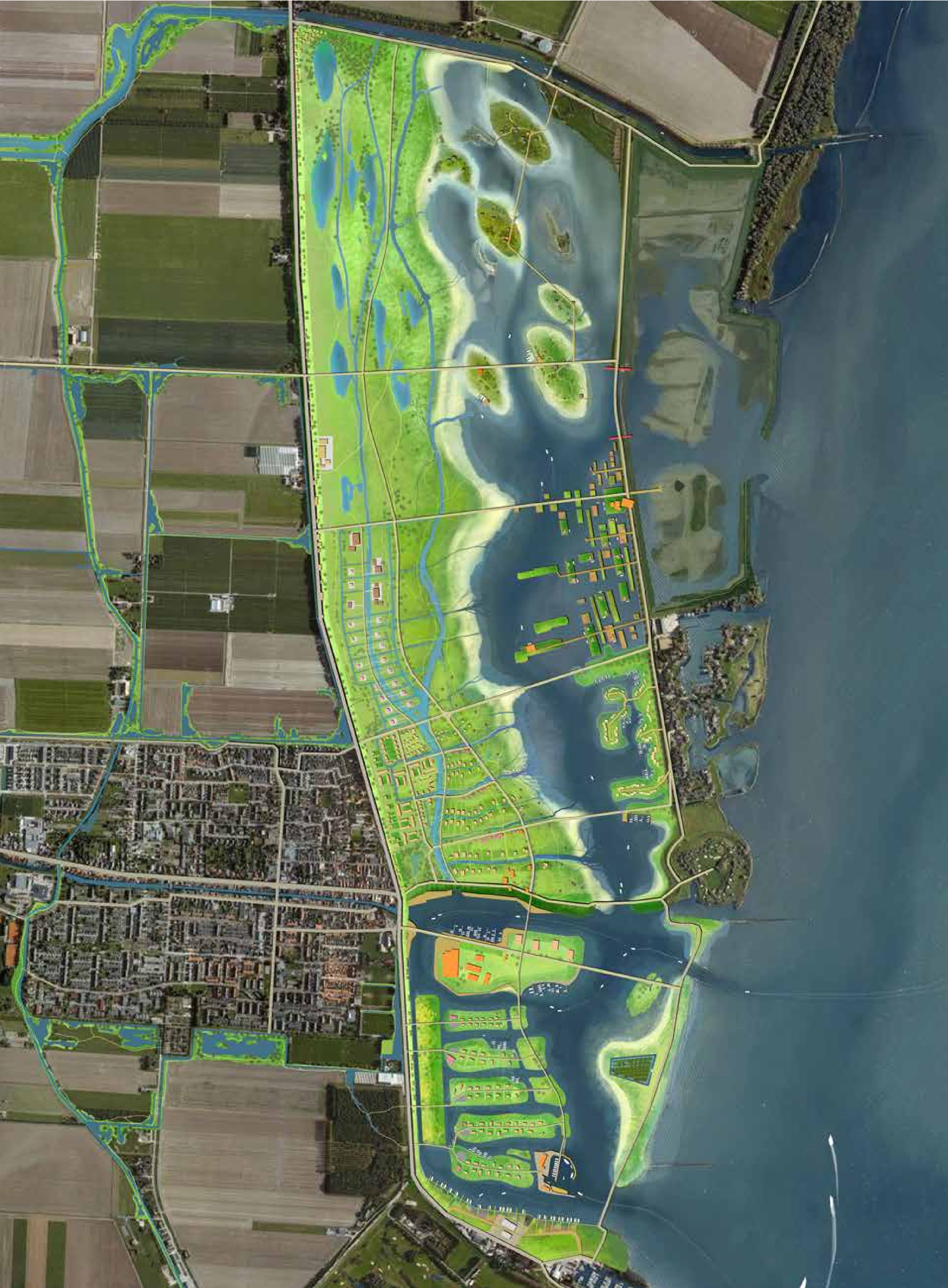


Figure 50.
Impression of the exhibition room next to the aquarium with an open connection to the sea.



NaiLi Zhao

SAFE AND DYNAMIC INTEGRATED FLOOD RISK MANAGEMENT

REBALANCE NATURAL PROCESS AND HUMAN INTERVENTIONS

Year: 2013
Location: Hoeksche Waard, Netherlands

First mentor: Anne Loes Nillesen
Second mentor: Steffen Nijhuis

Long-term climate scenarios (50-100 years) address the need for more resilient water systems. This project focuses on this aspect in the Rijnmond Drechtsteden area. In the past decades, the flood risk management system in this area has relied heavily on 'structural' measures such as dams and dikes. These measures have not only created barriers between human activity and water, but also increased the potential consequences of a flood.

The integrated flood risk approach applied in this project is more resilient. This strategy involves both structural and non-structural measures on four scales: Delta scale, Dike-ring scale, Community scale, and Building scale. Decisions made at larger scales will affect the strategies on smaller ones, and vice versa. Taken together, the whole package of measures will make the area safer and more attractive to live and work in, and to visit.

The project investigates how an integrated flood risk management strategy can reduce flood risk while enhancing both the estuarine ecosystem and the spatial quality of the urbanized delta. By exploring and visualizing the possible combination of measures on different scales, the project aims to include the water in the urbanized delta region, in a way that strengthens the identity of both the natural landscape and human settlements.

The primary dike in the Rijnmond Drechtsteden area has weakened the original connection of many settlements to the water and thus negatively affected the vitality of riverfront settlements. Alluvial flats and marshes were gradually washed away after the construction of the Delta Works; in particular, the closure of Haringvliet sluices in 1971 had a severe impact on the natural conditions of the area.

This project proposes restoring the tide in the area by means of a 'Controlled Tide'. This means the Haringvliet sluices will generally stay open except during extreme storm surges. This intervention will help restore the tidal influence and salt-freshwater balance; in addition, a one meter tidal fluctuation will be introduced in the Hollandsch Diep. At the same time, rising sea levels mean that the Hollandsch Diep will need to store more water, whether the barrier is open or closed.

The decision to open the barriers on the Delta level will affect the water management system on smaller levels as well. Numansdorp will act as a local showcase to illustrate the impact and possibilities created by decisions at the Delta level. This vital harbor village lost its connection to the water with the closure of the Haringvliet sluices. The proposed design will not only address flood safety, but also bring extra benefits.

On the dike ring level, we propose partly opening the primary dike ring to allow the water and tidal influence to reach the rural edges of the ring. Simultaneously, the secondary dikes will be re-enforced to protect the more densely inhabited areas. By increasing the floodplain by 1.8 square km, the water storage capacity of the Hollandsch Diep will increase, hence decreasing the peak water level. Within this new flood plain, the historical harbor area will be reconnected to the water, thus creating potential for a recreational harbor.

In addition, we propose new developments in the new flood plain, consisting of flood-adaptable housing, which will link the city center to the waterfront. Between these new developments wetlands and creeks will be restored, enhancing the ecological quality. Instead of viewing water as a foe, which must be tamed and conquered, this project makes water a friend for planners and water managers.

Figure 51.
(left page) Map of final design: the levee is moved backward and a waterrelated zone created.

Figure 52.
(below) Section of the new configuration, including floodbed development.

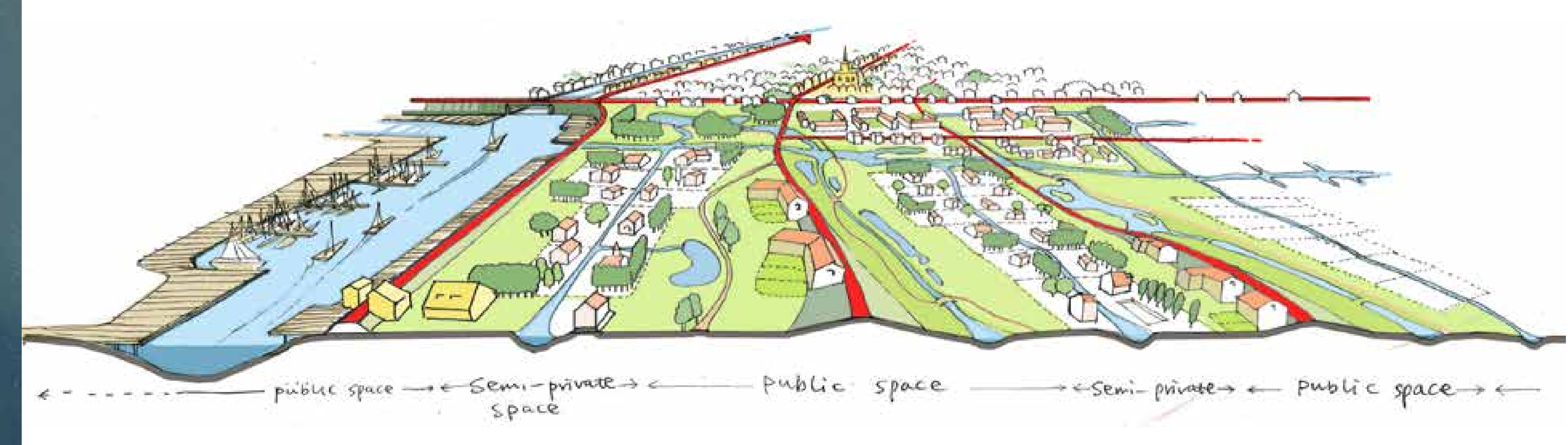
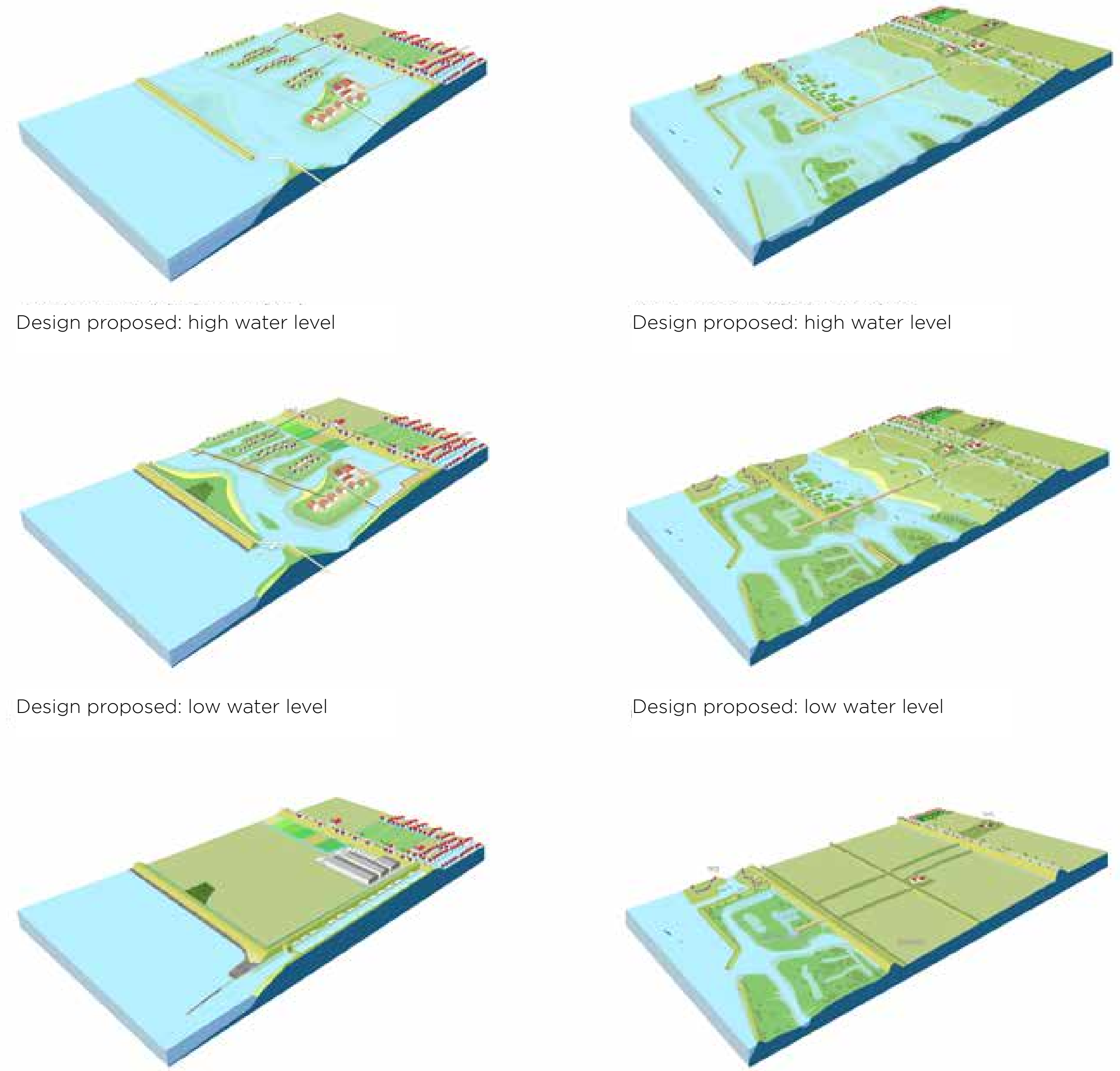


Figure 53.
Design proposals for high and low water levels, compared to the existing situation.



Design proposed: high water level

Design proposed: high water level

Design proposed: low water level

Design proposed: low water level

Existing situation: harbor area

Existing situation: polder area

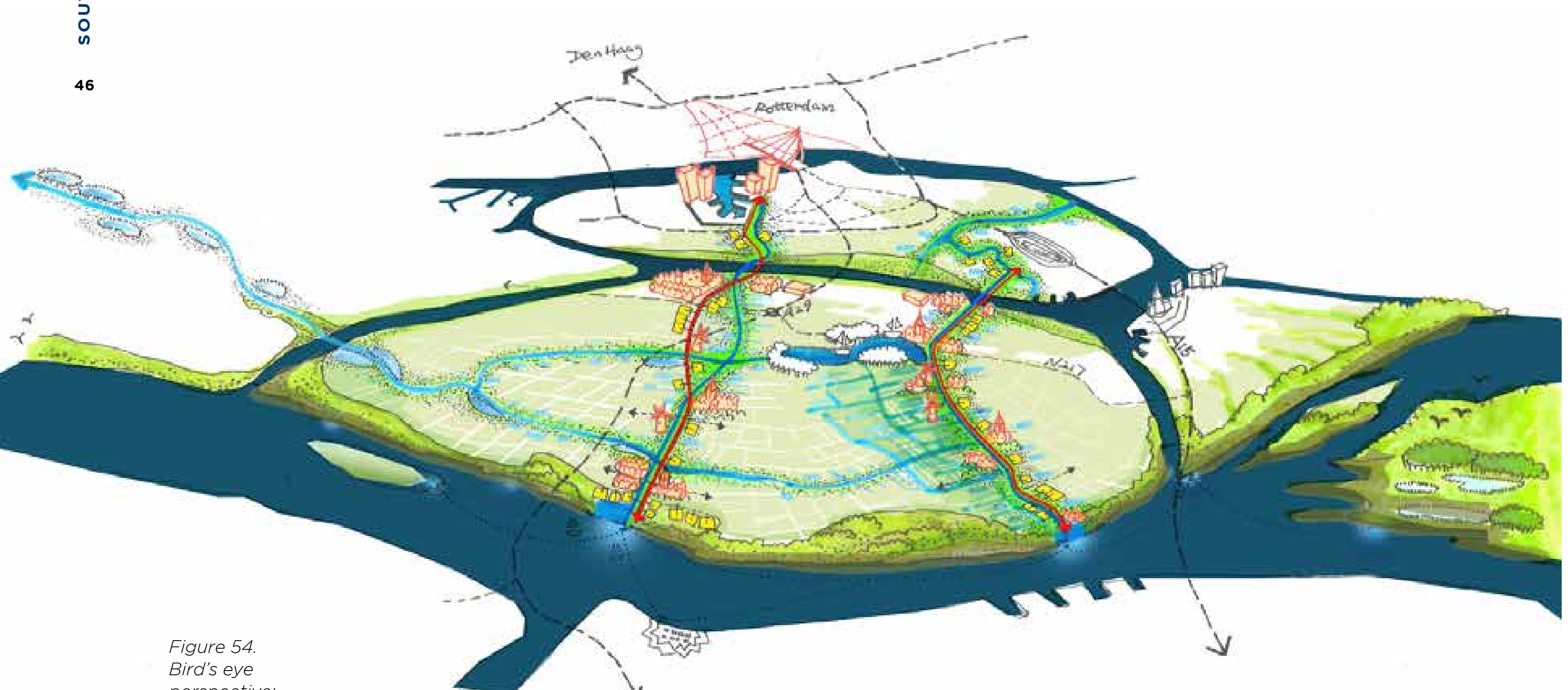


Figure 54.
Bird's eye perspective: connection between Hoeksche Waard and city of Rotterdam; overall strategy.

Figure 55.
Cross-section and impression of the harbor area.

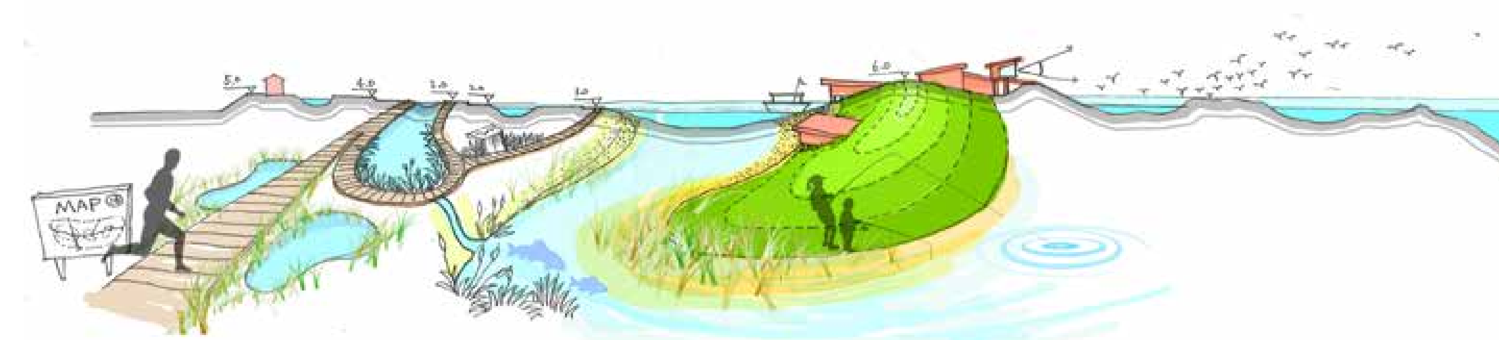
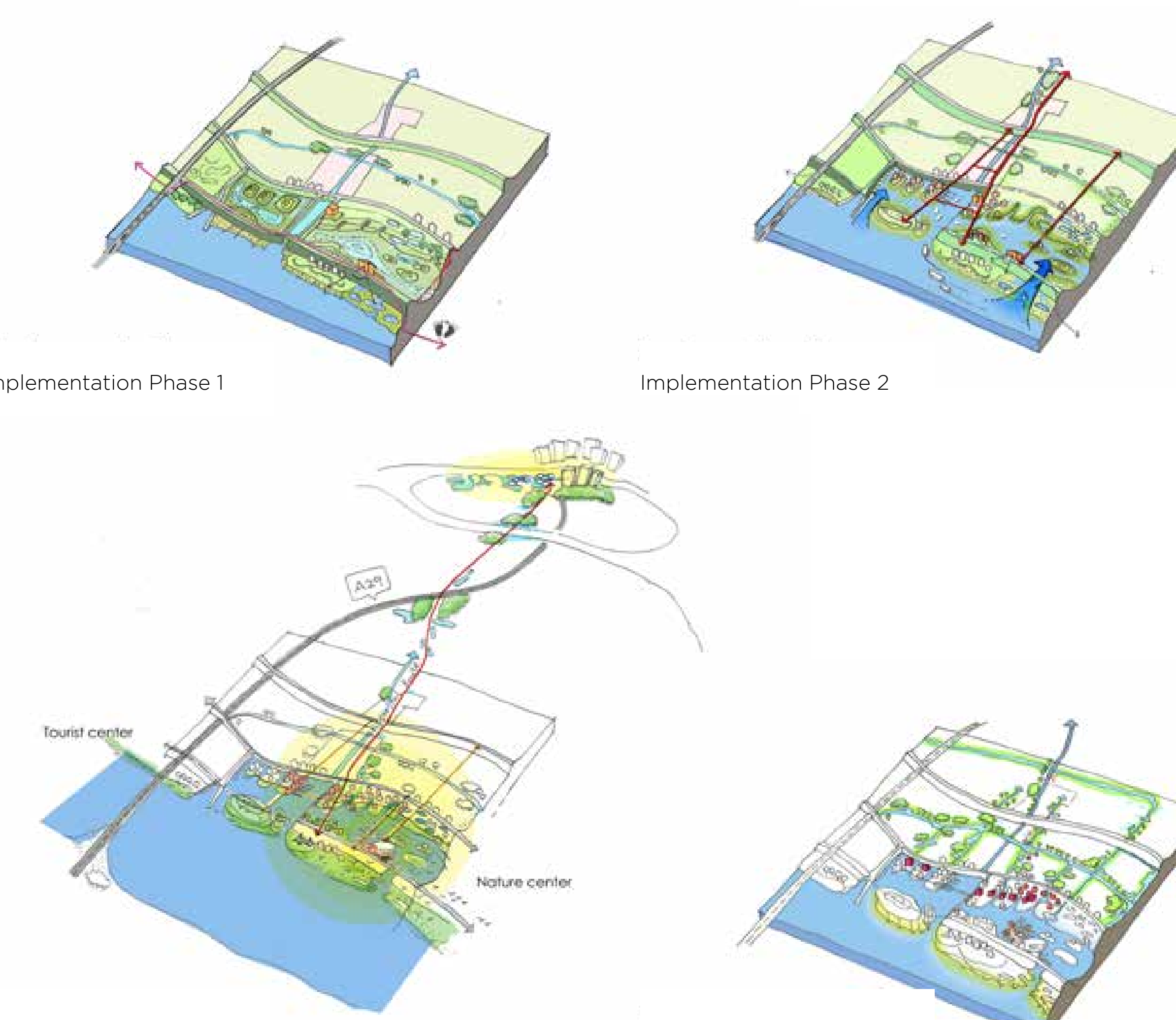


Figure 56.
Cross-section and impression of the tidal wetlands: wetlands wandering.



Implementation Phase 1

Implementation Phase 2

Implementation Phase 3

Implementation Phase 4

Figure 57.
Implementation Phases 1-4.:
1. Small scale retention ponds; green conncetor.
2. Dike relocation and strengthening; 'Let Water In'.
3. 'New Frontier' expo; public facilitation.
4. Senior apartments; eco-structure further inland.

Figure 58.
(top) Cross-section of the dike-in-dune parking garage.

Figure 59.
(above left) Staircase connection boulevard to beach.

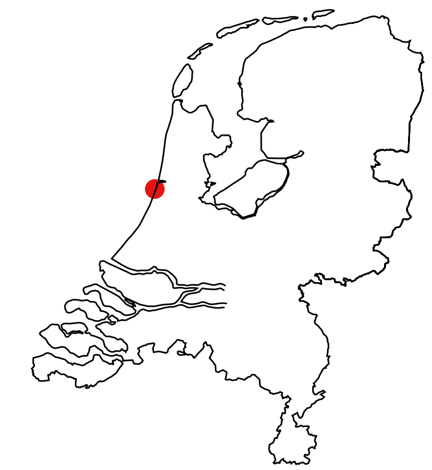
Figure 60.
(above right) Recreational homes at edge of dunes.

Figure 61.
(below) Design plan.

Maaike Warmerdam

RETURN TO THE COAST

CREATING VITAL AND ATTRACTIVE SEASIDE TOWNS



Year: 2011
Location: Zandvoort, Netherlands

First mentor: Maurits de Hoog
Second mentor: Saskia de Wit
Third mentor: Anne Loes Nillesen

Spatial policy is high on the agenda for the Dutch coast, not only to provide long-term flood safety, but also to enhance the spatial quality of the area. 'Return to the Coast' is a design vision that combines an integral approach for safety with an incentive to improve spatial quality in seaside resorts. This combination offers coastal communities the potential for development, and provides urban planners interdisciplinary opportunities.

The coastal city of Zandvoort has strong assets: located in a busy metropolitan region, it has a direct train connection to Amsterdam. However, Zandvoort is trailing behind several other coastal resorts, due to its lack of vitality and spatial quality. The project 'Return to the Coast' can help Zandvoort not only in its urban development strategy, but can also offer a development vision that can strengthen the resort's position in the metropolitan region.

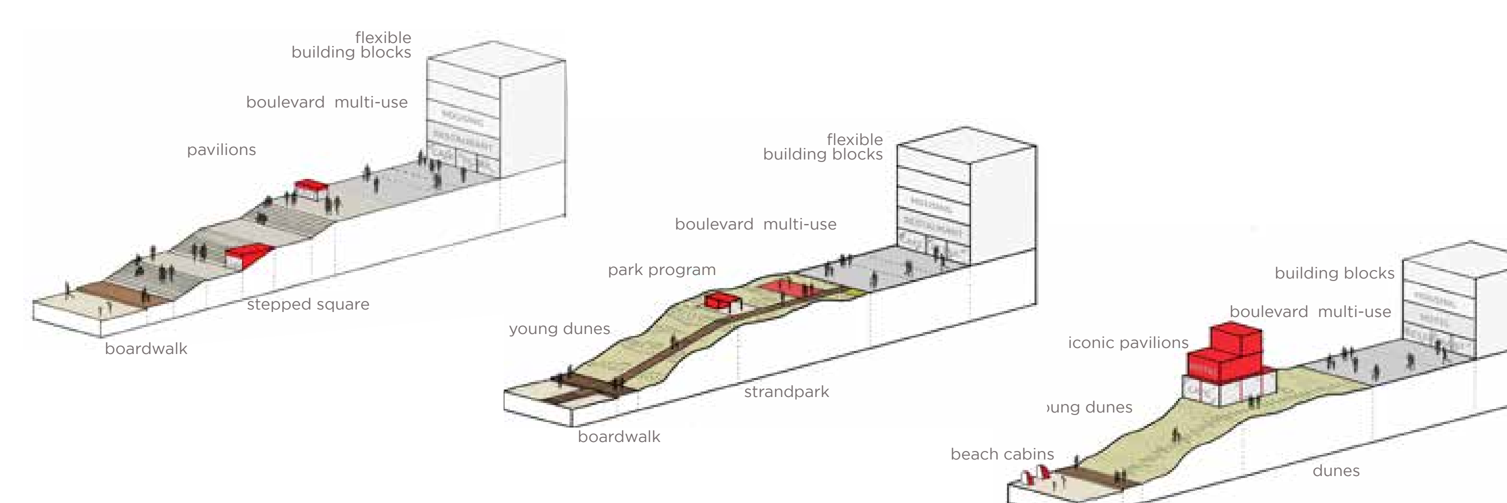
Typology exploration and building blocks
Different international coastal cities were compared. Considering city character, sort of tourism, and public accessibility permitted us to create a varied typology for seaside resort towns. Three main types were identified: The 'Beach Park' is a cultural beach town in a metropolitan dune park. Because of its accessibility and its extensive recreational network, the Beach Park mostly attracts day visitors. The 'Urban Coastal City' is located in a more urbanized area and attracts short-stay visitors because of its high density, good accessibility, and wide supply of functions with a year-round nature. Finally, the 'Specialized Beach Resort' addresses the demands of an ageing population, with health care facilities. Its specialized character attracts visitors who stay for a longer period.

A comparison of European metropolitan seaside towns shows that Dutch seaside towns score low, particularly on aspects such as architecture, mixed-use, and permeability. Placing Dutch coastal cities in a wider context, we can create generic guidelines that could be used in other locations. These guidelines are characterized by three functions: identity, vitality and connectivity. For example, urban seaside towns generally have train stations. An important guideline is to create a logical route from the station to the beach, one which enhances a sense of place. A permeable seafront, sightlines, and a multifunctional barrier are all essential for a vital seafront that engages local qualities. The identified typologies and the generic guidelines can contribute to the current debate on the identities and design of coastal cities such as Zandvoort.

Vision for development
For the development of Zandvoort, it is important to approach the spatial task both integrally and by scanning the different scales. This stimulates local support, creates diversity in development, and helps to link the coastal area to the hinterland. The integral approach can also provide a new impetus to Zandvoort, gradually transforming its profile from a coastal resort exclusively focused on tourism to a community that is regionally oriented and involved in the greater metropolitan region. Three points are essential here: a multifunctional flood defense, which can contribute to further development; new housing, which can act as an urban catalyst; and a high quality connection between the train station and the beach. The proposed design outlines the potential for development, and deploys the planning process in phases, allowing different subsectors to develop independently.

Developing a wider dune plateau (the so-called 'dike in dune' construction) shifts the flood defense seaward, thus creating more space for development at the boulevard side. The multi-functionality of the flood defense provides both a long-term solution for flood safety and an added value for the public environment. This creates another win-win situation: while the flood safety intervention entails high costs, at the same time it provides an impulse to the spatial quality of the entire Zandvoort coastal area.

Figure 62.
Gradually developing multifunctional flood defense: the 'dike in dune' construction.



THREE | THE LAKE IJSSEL REGION

Frits Palmboom

LAKE IJSSEL - THE IJSSELMEER

INTRODUCTION

The IJsselmeer, or Lake IJssel, represents the northern flank of the Dutch Delta. In several aspects, this region is quite different from the South West Dutch Delta and the Rotterdam Rijnmond region. For one thing, as a delta landscape, it is less dynamic then the other two delta regions. Also, as an urbanized area dominated by the city of Amsterdam, the northern delta is more mono-centric than the area around Rotterdam. Finally, the IJsselmeer area is less industrialized and serves a less important transport function than the other parts of the Dutch Delta.

Creation of a new, artificial landscape
The former Zuiderzee (Southern Sea) was closed off from the North Sea in 1935 and this large body of water was transformed into an inland lake named the IJsselmeer. The construction of the Afsluitdijk (Closure Dam) signified the end of tidal influences and had two major implications. First, it turned the original salt water sea arm into a large fresh water lake, fed by the Ijssel River. The lake became crucially important for the Netherlands as its central fresh water reservoir, answering the need for drinking water and agricultural irrigation. Second, it created favorable conditions for reclaiming large parts of land in this former sea arm. In the newly won polders, based on the original plan of the civil engineer and minister Cornelis Lely (1854-1929), a completely artificial landscape was created. Several New Towns were designed and founded as a way to reduce the population pressures on the Amsterdam urban area; the new polders created a region for large-scale agriculture that was huge by Dutch standards.

Delta Paradox
These physical changes deeply influenced the environment, a development that can be called the delta paradox. On the one hand, we have the natural system, which originally followed the principles of the 'fluid landscape', with its almost endless gradients, its spatial continuity, its dynamics, and unpredictability. On the other hand, we have population growth, intensive farming, and urbanization, all of which require control, safety guarantees, and minimizing risk as much as possible. The delta paradox leads to an increasingly compartmentalized 'fluid landscape'.

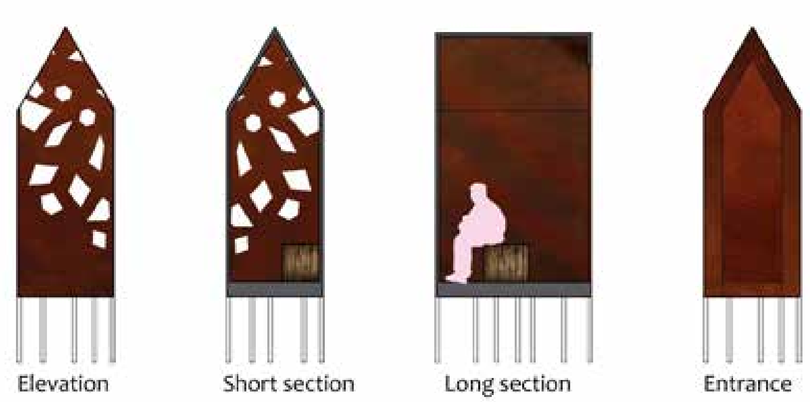
To protect the cities and the agricultural land, we see the continuous construction of new defense lines, which split the landscape into manageable sections. However, this compartmentalization often has a strained relationship with the open and dynamic character of the natural system. A symbol of this phenomenon is the Houtribdijk, a dike (or really a dam) originally intended to enclose the last large-scale reclamation project, Markerwaard. Although the project did not materialize and was finally called off a decade ago, the hard structure of the Houtribdijk remains in place. This leads to an important question for the Delta Interventions studio: Can we give a new meaning to this 'superfluous' dike? Can this line of compartmentalization be softened, can new ecological gradients be created, and can we evolve a more attractive landscape?

Spatial quality
In terms of urbanization, the northern delta is mono-centric. Its main pole of growth and power is the city of Amsterdam, with the old towns along the coast of the IJsselmeer and the new towns in the polders as satellites. These satellite towns are under continuous pressure to grow and develop, while the areas further away from Amsterdam are generally in decline. The historical city Enkhuizen and the new town Lelystad, located at opposite ends of the Houtribdijk, are both looking for new economic impulses: for example, new forms of agriculture, or new energy systems based on wind, water, or sun. However, to adequately adapt this spatial development in the delta landscape to local and national needs, we urgently need designs and future visions that combine these functional requests with enhanced spatial quality at all three levels: that of the city, the landscape, and the water.

Diverting the pressure
Because of its location next to Schiphol Airport, a major European hub, as well as its port, the Amsterdam Metropolitan Region is well integrated in global transportation networks. With its strong historical identity and its excellent cultural facilities, Amsterdam is both a gateway to the Netherlands and a showcase for its culture. Tourism is a powerful economic sector, but has begun to dominate daily urban life and get 'out of hand'. For the Delta Interventions Studio this poses many research and design questions: How can this tourist pressure be diverted to other parts of the region, including the IJsselmeer area as a whole? Could the IJsselmeer function as a space of respite? What hidden potential does the Ijsselmeer's spatial character offer?

Integrated approach
In all parts of the delta landscape, problems and challenges are closely related and are constantly evolving. As a result, Delta Interventions Studio's students have been encouraged to take an integrated approach: to relate their design to different fields of knowledge, and to relate the design for a specific site with the delta region as a whole. The success of delta intervention designs depends on the commitment to follow this integrated approach:
- Combining water management with nature development;
- Illustrating how the design contributes to the attractiveness, the beauty, and the spatial quality of the area;
- Showing how the design builds upon the historical evolution of projects, interventions and approaches;
- Exploiting the IJsselmeer area, as the Blue Heart of the Netherlands, creating a space of respite from the metropolitan stress;
- Offering an untapped range of recreational and economic opportunities, with an eye to relieving the pressure on the city of Amsterdam;
- All the while taking the international attractiveness of the local cultural and natural heritage as an important starting point for design.

Figure 63.
Impression of pavillions in the floodplain.



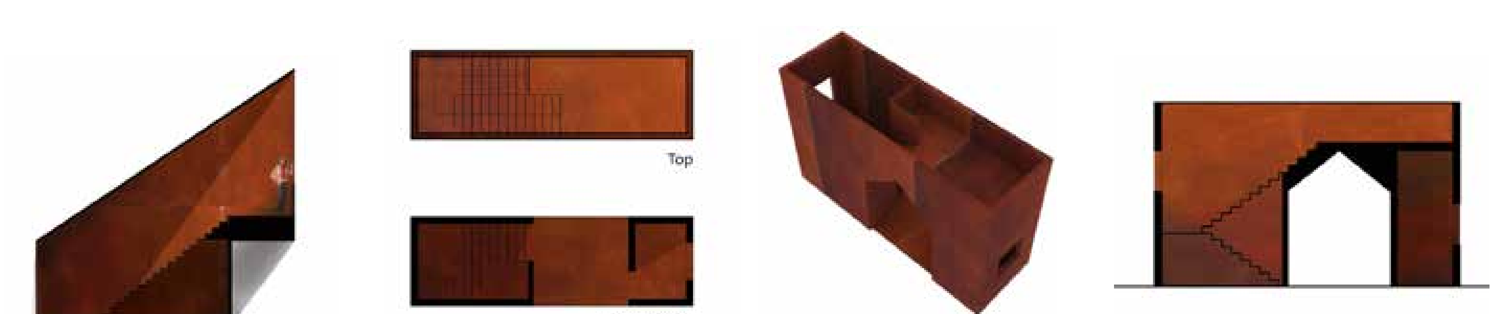


Figure 64.
Drawings of the different pavillions along the IJsselmeer.

Natsuki Takeshita

A NECKLACE FOR THE IJSSELMEER

Year: 2014
Location: IJsselmeer, Netherlands

First mentor: Frits Palmboom
Second mentor: Maarten Meijs
Third mentor: Jack Breen

This project intends to revitalize the currently underdeveloped rural region around the IJsselmeer by means of water-related design. Since the Dutch landscape is by definition almost fully artificial - a construction - the key principle of this project is to use architecture as part of the landscape. To revitalize the area, a circuit of small architectural pavilions was designed.

The project started with the history of the Zuiderzee and IJsselmeer, considering how the region has changed through the years; this change was then expressed in a layered approach. This brought to attention a ring of forgotten former coastal cities, which once prospered around what is now the country's largest lake. Since it is difficult to attract visitors to a rural area with just one attraction, we propose a network of lookout pavilions along the edge of the lake. These can form the basis of an attractive, high quality scenic and architectural tourist route.

To create a balanced design, the form of the pavilions needs to consider the landscape, the viewer's perception, and the unity of the buildings. To make a coherent and integrated design, both distant perspectives and those from the inside of the pavilions had to be considered, as well as the use of material and texture. Each building has a lookout or window overlooking the lake and all have the traditional Dutch house shape, which creates a sense of nostalgia and familiarity. The different use of the same shape, materials and structure gives each pavilion its own personality, while the similarity between the pavilions defines the whole route as one story. This unity creates an invisible necklace around the lake, each pavilion providing a dramatic experience of the IJsselmeer landscape, ultimately giving the former Zuiderzee region a new identity.

Figure 65.
Cross-section showing the light entering the penetrated roof.

Figure 66.
Impression of two pavillions, positioned on top and alongside the levee.

Milo Janssen

WADDEN RHYTHM

THE MARKERWADDEN CENTER

Year: 2015
Location: Houtribdijk, Netherlands

First mentor: Frits Palmboom
Second mentor: Koen Mulder

Figure 67.
(left) Development of delta in 2021.

Figure 68.
Figure 69.
Figure 70.
(below) Connection to the monitoring zone.

Figure 71.
(Bottom right) Houtribdijk and MarkerWadden Center, top view..

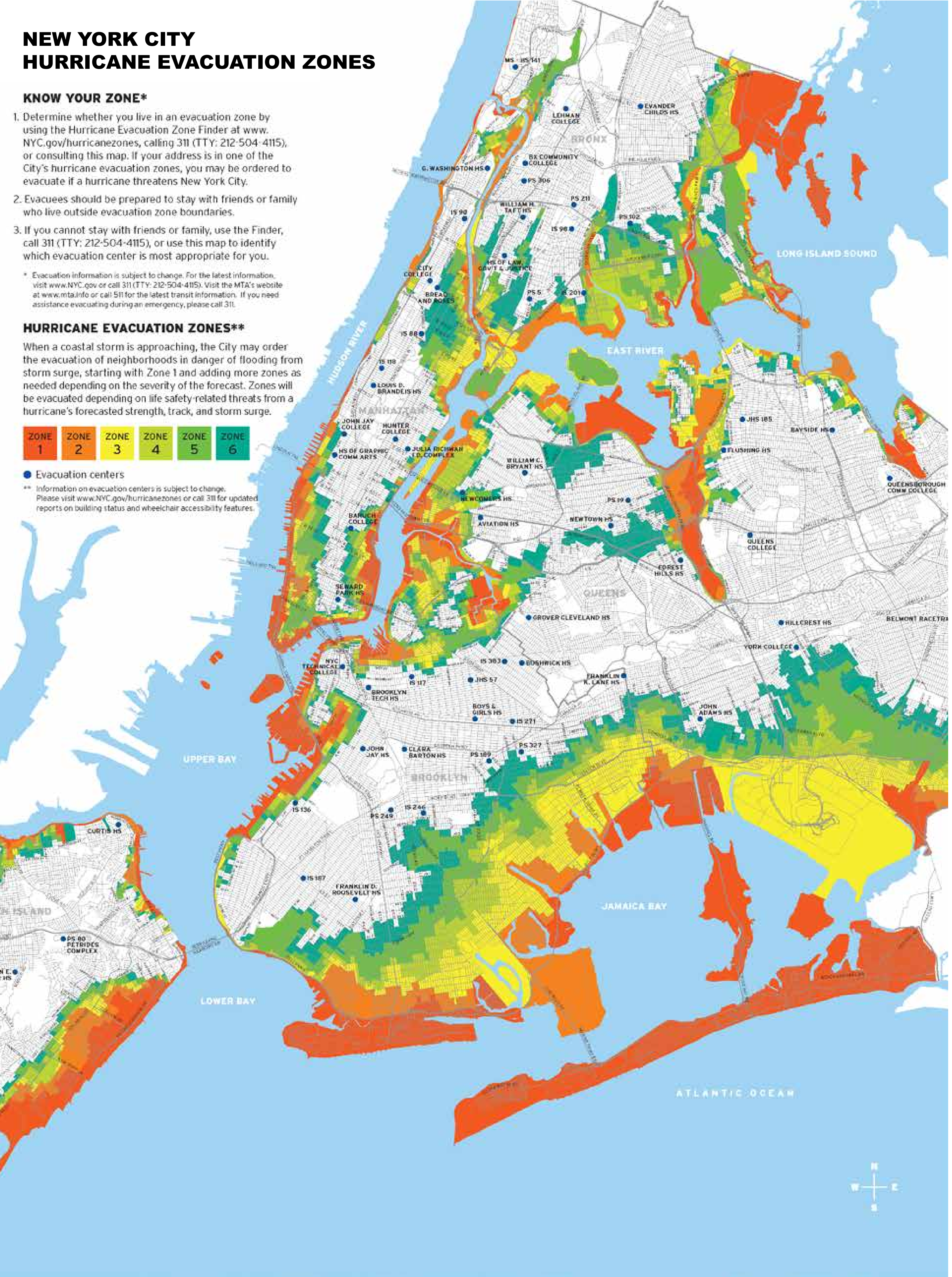
What was once an inland sea, the Zuiderzee, became a large fresh water lake with the construction of the Afsluitdijk (Closure Dike) in 1932: the IJsselmeer (Lake IJssel). In 1976, a dike - or actually a dam - closed off even more of the water body. This intervention, the so-called Houtribdijk, was meant as the start of a new land reclamation project. However, the lake which was created, the Markermeer (Lake Marker) eventually stayed a closed-off lake, with many environmental and ecological consequences. In order to promote the recovery of nature in the Markermeer, an island group called MarkerWadden is being planned beside the Houtribdijk.

The proposed MarkerWadden research and visitor's center would serve as an ecological restoration hub, adding to the waterscape of the Markermeer and to the future MarkerWadden development. The distinctive features of the landscape of the Houtribdijk and Markermeer provide the context for this structure: openness, horizontality, serene and flat landscapes, the dynamic influence of the water, the linearity of the dike, and the ever changing movements of white seabirds and sails. These features determined the design approach and its overall theme: 'rhythm'.

Even though the Markermeer is fully closed off, the lake is still heavily influenced by water dynamics, such as water level fluctuations and storm surge, providing a complex hydro-ecological environment. The architectural intervention, its program and function in the landscape, is directly connected to these water-related properties. Our water-related design operates iteratively, intervening at various scales and spheres simultaneously. Practical aspects such as the access road, the relationship between the dike and road, and the different access routes are approached as part of an interrelated design. This led, among other things, to an additional hydraulic intervention, namely a sheet pile placed in the lake in front of the center, in order to create an additional sandy shore alongside the Houtribdijk. Another water-related design aspect is the elevated wooden path on poles outside the viewing area, which is meant to make visitors aware of the flow of the water.

The project aims to encourage people's curiosity, invite them into the environment, and eventually to evoke an awareness of the exciting developments taking place in the MarkerWadden. In order do this, we designed the proposed research and visitor's center so that visitors follow a route that involves them with the water landscape.


FOUR | NEW YORK CITY, USA



Anne Loes Nillesen

NEW YORK CITY

INTRODUCTION

New York City is a metropolitan area with a high population density and an important national economic function. The area is located on the Hudson River close to its mouth in the Atlantic Ocean. The main flood risk in New York City is the threat of hurricanes arriving from the Atlantic. The Federal Emergency Management Agency (FEMA) has indicated areas of the United States at risk of flooding from different categories of hurricanes, and New York is among these. The city has already faced several hurricanes, and Hurricane Irene functioned as a wakeup call when it came close to causing great flood damage in 2011 (Aerts et al., 2013).

New York's vulnerability to flooding became apparent to the world in 2012 when Hurricane Sandy hit New York City and New Jersey. At the moment Sandy reached New York, its force was already reduced to that of a tropical storm. However, it struck at an unfortunate angle, which resulted in high water levels and enormous flood damage (Regional Plan Association, 2013).

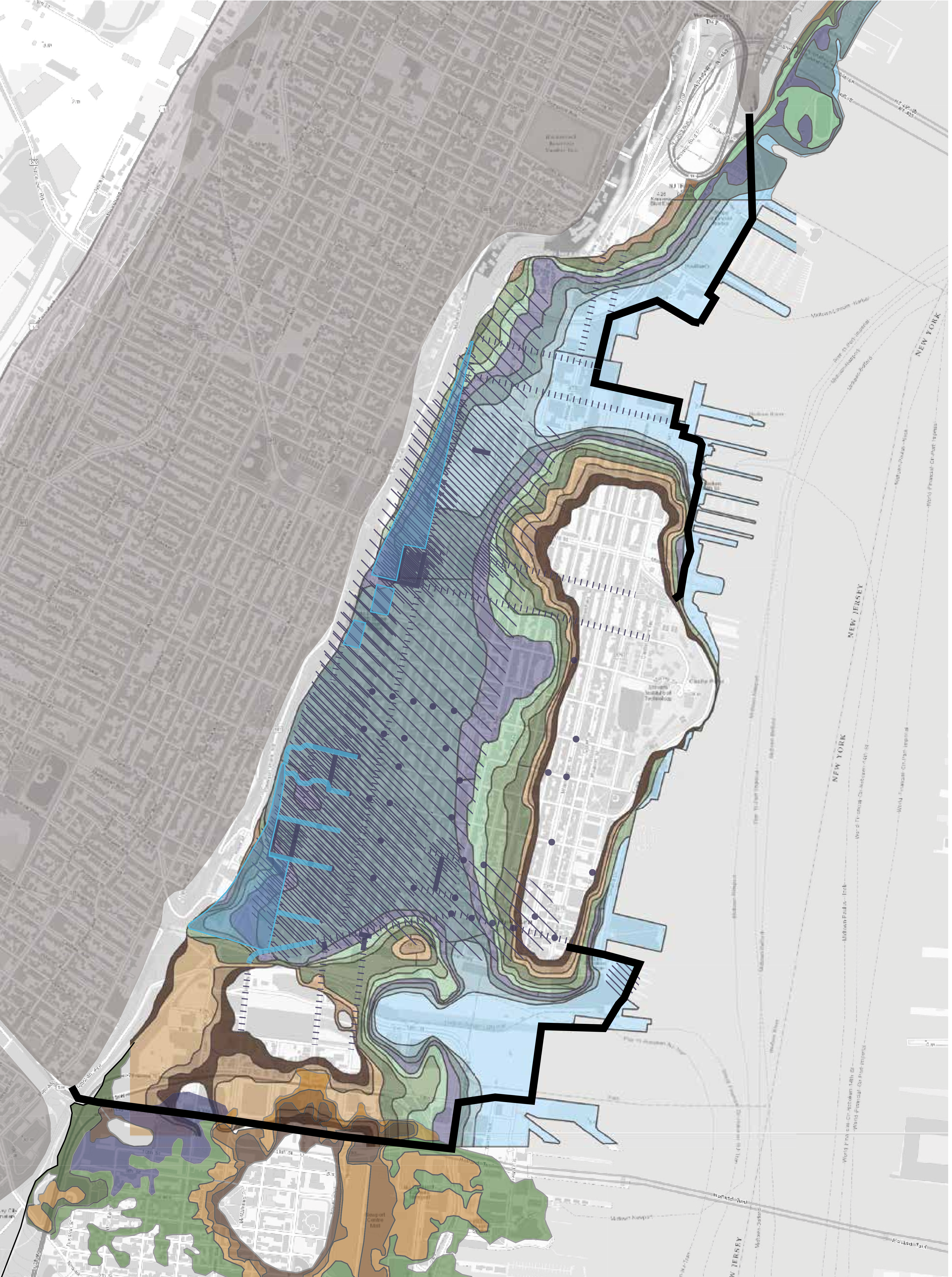
The Delta Interventions Studio addressed flood risk protection in projects in different areas of New York City and New Jersey. The goal of the New York studio was to explore how different areas within the region could be approached differently based on their unique settings. The studio was loosely connected to the 'Rebuild by Design' competition: some of the students joined or cooperated with the competition teams, while others worked alongside them and developed individual projects.

Manhattan, the most densely built part of New York City, already has flood zoning. This inspired architectural design projects to create flood proof buildings, either by keeping the water out or by connecting them to the dry spine of Manhattan to make evacuation easy.

The urbanized low-lying former marshland of Hoboken was flooded during Sandy, turning the eastern high point into an island. In addition to the flood risk the area faces from hurricanes, it also suffers regular inundation during high rainfall events. Several options for flood risk protection were explored from both a civil engineering perspective as well as a spatial planning one. Proposals varied from reinforcing and extending the current dikes to water storage to handle heavy precipitation.

On Coney Island, Hurricane Sandy washed over the existing low sand dunes and flooded beachside houses. Something similar happened in Jamaica Bay, where the storm surge pushed through the small opening of the bay, resulting in high water levels and flooding in the neighborhoods. In these lower density areas, the projects focus on relevant spatial interventions that can both flood proof the area and provide (economic) opportunities to local communities. Also in this case, civil engineering and architecture students joined forces to design a multifunctional flood defense building that closes off the bay.

Taken together, this selection of projects presents a wide palette of possibilities for implementing local flood risk protection. Where previous studio projects located in the Netherlands have tended to focus on physical systems and top-down regional interventions, the projects in the New York and New Jersey studio, offer more locally oriented interventions that address the social aspects of communities.



Eline Fierinck

NO HOBOKEN IS AN ISLAND

A TESTCASE FOR THE DUTCH APPROACH AGAINST FLOOD RISK

Year: 2014
Location: Hoboken, New Jersey, USA

First mentor: Anne Loes Nillesen
Second mentor: Nico Tillie

Floods, caused by rising sea levels, storm surges, and increasingly common excessive rainfall, threaten New York. In addition, the region faces major spatial problems: not only is there pressure on the land in an urbanized delta, but the city also suffers from bad local connections, caused by infrastructural barriers and an insufficiently used fringe. The city of Hoboken, located on the banks of the Hudson River, was an integral part of the Port of New York and New Jersey and home to major industries for most of the 20th century. In 2012 the threats of flood became reality when the area was devastated by the storm surge and high winds of Hurricane Sandy, leaving 1,700 homes flooded and causing $100 million in damage. To diminish the threat of future flooding, this project addresses the insufficiently used fringe of Hoboken.

In Hoboken pressure on the land comes from various directions: the many demands for a good living environment and more job opportunities, combined with the demand for good connectivity. This project connects Hoboken to the neighboring area of Union City, with a water storage area at the edge of the Cliff. The connecting route has a high density of functions, so water storage is provided by a water square, while residential areas have more space, permitting the use of a park for water storage. The route for people down the Cliffs is combined with a visual route for storm water. This storm water is stored at small, interlinked squares, which have additional functions: a playground, a sports facility, and the market square.

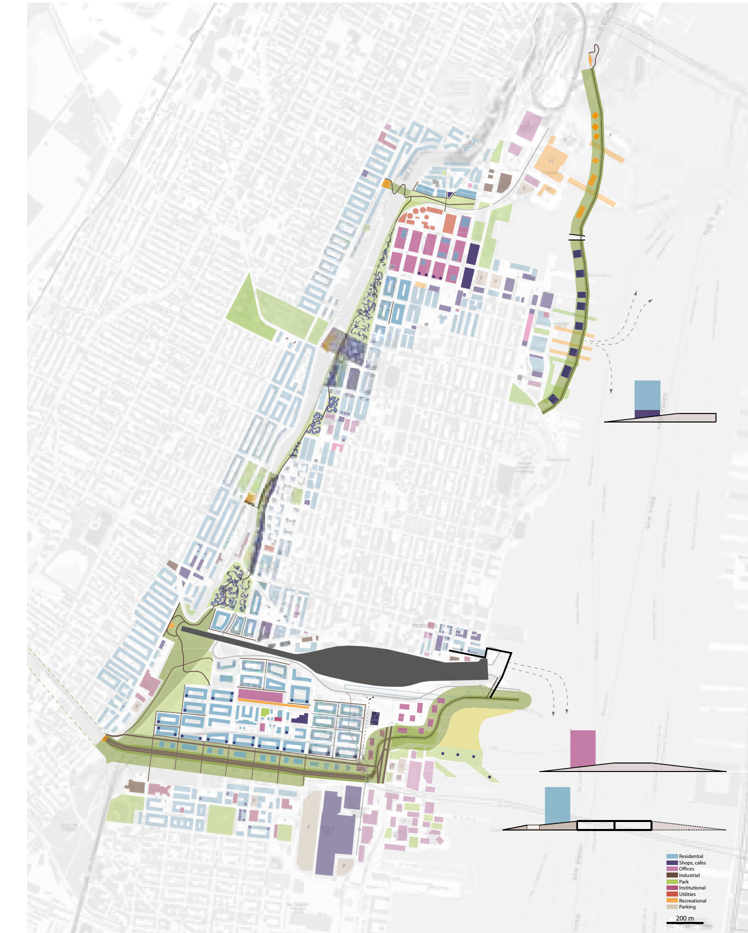
A super levee was designed for Hoboken's waterfront in such a manner that the old historical space remains evident. The levee is placed slightly in front of the old waterfront. This design is based on the principle that if a wave should overtop a levee, then there should be some space behind the levee where that water can be stored temporarily.

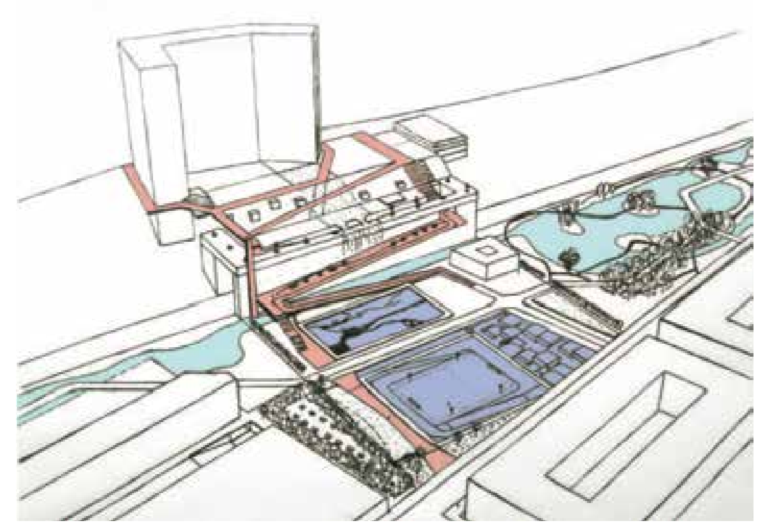
The buildings at the new waterfront are designed so that they do not close the rest of the city off from the water, as is currently the case with a large part of the existing waterfront. To reduce the effect on the views of dwellings and public space, all new buildings are placed facing a private garden. The height of the levee is based on the following calculation: highest water level + high tide + estimated sea level rise. Since civil engineers estimate that the levee may need to be up to 2.5 meters higher in the future, we made a design which allows the levee to be adapted. The width of the levee permits the additional height, and the first floors of the new buildings facing the waterfront are twice as high as normal.

Figure 72. (left)Protection and Storage: combining the stormwater flood map with the usable space led to the allotment of a water storage area (light blue).

Figure 73. (left) Hoboken's masterplan.

Figure 74. (below) Slope connecting the higher and lower part of Hoboken.





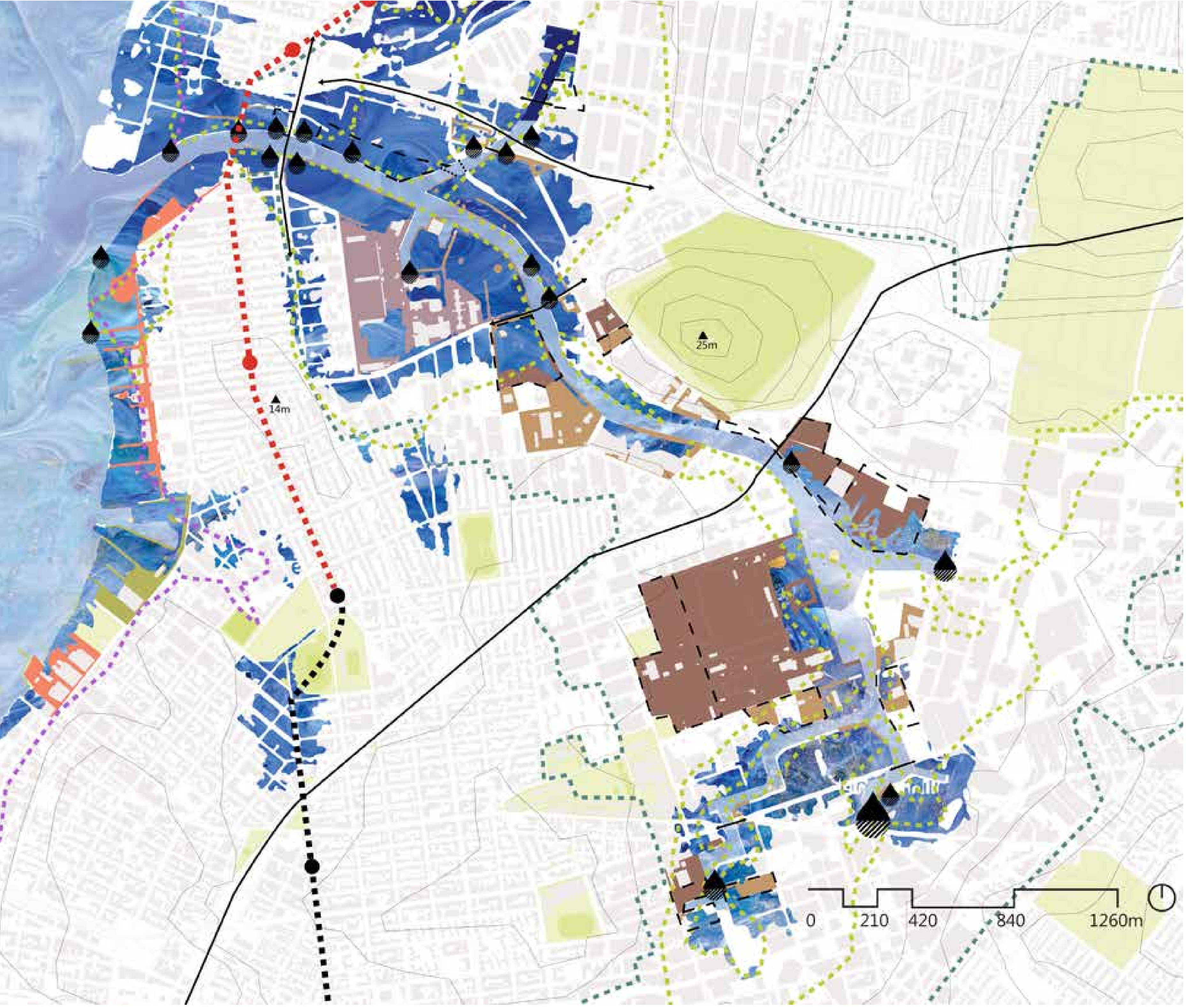


Figure 75.
(above) Map of project.

Figure 76.
(below) Marina at mouth of the inlet.

Larissa Guschl

WORKING WATERFRONT

ADAPTIVE MULTI-LAYER FLOOD PROTECTION ON BROWNFIELD AREAS

Year: 2014
Location: Newtown Creek, Brooklyn, New York

First mentor: Frits Palmboom
Second mentor: Diego Sepulveda Carmona

Newtown Creek, in Brooklyn, NY, used to be one of the vital industrial centers of the New York City region. Oil refineries, shipyards, foundries, industrial food processors, textile mills, and paper mills lined the river. Most of those factories are long abandoned, leaving behind one of the nation's most polluted canals, suffering from raw sewage and oil spills. To make matters worse, the low-lying neighborhoods along Newtown Creek and regionally important infrastructure are also flood prone. Hurricane Sandy demonstrated the high vulnerability of this area, and its storm surge had disastrous ecological consequences.

This project has two focuses: developing and renewing the working waterfront at Newtown Creek, and a mixed-use waterfront project at Greenpoint. The project uses the Dutch multi-layer safety approach: structures that prevent flooding, spatial planning that mitigates flood consequences, and evacuation strategies.

The design works in different phases on different levels, creating opportunities for a variety of uses and interactions with the waterfront. First, the former marshland is reconstructed to form a tidal inlet surrounded by parks. The mouth of the inlet provides a perfect location for developing a local marina. At the next level, a terraced structure allows local residents access to their small boats and sailing ships. In the densest part of the waterfront, a raised bulkhead offers a third level, providing space for a 16-meter wide water promenade. Where the waterfront opens up to Transmitter Park, an outdoor theater reinforces the natural curve of the waterfront. Finally, there are individual elements associated with the waterfront park: a boathouse established in an existing industrial building and an inter-tidal storm surge barrier, which serves both as a pedestrian bridge and a passage for ships, while keeping the water level from rising during a storm.

Figure 77.
(right) Bird's eye perspective of proposed waterfront.

Figure 78.
(below) Recreational space along the waterfront.

Bram Willemse

RESILIENT COMMUNITIES

A SPATIAL FRAMEWORK CONTRIBUTING TO RESILIENCY AND LIVING QUALITY

Year: 2014
Location: Coney Island, New York, USA

First mentor: Anne Loes Nillesen
Second mentor: Steffen Nijhuis

The increasing frequency and intensity of storms forces us to find different ways to develop our coastlines. To fully benefit from their potential, flood-risk defenses needs to be adapted to their context. This project focusses on Coney Island, New York and investigates how a spatial framework can be created that contributes to resilient flood-risk protection, while improving the living quality of communities.

The basis of this project is the context of Coney Island. Due to the shape of the peninsula, the area is very exposed to storm surges. While the main coastline is high enough to absorb the energy of a surge, the leeward side is not. The man-made bay also lacks the proper water circulation associated with natural bodies of water. The shape, depth and coastal typology of the Coney Island bay create a funnel in which the storm surge is pushed ever higher; as the water cannot decrease its energy enough, the water is pushed towards the land.

Protection measures that decrease the energy of the storm surge are needed, so that the surge cannot push onto land. Two methods are used here to decrease the flood risk: physical and frictional resistance. Physical barriers (even two meters below the water level) can decrease the storm surge by thirty percent. A series of physical barriers is applied in this design; this will decrease the energy of storm surge and therefore its run up. An added benefit is that the water behind this series of barriers will still be connected to the main body of water, maintaining the circulation to prevent stagnant water and pollution. However, the currents will be decreased, and sediments could pile up behind the barriers.

The second method of decreasing flood risk is by increasing frictional resistance. This can be done by promoting the mix of fresh and salt water, which will facilitate the growth of wetlands, which can potentially decrease the energy of a storm surge. Water that is pushed through this vegetation slows down due to the fine maze of roots and leaves. The created wetlands will also serve as a filter to improve the ecological quality of the area. As runoff and surface water pass through, the wetlands remove or transform pollutants through physical, chemical, and biological processes. Improving the water quality will also increase the area's recreational value.

By using dynamic natural processes as the basis for flood-risk protection, the communities will regain the vibrancy and flexibility needed to make them resilient. This will establish an enjoyable leisure landscape linked to the historical morphology and identity of the Coney Island Creek. The green paths that are created will function both as living filters and as connections between the community and the water, encouraging an active use of the waterfront.

By focusing on the adaptivity of a design over time, a synergy between flood-risk protection, ecological quality, and quality of life can be created.

Figure 79.
(left) Map of the masterplan design for Coney Island

Figure 80.
Figure 81.
(below) Impressions of the new Coney Island creek.

*Figure 82.
(above) Impression of the recreational waterfront development along the Coney Island Creek.*

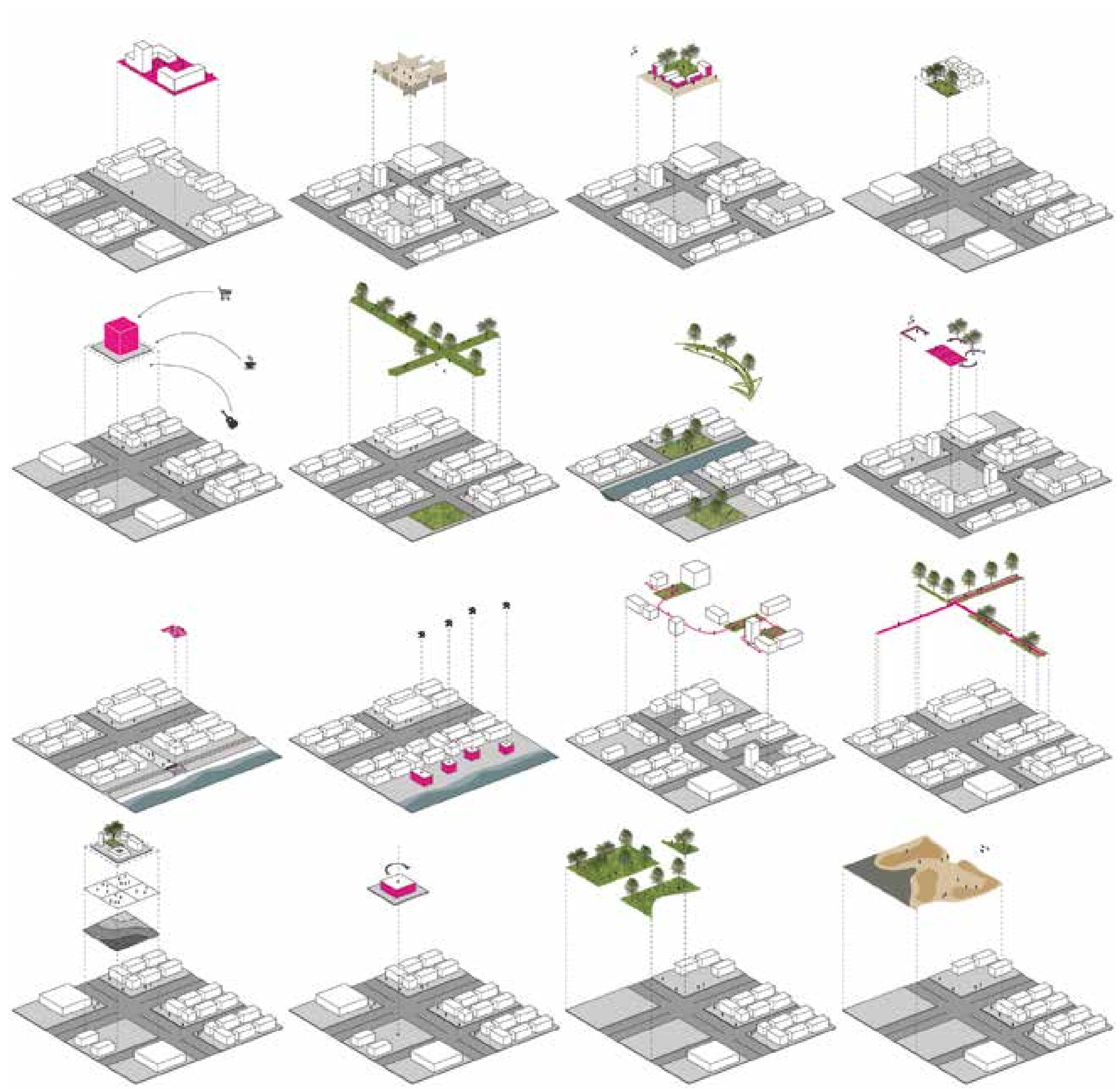


*Figure 83.
(right) Analyses of different spatial configurations of neighborhoods at Coney Island.*

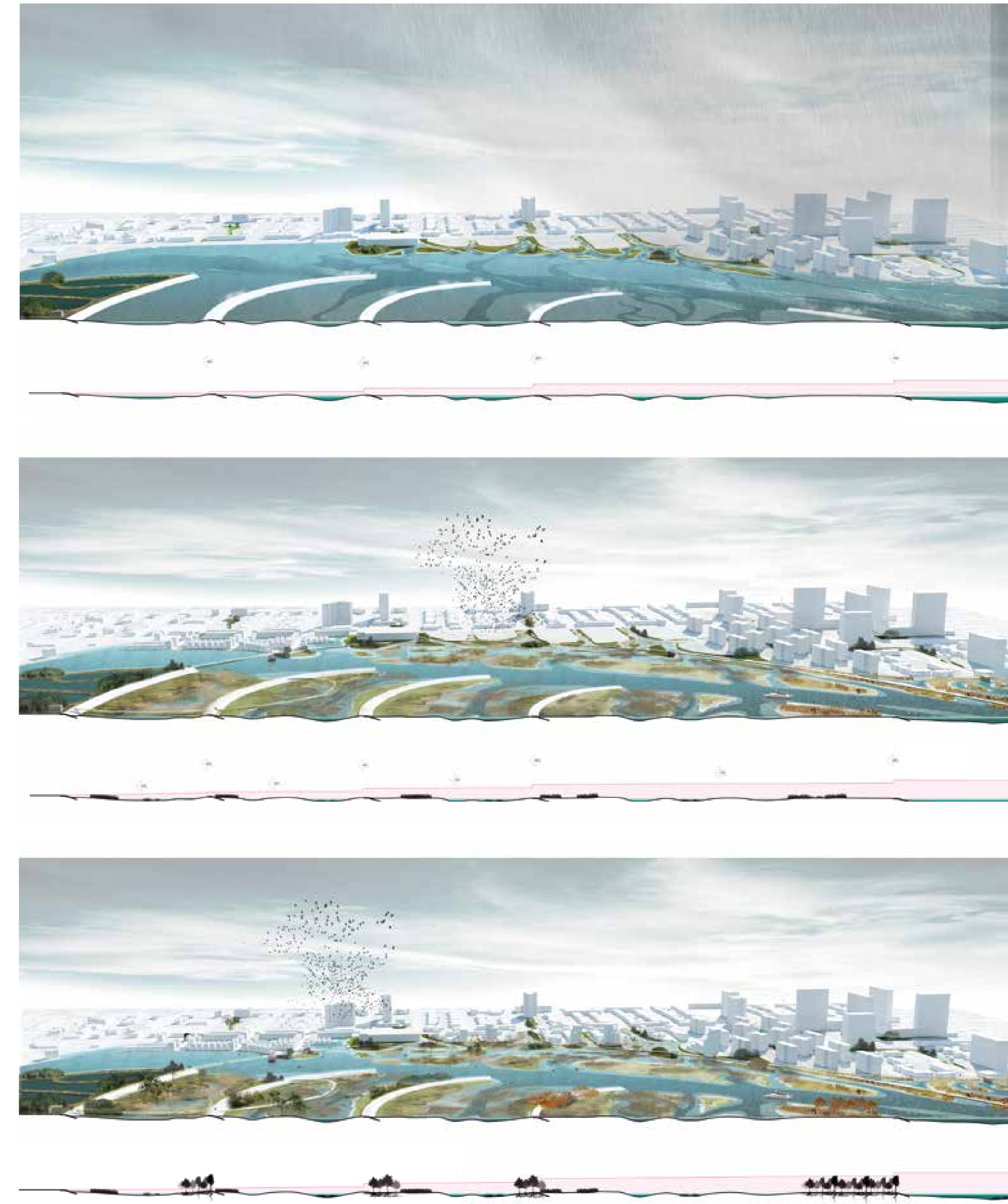
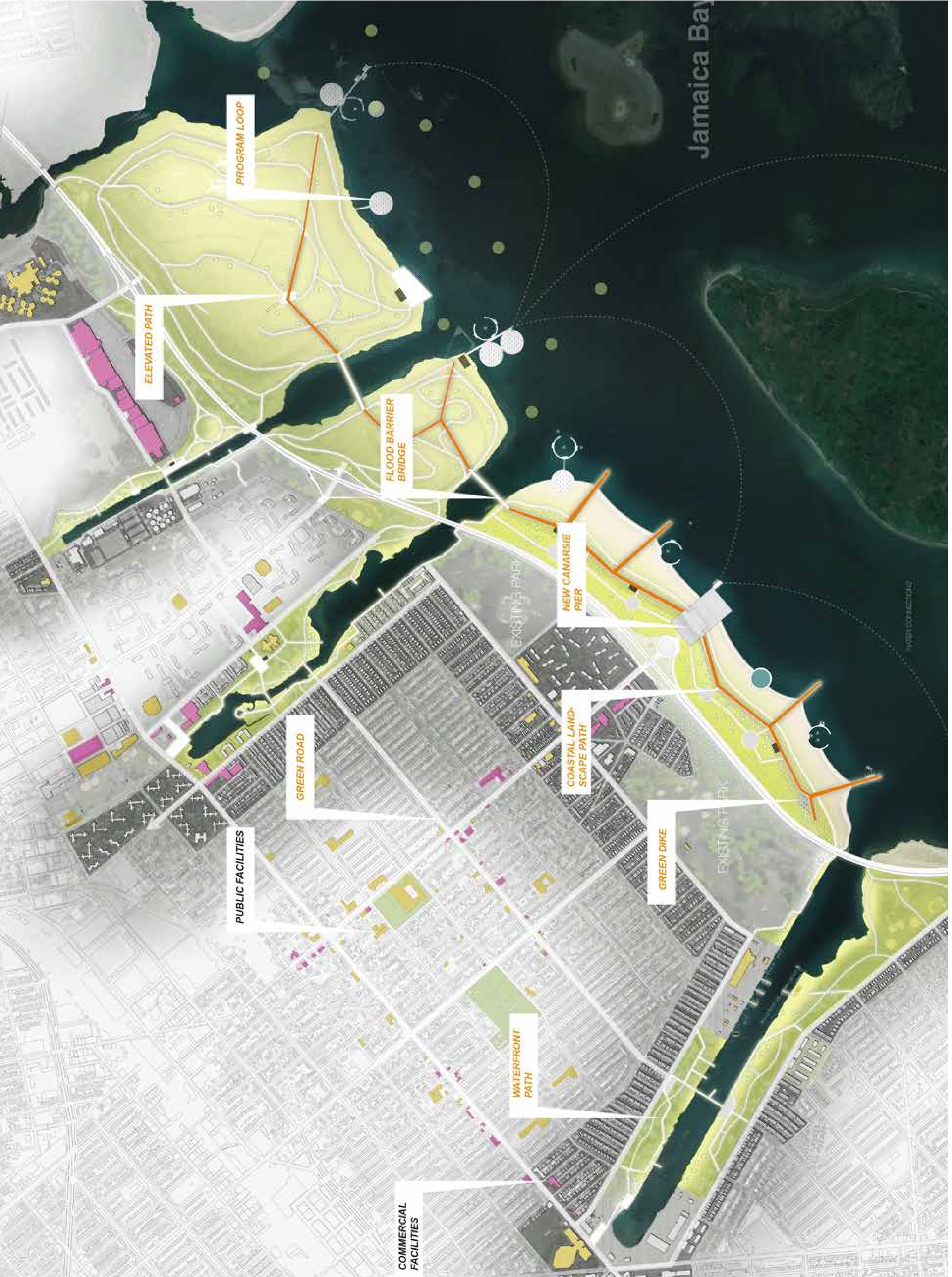


*Figure 84.
Development in time of the natural Coney Island Creek flood risk protection system .*

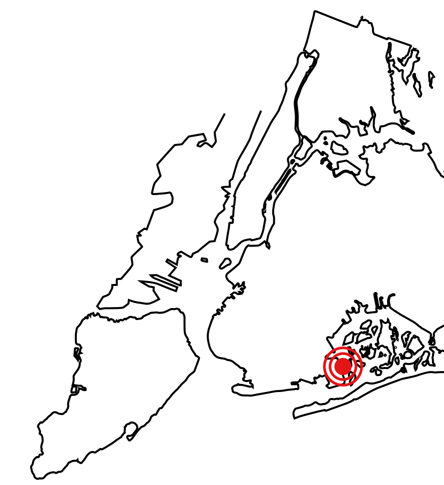
*Figure 85.
Top view of Building-with-Nature flood risk protection.*



Shengjie Zhan

SAFE & ATTRACTIVE

CLIMATE CHANGE ADAPTION AND SPATIAL QUALITY



Year: 2013
Location: Jamaica Bay, New York, USA

First mentor: Frits Palmboom
Second mentor: Fransje Hooimeijer

This project develops resilient design strategies for flood risk areas in Jamaica Bay, in New York. Jamaica Bay is located on the southern side of Long Island, near the island's western end and was extensively damaged in 2012 by Hurricane Sandy. As part of the New York 'Rebuild-By-Design' research project, Jamaica Beach's location in the delta and its geographical characteristics make it a perfect place to test how to deal with the relationship between natural forces and human activities. First, there is the contrast between the Jamaica Bay area and other areas in New York City: although the whole city area is densely urbanized, Jamaica Bay has remained quite natural. As a typical delta area, Jamaica Bay is also one of the areas most heavily influenced by natural disasters in the region. The bay is frequently confronted with flooding and storms, and has to deal with the rise of sea level and other climate-related flood risks. However, since this area is not so densely urbanized as other parts of New York City, many areas remain vacant, in a natural condition, which offers opportunities to integrate nature conservation and urban development.

The goal of this project is to find a way to apply integrated flood risk management to enhance the spatial quality of the open landscape and to create a link between urban area and waterfront area. After identifying and evaluating the context and possible alternatives, different strategies are proposed - in different layers (occupation layer, infrastructure layer and landscape layer) and at different scales. The coastline of Jamaica Bay is quite diverse and vulnerable; the mudflats and salt marshes which provide a natural transition area are gradually disappearing, further degrading the situation. Many houses have been built in areas of high flood risk, but few measures have been taken to deal with the threat; in addition, there are few public facilities, and little accessible open space.

The coastal hazards in New York City can be divided into two categories, each of them with five types, and these hazards will occur in different intensities and with different levels of probability. As these coastal hazards threaten different types of coastlines in different degrees, these diagrams indicate the risk level of these coastlines. In the Jamaica Bay area, all the coastlines are at risk of storm surge, sea level rise and gradual wave actions.

This project evaluates different coastline strategies according to their ability to deal with different hazards, and according to their potential co-benefits and disadvantages. Figure 90 (next page) presents different alternatives in terms of their flood defense performance and identifies some disadvantages in the specific context of Jamaica Bay. Overlaying evaluation layers upon hazard standard diagrams allows us to choose the strategies with the greatest potential. Different flood defence strategies have different co-benefits in any given site. The combined strategies with the greatest potential will also be collected in the final toolbox.

The final design integrates a coastal park and a new flood adaptation plan for urban areas into a single comprehensive plan that is both multifunctional and resilient. Thereby, the project improves the spatial quality of both the urban area and the waterfront area, which would make the Jamaica Bay watershed area safer, more attractive, and more accessible.

Figure 86. (left page) Waterfront area, roads, path systems and connections.

Figure 87. Figure 88. (below) Canarsie Pier area at high and low tide.

Figure 89.
Masterplan.

Figure 90.
Evaluation diagrams overlayed on the hazard standard diagrams to choose potential strategies.

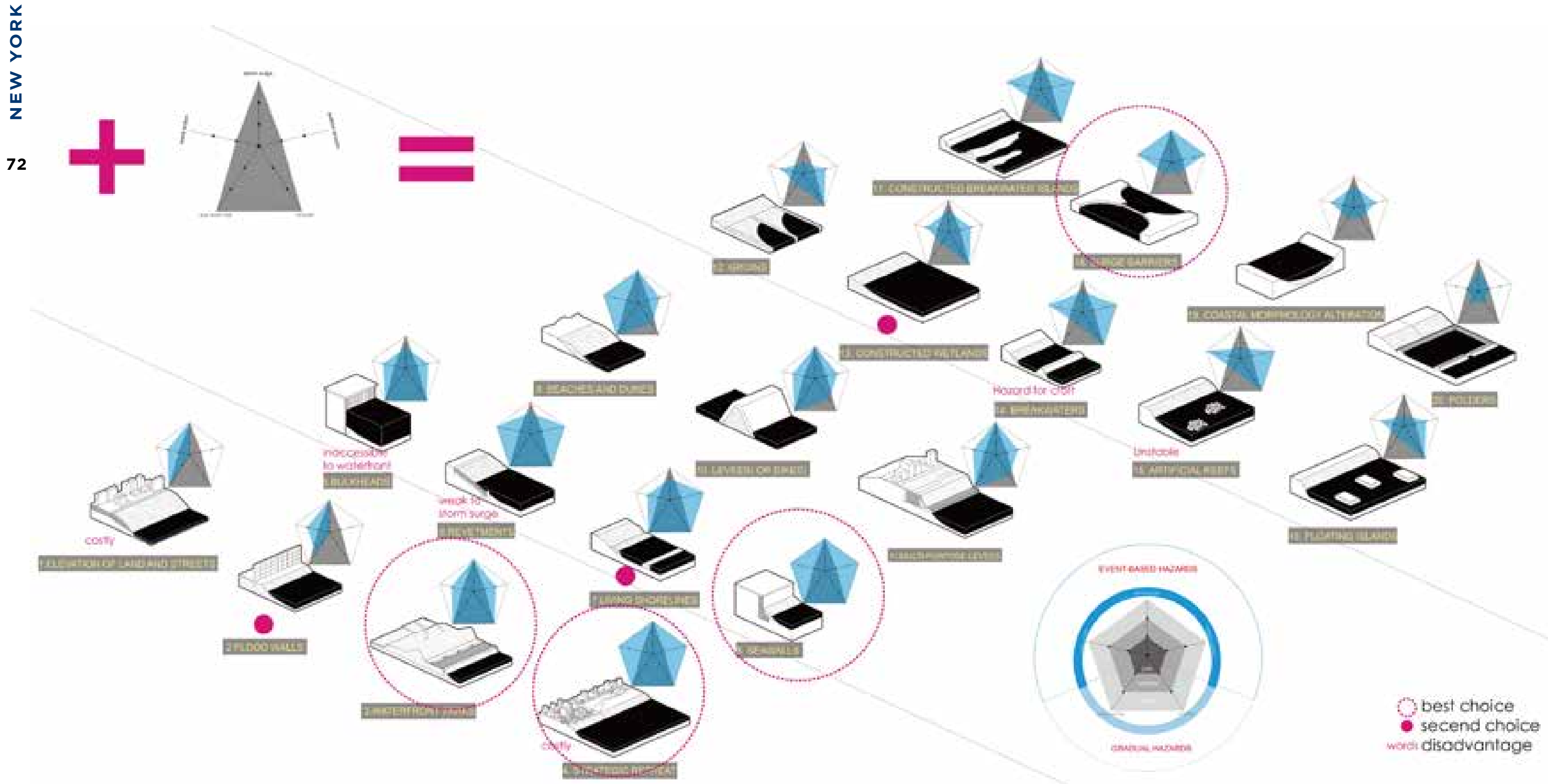
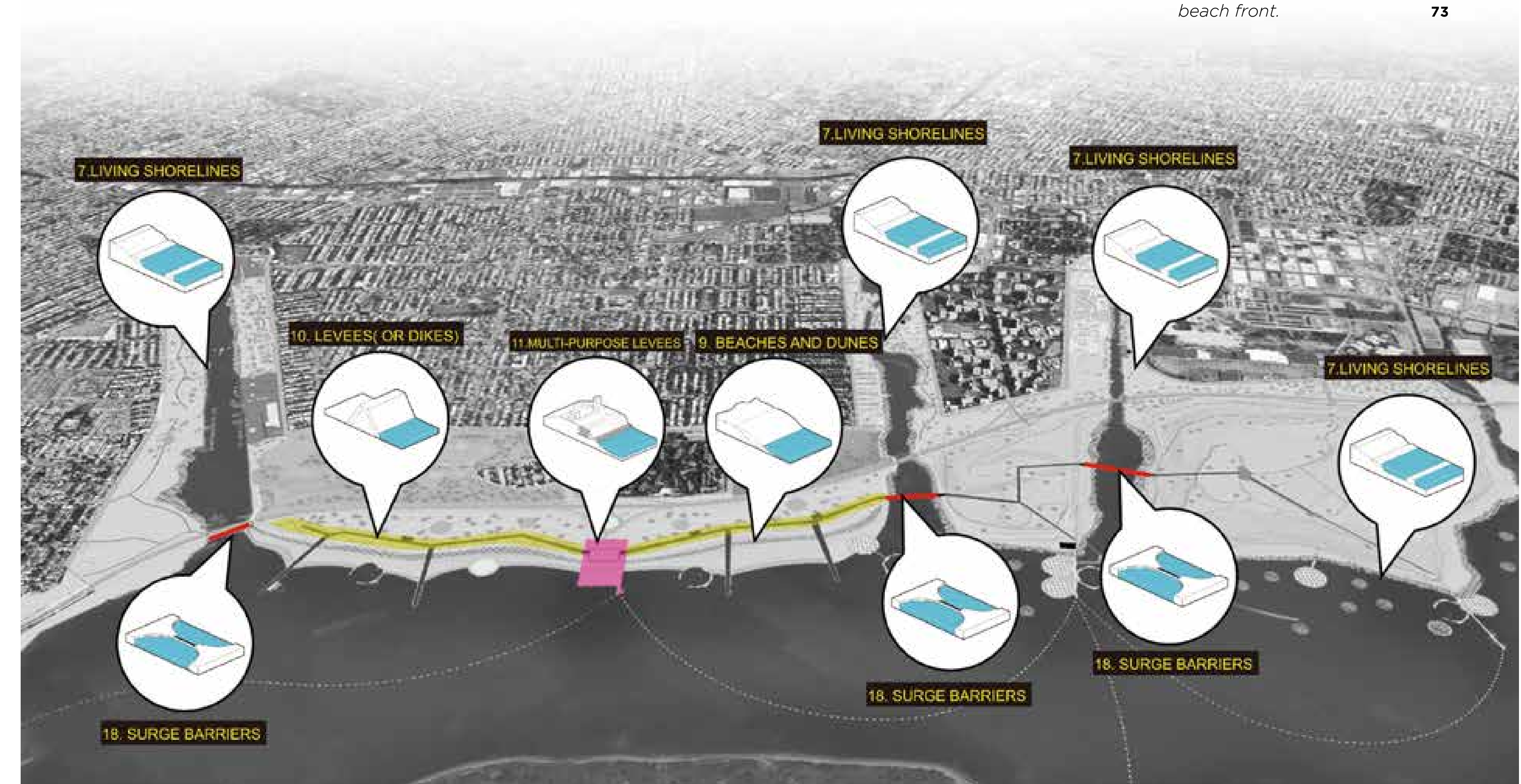


Figure 91.
Floating wetlands, recreational platform and swimming pools at low tide.

Figure 92.
Floating wetlands, recreational platform and swimming pools at high tide.

Figure 93.
Flood risk management along beach front.



Yi-Hsuan (Rachel) Li

PLAN B

AN EMERGENCY EVACUATION PLAN FOR HOSPITALS IN MIDTOWN MANHATTAN

Year: 2014
Location: Manhattan, New York, USA

First mentor: Anne Loes Nillesen
Second mentor: Maarten Meijs

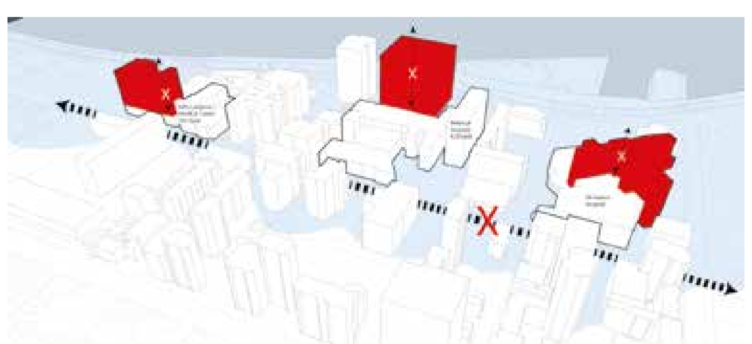
During Hurricane Sandy, three of the biggest hospitals in Manhattan had to evacuate their patients when faced with a power outage. As the elevators were not functioning, staff members had to transport more than four hundred patients manually via the hospital staircase. Fortunately, no deaths occurred during this evacuation; still, it is essential to develop a safer emergency evacuation plan, which we called Plan B.

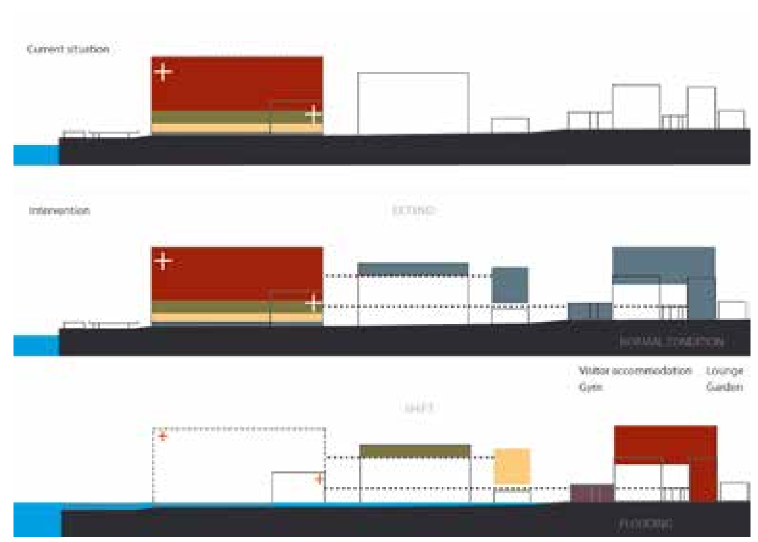
This plan proposes an elevated bridge, which would connect separate medical buildings within the Manhattan flood risk zone. The bridge can be used as an evautaion route duuring a flood event. In the flood proof area of Manhattan, a new tower is proposed, whose interior consists of a long ramp; this tower can be reached via a sky bridge connected to the medical centers. In normal circumstances, the tower and sky bridges can be used as an elevated walkway and public space.

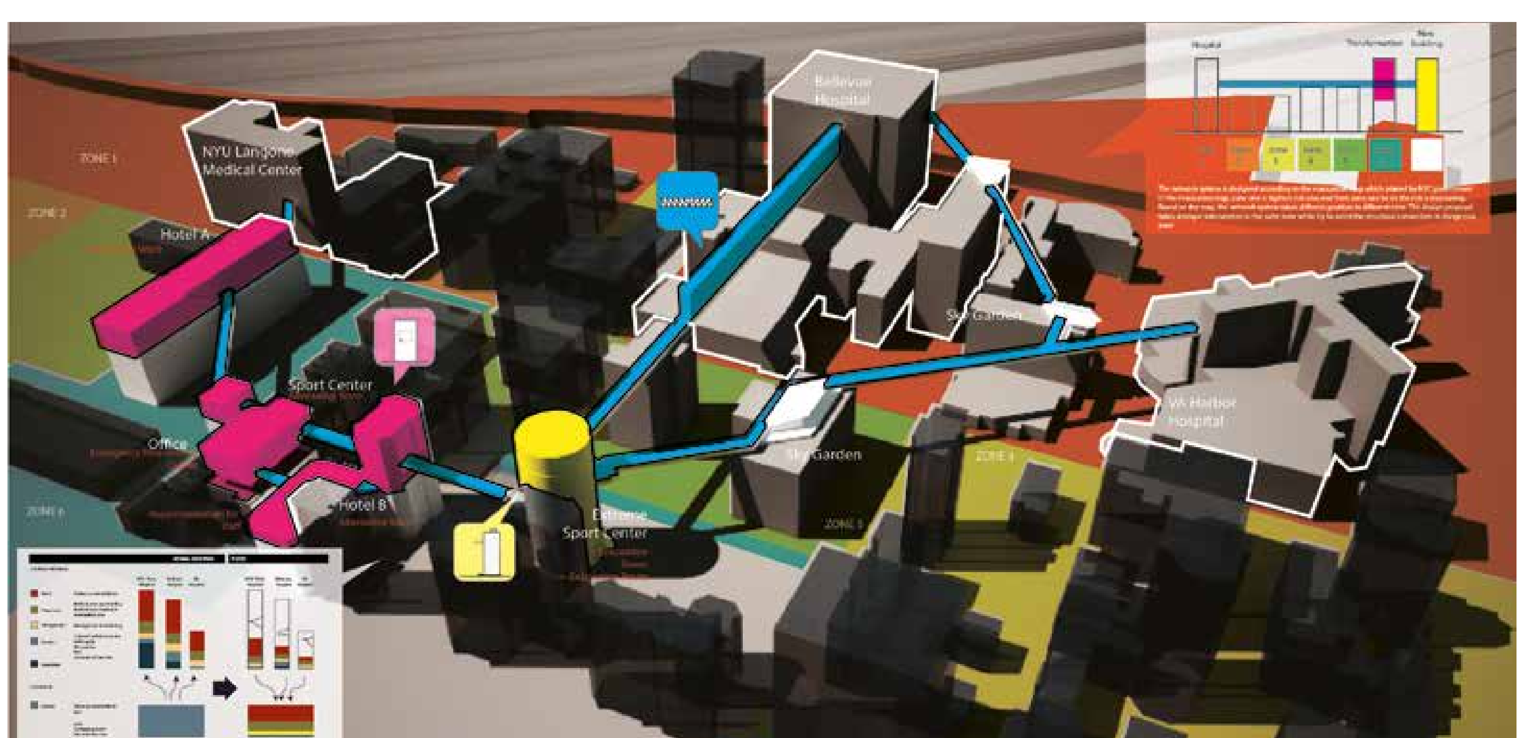
Figure 94. (below left) Map indicating the Manhattan hospitals wich are currently in the flood and evacuation zone.

Figure 95. (below right) Functions of the proposed hospital during normal times and flood emergency situations.

Figure 96. (bottom) Overview of the bridge and evacuation building in relation to the existing hospital buildings in the flood zone.







Defne Osmanoglou

FLOOD SAFETY IN DELTA CITIES

A COMPREHENSIVE RISK BASED MODEL

Year: 2015
Location: Hoboken, NewJersey, USA

Mentors:
Matthijs Kok
Matthijs van Ledden
Bart-Jan van der Spek
Anne Loes Nillesen

Flood safety in low-lying delta regions has always been a challenge. Floods in vulnerable urbanized deltas are often caused by heavy rainfall, high river flow, extreme sea levels, or combinations of all three. Currently, we lack the tools and experience to assess the effectiveness of combined measures to reduce pluvial, riverine and coastal flood risk in urbanized deltas.

The objective of this study was to develop a comprehensive risk-based model, which can support decision making in delta cities on measures to protect against pluvial, riverine and coastal floods. An idealised hydrologic model was developed to evaluate how combining these three factors in urban environments affects flood extent and frequency. The model quantifies pluvial, riverine and coastal flooding and identifies the contribution of different weather events to floods in a delta city. The city is schematised with a standardized layout, in which different elements of a city's flood protection system are connected. The city was considered as a storage basin where different sections have different values depending on various functions: their elevation; incoming and outgoing water flows; and the strength of different flood protection elements, including waterfront resistance, discharge capacity, and storage capacity. By calculating the hydrological water budget, flood levels in the city can be computed as a function of precipitation and water levels over time. The computed flood levels are coupled with stage-damage relationships to define the direct economic damages. By comparing the potential economic damage and the cost of investments, an optimal mix of measures can be defined at three levels: 'Resist' (flood defence structures), 'Discharge' (water pumps), and 'Store' (storage areas).

The City of Hoboken in New Jersey was used as a case study to apply the idealised risk model. Historically, Hoboken was an island, and low-lying areas flood when water levels in the Hudson River increase due to storm surges. In combination with severe rainfall, the impermeable surface and a lack of drainage, floods also occur during high rainfall events, especially when the excess water cannot be drained into the river. The consequences of a flood can be significant because of Hoboken's economic value and its central location.

The model serves as a practical and convenient tool, which can be used when looking for an optimal combination of flood risk reduction measures in delta cities. The model can quickly identify the different flood events in a delta city and it can quantify their frequencies and scales. In this way, it offers a realistic insight into the rates between pluvial, riverine and coastal flooding and the required flood risk reduction measures. This comprehensive flood risk model is an effective and efficient tool for urban planners, engineering companies, and decision makers in delta cities

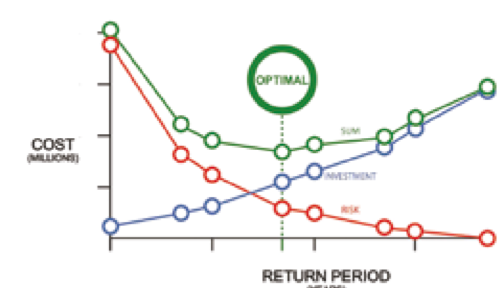
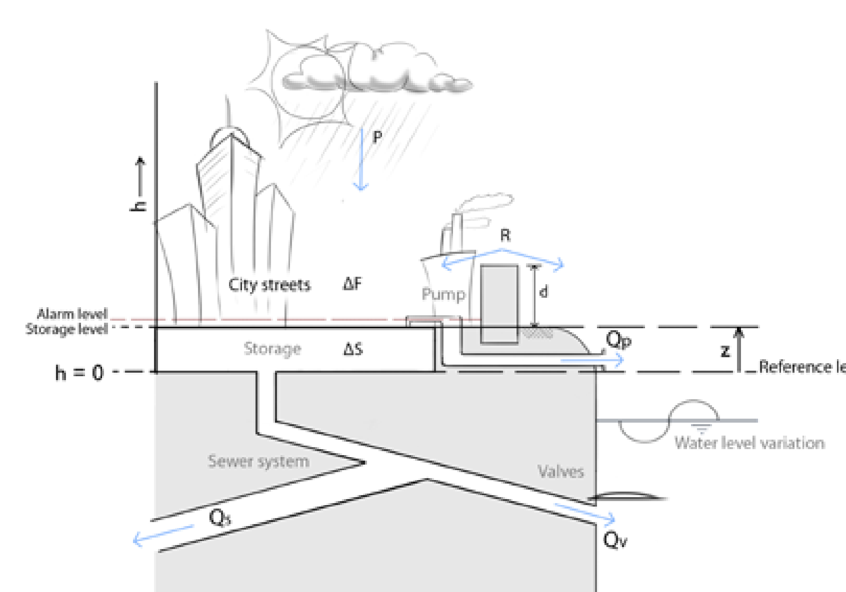
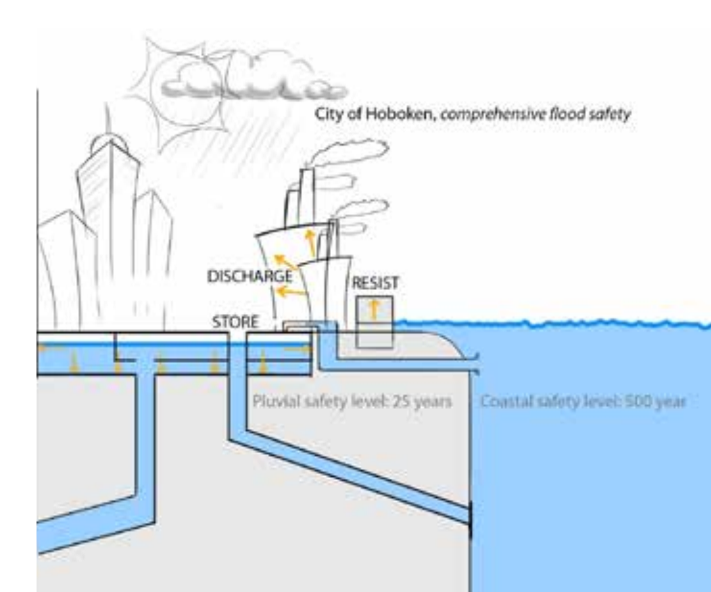


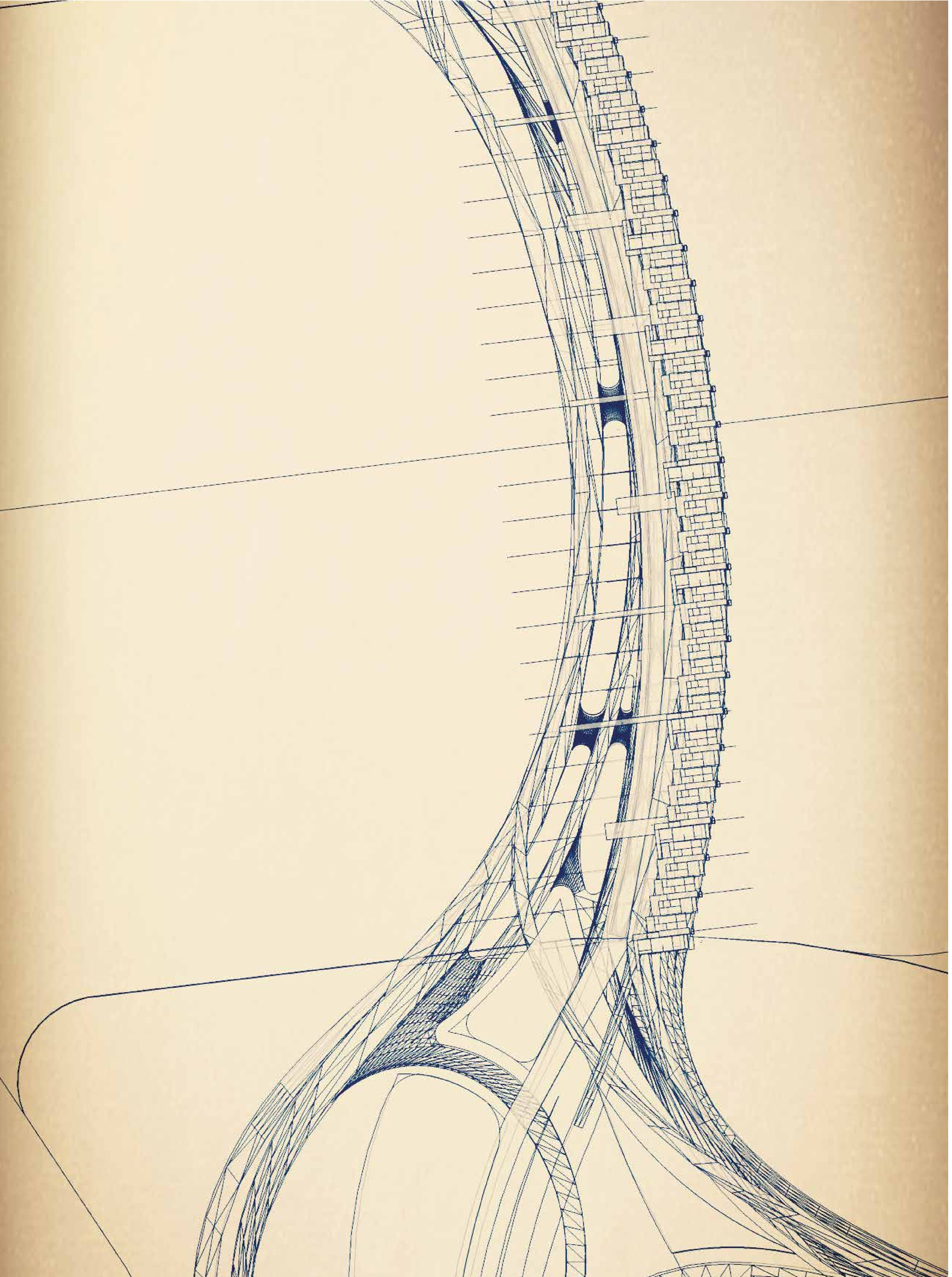
Figure 97. (left) Optimal intervention.

Figure 98. (below left) City of Hoboken, current water system and levels.

Figure 99. (below right) City of Hoboken, comprehensive flood risk reduction measures.







Xichen Sun

LIVING OVER THE SEA IN JAMAICA BAY

A BARRIER BUILDING COMPLEX

Jamaica Bay is one of areas in New York that suffered the most during Hurricane Sandy in 2012. In order to protect this coastal front line, flood risk prevention measures need to be taken. Jamaica Bay has a high ecological value and presents an attractive natural landscape, which offers potential for leisure and recreation. This project combines flood risk protection, while developing the recreational potential of the area, by proposing a multifunctional barrier building.

The barrier building is located along the artificial inlet which has been proposed on the weakest stretch of Rockaway Peninsula. The building has two faces: Seen from the sea, it acts as a barrier with a defensive structure, while from inside, it offers an urban appearance on a human scale. The 500 meter long building contains apartments and commercial facilities, as well as functioning as a bridge, connecting and integrating the peninsula, which is currently cut off.

Our cooperation within the Delta Interventions studio also yielded a conceptual design for a comprehensive flood risk reduction system for Jamaica Bay as a whole, of which this barrier is one section. The system was designed by Chris Siverd, a civil engineering student also taking part in the Delta Interventions studio (see next page in this volume).

Year: 2014
Location: Rockaway Peninsula, New York, USA

Mentors:
First mentor: Frits Palmboom
Second mentor: Maarten Meijs

Figure 100. (left page) Map of the proposed barrier building in tis context.

Figure 101. Impression of the barrier building.

Figure 102. Birds eye view of the barrier building at the Jamaica Bay inlet.

Figure 103.
Phase 1. 2012-2017.

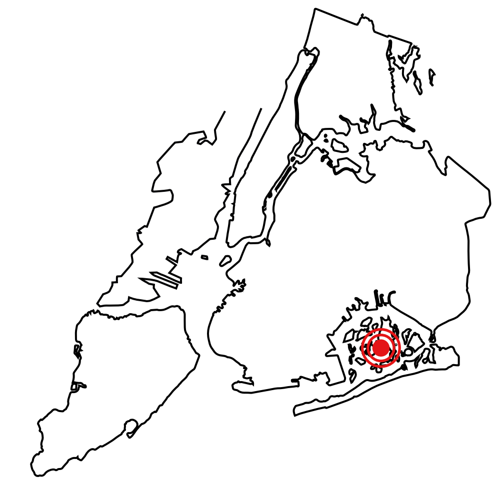
Figure 104.
Phase 2. 2012-2022.

Figure 105.
Phase 3. 2032-2132.

Chris Siverd

A COMPREHENSIVE FLOOD RISK REDUCTION SYSTEM

A CONCEPTUAL DESIGN FOR JAMAICA BAY



Year: 2014
Location: Jamaica Bay, New York, USA.

Mentors:
Bas Jonkman
Ad van der Toorn
Mark Voorendt
Anne Loes Nillesen

This study is a response to the flood risk reduction efforts after Hurricane Sandy. It presents a feasible flood risk reduction system for Jamaica Bay, New York City, and a preliminary design for a storm surge barrier, which would be part of this system. From a hydraulic engineering perspective, we started out from the following research question: What is the most implementable solution or series of solutions that decreases the probability of flooding in Jamaica Bay to at least 1/100 years with a 1/500 year resilience requirement? The design also addresses environmental impact, resiliency and adaptability, legacy pollution, and vessel traffic.

Implementing a comprehensive Jamaica Bay Flood Risk Reduction System (JBFRRS) was considered necessary to reduce flood risk in this area. The JBFRRS is to be implemented in three phases to decrease initial costs, address pollution in the bay, and accommodate the uncertainty regarding future sea level rise. The storm surge barrier is designed to accommodate overflow during storm tide events. This multipurpose structure not only functions as a temporary storm tidal storage, but also features piers with shallow foundations to take advantage of favorable soil conditions. From a technical point of view, the multi-functionality includes reliable vertical lift gates and water-retaining top beams to reduce overall height and costs of the barrier. Our cooperation within the Delta Interventions studio also yielded a conceptual design of a storm surge barrier that could be built across a proposed inlet on the Rockaway Peninsula. This project was designed by Xichen Sun, an architecture student also taking part in the Delta Interventions studio (see previous page in this volume).

At this point, we deem the design and construction of the JBFRRS and barrier feasible. This design effectively meets the requirements of the project and the stakeholders' criteria, because it incorporates features that lower the height of the barrier and keep its costs to a minimum. In addition, this design allows the JBFRRS to adapt to future sea level rise if necessary.

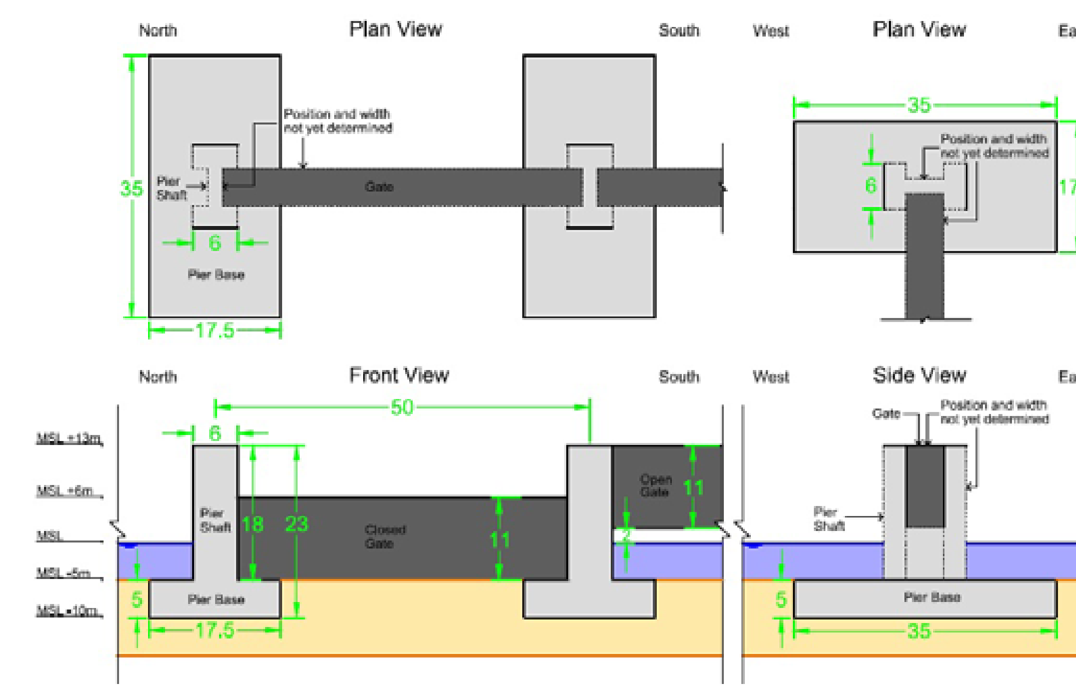
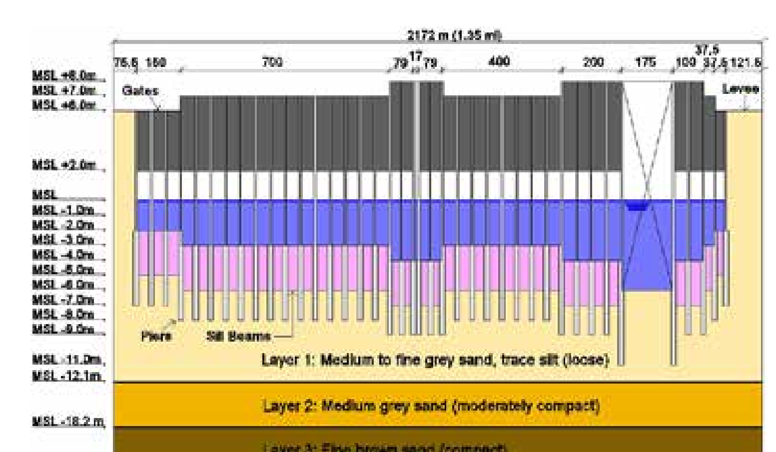
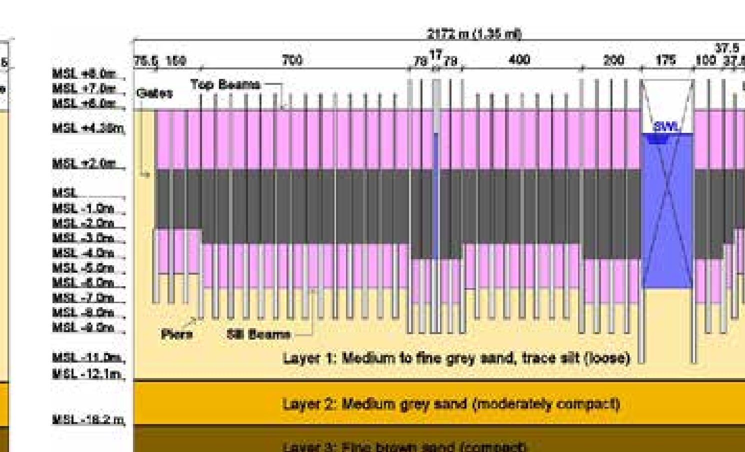


Figure 106.
(right) Preliminary design dimensions in meters.

Figure 107.
(bottom left) Open gate configuration, view toward Jamaica Bay, horizontal scale 50x.

Figure 108.
(bottom right) Closed gate configuration, view toward Jamaica Bay, horizontal scale 50x.





FIVE | HOUSTON GALVESTON BAY REGION, TEXAS

Baukje Kothuis, Sebastiaan Jonkman, Antonia Sebastian

DELTA PLANNING AND DESIGN IN THE HOUSTON GALVESTON BAY REGION, TEXAS

INTRODUCTION

During the past decade, a major hurricane and multiple rain-induced flash floods have devastated parts of the Houston Galveston Bay Region in Texas. This forcefully directed attention to the extensive planning and design challenges that the region faces in order to mitigate flood risk, including the complex hydraulic system, lack of zoning, and urban sprawl. Although the occasion is regrettable, these challenges make this area an interesting case study location for the Delta Interventions Studio.

On September 13, 2008, Hurricane Ike made landfall near Galveston Island. The hurricane claimed over a hundred lives in the United States. Many communities along the Texas Coast experienced major damage to residences, personal property, infrastructure, local economy, and the environment. Storm surge was measured as high as 17.5 feet (5.3 m) just east of Galveston Bay in Chambers County and much of the region received more than 10 inches (25 cm) of rainfall in 24 hours (Berg, 2009). Hurricane Ike's total direct damages are estimated to be as high as $29 billion (NOAA, 2011), the indirect economic effects being many times this amount (TEEX, 2010). At the time, Hurricane Ike was one of the costliest storms in US history, second only to Hurricane Katrina.

The region is also prone to severe rain-induced flooding. For example, in 2001 Tropical Storm Allison caused severe inland flooding in Texas when up to 37 inches (94 cm) of rain fell, but there was relatively little associated storm surge (USDC, 2001). Still it is the costliest tropical storm in US history ($5 billion). While not as damaging as a hurricane like Ike, these extreme rainfall events occur much more frequently than surge events and have the potential to extensively disrupt social and economic life, as well as cause people - seemingly unaware of flood risks - to be at risk in flash floods.

The flood risk issues in the Houston Galveston Region are complex, stemming from different sources (e.g., ocean, bay, river environments), encompassing different hazards (e.g., rain, runoff, surge), and having to deal with the effects of climate change and sea level rise. For example, storm surge inundation risk is a function of several interrelated components including the physical hazard, a combination of the surge in the Gulf of Mexico and local (residual) surge within the Bay, and the extent of the damage, governed by urban and economic development patterns in inundated areas. Therefore, several strategic alternatives for surge risk reduction have been studied over the past few years, ranging from a coastal protection system, dubbed the 'Coastal Spine' (see Figure 110) to inner or mid-bay protection system alternatives (see Figure 109). Eventually, given the complexity of the system, it is expected that a regional intervention strategy and system-wide approach, including multiple elements ('multiple lines of defense') that incorporate both grey and green interventions, will be necessary to mitigate flooding in the region.

After each of the major floods, substantial reconstruction projects have been initiated. However, the new or repaired structures often resemble the previous structures to a large extent. While some outliers exist (e.g., Texas Medical Center [TMC] post Allison), more flood- and water-conscious planning and design can create a safer and more attractive living environment in the Houston Galveston Bay Area, at the same time building resilience and public awareness of flood risk. Unfortunately, this is not a simple task in a region which consists of different areas with diverging and locally-specific spatial, socio-economic, and water related characteristics. This introduction discusses these characteristics, specifically addressing flood related issues, to explain the specific planning and design challenges for spatial interventions in this extremely rapidly urbanizing delta.

The City of Houston
Houston is the fourth largest city in the US, situated on the northwestern tip of Galveston Bay. The city boomed after the Great Hurricane of 1900 and the construction of the Ship Channel in 1915 and is still expanding. The current population of 2.2 million people is expected to double by 2050 (OSD, 2014). The city is extremely vulnerable to flooding and Harris County has one of the highest rates of repetetive flood losses in the US. Not only are residential plots situated in flood-prone areas, these areas also host major industries and businesses of national and global importance. These include large petrochemical plants in the Port of Houston, as well as the Texas Medical Center downtown, both of which are built on the banks of bayous.

The areas around Galveston Bay are drained by numerous of these bayous, slow-moving, tidal-influenced, coastal 'rivers'. These small rivers can be quickly overwhelmed by intense precipitation events and the resulting floodplains are extremely wide, often hundreds of feet across. Houston was originally built on the banks of two of these bayous (Buffalo and Brays Bayous) and has experienced frequent rainfall-induced flooding during its history. Since many of the bayous have been channelized over the years, the normally slow moving water can quickly turn into a raging river during extreme storms (Sebastian 2015). On several occasions, the region has received more than 6 inches (15 cm) of rain in a few hours, causing rainwater to fill the bayous, freeway underpasses and low lying areas. As far as flooding, rain-induced floods are the major issue here; hurricane surge does not directly impact downtown Houston. It was the wind damage that was most devastating during Ike, causing widespread, and lengthy, power outrages across the city.

Awareness of flooding and when it is going to occur is a major issue in Houston; therefore several warning systems have been built or proposed. For example, the Harris County Flood Warning System measures rainfall amounts and monitors water levels in bayous and major streams on a real-time basis to inform residents. The Rice University/TMC Flood Alert System is an integrated system issuing flood warnings and forecasts for the TMC Complex. This complex also features 25 automatic floodgates, installed at all of the entrances and drives, and built into a granite clad concrete wall that surrounds the entire facility.

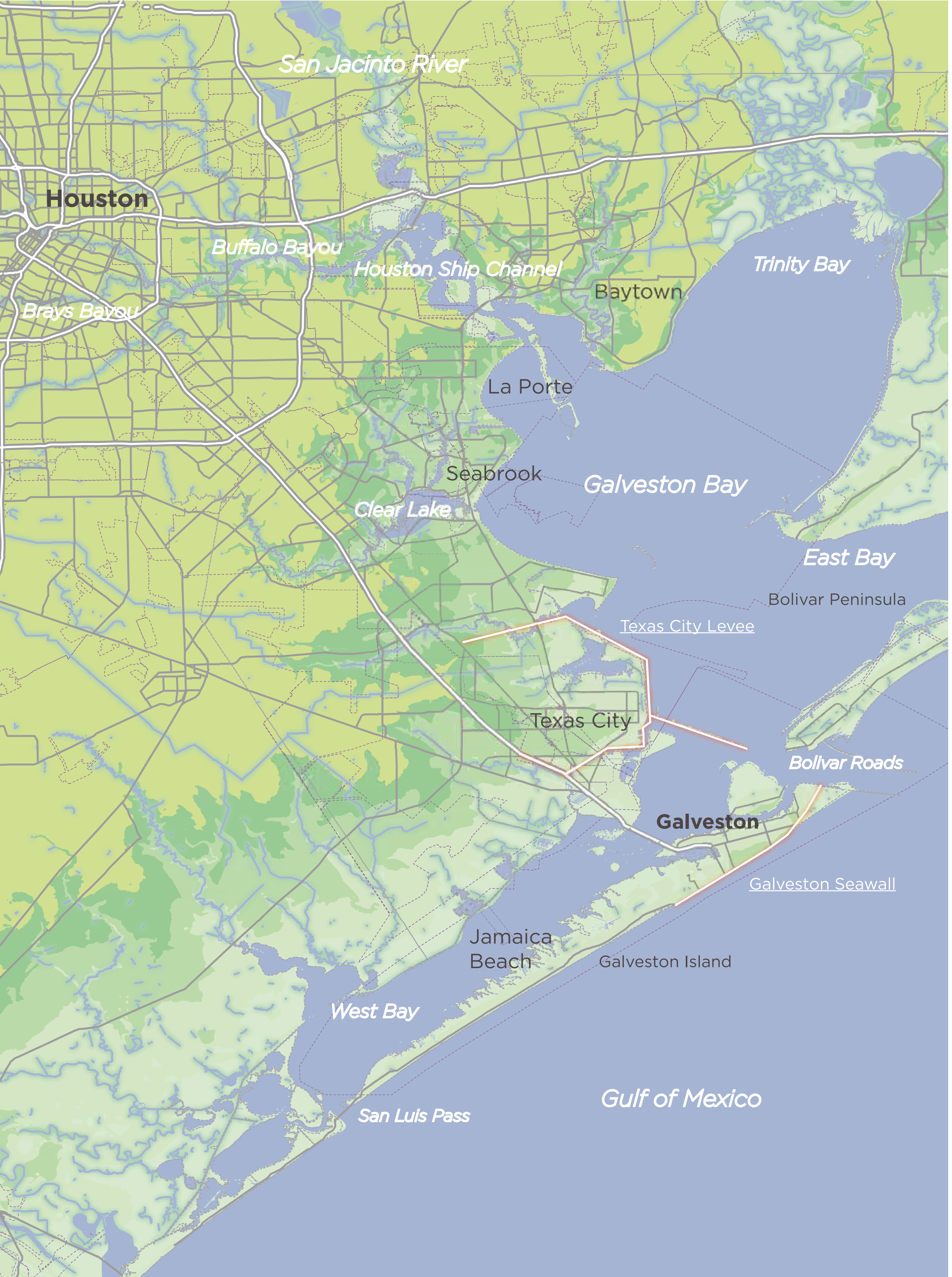
Galveston Bay shores
The west shore of Galveston Bay runs from Morgan's Point to Eagle Point. More than 1 million people live within the low-lying evacuation zones, and this number is expected to double by 2035 (Bedient 2012). It is an area of primarily suburban communities, characterized by sprawl and interspersed with some industrial activity. There are lots of local businesses and schools located here, but also the NASA Johnson Space Center, a major economic impetus. In the past two decades, the Clear Creek watershed area has repeatedly been subjected to floods, caused by rainfall as well as storm surge, both causing extensive property damage.

Further south is Texas City. The Texas City Levee has protected the city - and a large cluster of petrochemical industries within its boundaries - from storm surge since its construction in 1962. Texas City Levee remained structurally intact after Hurricane Ike, and was not overtopped, although debris was found on top of the levee and it required repairs for two years.

The flood issues are different along the east bay shore than along the west bay. The region is not heavily populated; in addition, it does not get a lot of surge during hurricanes because these spin counter clockwise. On the other hand, the coastline is severely inundated from the ocean side; in fact, this was wherethe highest surge during Ike occurred. The parks, rice fields and grazing pastures in this area took several years to recover from the saltwater intrusion.

The industrialized north end of the bay, including the Houston Ship Channel, has very different characteristics again. The area is heavily industrialized, and houses a low-income population. From a flooding standpoint, it also faces a different threat; the Ship Channel could potentially experience much higher surges than the west bay shore because of the 'funneling effect' that happens when surge enters the San Jacinto River. Since it is constricted to a smaller area (channel), the surge water level becomes much higher in the industrial portion of the ship channel than at other locations around the bay.

The Barrier Islands
Galveston Island and Bolivar Peninsula, two barrier islands separated by the Houston Ship Channel, form the southern edge of Galveston Bay. Galveston Island is about 27 miles (43.5 km) long and no more than 3 miles (4.8 km) wide, and has a population of about 50,000 people, mostly residents living in Galveston City. The city has a famous historical district, which attracts many visitors from around the globe. The western side of the island is occupied by beach houses, mostly second homes of Texas residents.



In the year 1900, the Great Hurricane killed more than 8000 people in and around Galveston, inundated the complete island and destroyed much of the city. To date, this remains the costliest tropical cyclone in history and is the storm of record for the Galveston Bay Region. Afterwards, a 10-mile (17 km) long seawall was constructed along the beach of Galveston. To the east, the island was backfilled to meet the height of the seawall, in order to raise properties. Since 1900, more than five major hurricanes have made landfall near the City of Galveston, but the seawall has largely protected the City from storm surge. During Hurricane Ike, the greatest damage to the city was caused by storm surge ebb that hit the back of the island as the hurricane crossed the Bay.

While the seawall provides a first protection for properties on the east end of Galveston City, flood risk on the island still poses many flood risk challenges for planners, architects, and engineers. Major issues that need to be addressed promptly include protecting the Galveston historical district, reconnecting the city to the ocean, and reducing coastal erosion. First, the existing seawall forms a hard boundary between the city and the sea, and its height is likely no longer sufficient to protect the city from future storm surge. The 1% annual chance surge calculated by FEMA in 2012 is now higher than the existing seawall: 18 feet (5.5 meters) instead of 17 feet (5.2 meters). Second, the backside of the city needs protection, as it is threatened by flooding due to storm surge ebb (wind set-up as the hurricane crosses the bay). Finally, the homes on the west side of the island need more protection: although they are on stilts and might be high enough to withstand sea level rise and storm surge, they still suffer damage from waves and erosion. On top of this, the consequences of climate change and sea level rise are likely to aggravate these issues at some point. Questions that are raised are whether protection on the west end should be at the individual/parcel level (e.g., more and higher stilts) or community level/island level (e.g., nourishments, extra sea wall). Erosion is one of the premier issues for the barrier islands, since the loss of beachfront also causes loss of property.

The second barrier island is Bolivar Peninsula. This island suffered heavy damage from Hurricane Ike. With fewer than 3000 permanent residents and about 5000 housing units, many of which are tourist-related, it might seem that major flood risk reduction plans are not a high priority. However, nothing is less true. Although the island is only a narrow strip of very low-lying land - 27 miles (43.2 km) long and only half a mile (0.8 km) wide at its narrowest point, it provided considerable protection for Galveston Bay by holding back high volumes of Gulf water during the hurricane; and thus should not be neglected.

Both barrier islands are critical to surge reduction in the overall Bay system. Maintaining the location and height of these islands (potentially even raising them) is critical for the system as a whole. Addressing erosion is therefore essential. Furthermore, the historical and recreational value of these islands, and their ecological habitat value (especially the west end of Galveston and Bolivar) need to be protected. These varied functions mean that we should consider designing a multifunctional flood reduction system that considers all functions of the system, is resilient, and adaptable. If a coastal spine concept is preferred, both islands need a so-called 'land barrier' in the system. To help provide the essential overall quality of the composition, technical, architectural, and spatial planning and design inputs are necessary, as well as an understanding of the local ecology and governance system.

Delta Interventions Studios Texas Design
Taking climate change into account, and with the frequency of compound flood events (rainfall and surge) shown to be increasing in the Gulf Coast (Wahl et al. 2015), a number of urban delta planning interventions are necessary: addressing water storage capacity, reducing the impact of river and coastal flood events, enhancing risk awareness of Houstonians, and improving the livability and spatial quality of the urban zone (e.g., Nillesen 2015). On a systems scale, adaptable flood mitigation is necessary to respond to the rapid developments in land use and urban sprawl, as well as to address the effects of sea level rise and climate change. On a smaller scale, preparedness for changing water levels must become the leading design principle for individual buildings and public spaces: flood-proofing these structures and areas must be one of the design conditions. Adopting new building codes and using improved building materials and methods, smart planning and design of public spaces to enlarge water storage capacity, and a policy to restrict development in flood prone areas, will make communities more resilient (GHF 2011).

These diverse planning and design challenges appeal to students of the Delta Interventions Studios. The studio offers them the opportunity to develop skills in a multidisciplinary environment with civil engineers, planners and policy analysts, the opportunity for international exchange and local collaboration, and the opportunity to apply and adapt concepts to an area with a different flood regime from the Netherlands. This stimulates the researchers to find answers to new problems at different scales, incorporating water-related aspects in their designs, and thus offering many opportunities to learn. The challenging design environment encouraged students to come up with a wide range of engaged and attractive designs. These vary from flood and hurricane resilient recreational complexes that reconnect Texans with their water environment (Ho, p. 94; Liu, p. 85) to the redevelopment of a watershed to address urban sprawl (Huang, p. 91); an elevated cultural building protected against a 500-year flood (Cao, p. 90); and a framework to help professionals to communicate flood risks more effectively to the public (Yam, p. 92). These projects have facilitated discussions about flood risk mitigation alternatives and are an inspiring contribution to decision-making on flood-related planning and design in the Houston Galveston Bay Region.

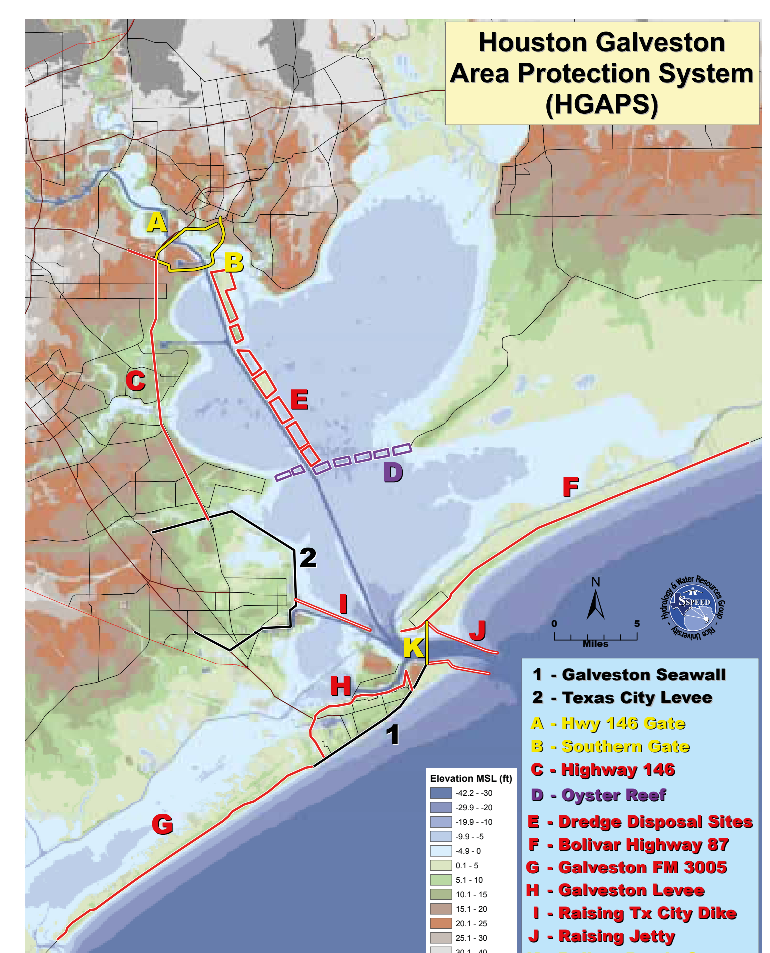


Figure 109. Houston Galveston Area Protection System (HGAPS)..

Figure 110. Coastal Spine. design including proposed flood defences.

Fangfei Liu

GALVESTON GOES SEAWARD

LIVE WITH THE WATER

Year: 2015
Location: Galveston Island, Texas, USA

First mentor: Anne Loes Nillesen
Second mentor: Koen Mulder

Galveston City is built on a barrier island facing the Gulf of Mexico along the Texas Gulf Coast. The southern sea-side of the city is protected by the Seawall, which brutally separates the city from the water. The project 'Living with the water' aims to extend the urban life of Galveston as well as tourism activities to the waterfront by creating an extensive recreational area along the sea.

The area's urban design provides different layers of water-related experiences. Different strategies are deployed to deal with flood threat in different areas. The project's main flood strategy is open and adaptive, which means the public's interaction will be flexible and variable. This concept has been applied throughout the design process, from urban scale to architecture scale, from structure design to detail.

A central building is proposed, functioning as an urban community center. The building is positioned behind the sea defense wall, which protects it from floods, but it will still have to be able to withstand hurricane force winds. The urban center is dominated by the landscape, with strong relations with the landscape both inside and outside. This provides a continuous and flexible space, offering users an integrated experience.

The building has a transparent, flexible outer wall along the whole building; within the building, several isolated boxes containing different rooms. The outer wall reflects the public character of the urban center, transparent and flexible. Three kinds of interior boxes are used: solid boxes with solid concrete load-bearing walls which also form the main structure of the building; glass boxes with removable glass facades; and isolated concrete boxes which are strong enough to resist a hurricane. The roof is supported by both the solid load-bearing boxes and a grid of columns: the columns refer to trees, as if the center were growing in the landscape.

The detail of the branch-columns shows how the concept of landscape-dominated architecture and that of hurricane robustness come together. The columns are optimally shaped to create a strong structure, at the same time forming an attractive element that embodies the concept of the 'landscape going inside', providing a connection with the landscape surrounding the building. This relation between the exterior and interior is further strengthened by the flexible openable outer façade, which breaks the boundary between the inside and outside and allows the landscape to continue freely. The more facade units open, the more public the building becomes, and the more the building becomes part of the landscape.

In case of a hurricane, the glass inner walls, the roof lights and furniture of the building can be removed easily and stored protected in the solid cores. The outer façade can be folded and stored in the roof. This concept reduces damage and contributes to a quick recovery after the hurricane.

Figure 111. (left page) Sketch design of Galveston recreational area along the Seawall.

Figure 112. Adaptable hurricane consequence reduction concept.

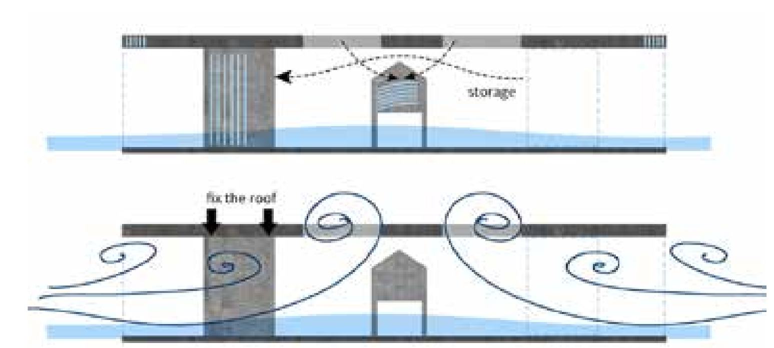


Figure 113. 3D model of recreational system for Galveston Bay.

Figure 114.
Impression of the interior solid core.

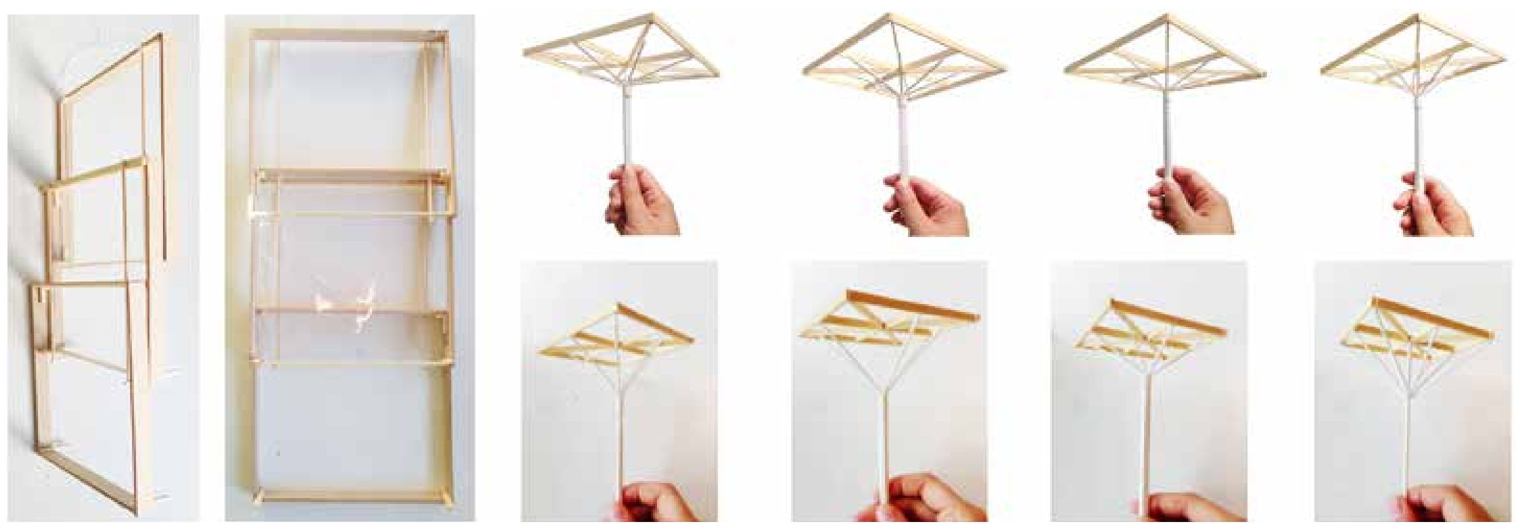


Figure 115.
Branch column and flexible facade testing models.

Figure 116.
3D model of the axonometric drawing showing both interior and exterior.

Figure 117.
Impression of the north-west entrance of the building.

Figure 118.
Impression of the library area.

Figure 119.
Impression of the interior glass core.

(Bubu) Qian Cao

HOUSTON DOWNTOWN CONNECTIONS

A CULTURAL BUILDING COMPLEX

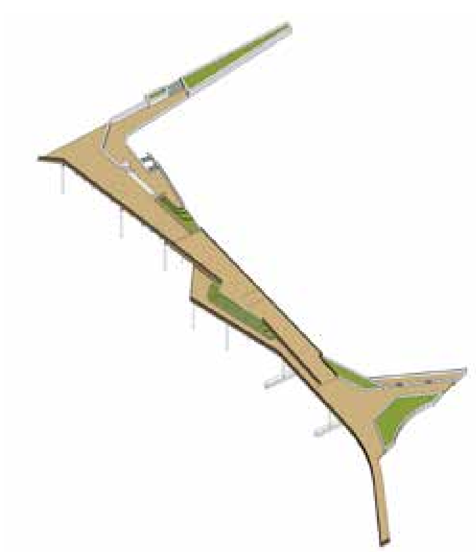
Buffalo Bayou is part of the Houston rain water discharge system and subject to flood risk from hurricanes and intense rainstorms. The proposed cultural building is located on the north bank of Buffalo Bayou in Downtown Houston, close to the museum district. In addition to the flood risk, the site also presents spatial challenges; the area is cut off by highways, resulting in a lack of connections with the central Downtown area. From the urban planning view, this represents an underused leftover space.

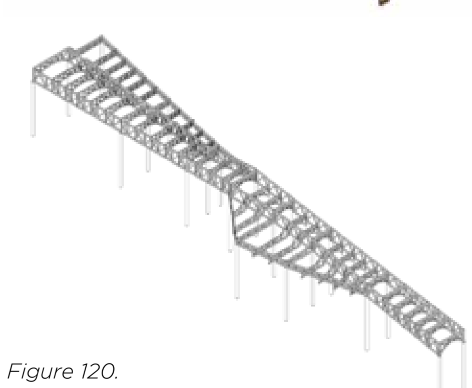
The project aims to activate the Buffalo Bayou area by connecting it to the museum district and creating a new attraction in Downtown Houston. The mixed-use extension plan will transform the current underused site into a lively place that improves the lives of Houstonians. The proposed buildings are elevated to protect against a 500-year flood; they are also connected with a pedestrian landscape bridge, which can function as an evacuation bridge in the event of a flood.

The southern edge of the buildings reflect the countours of the water. The terraced park establishes a transition between the water and the cultural complex, while simultaneously increasing the capacity of the channel. The different terraces provide three water defenses, respectively at 3, 6, and 9 meters (10, 20, 30 feet) above the water surface.

Year: 2015
Location: Houston, Texas, USA

First mentor: Frits Palmboom
Second mentor: Koen Mulder





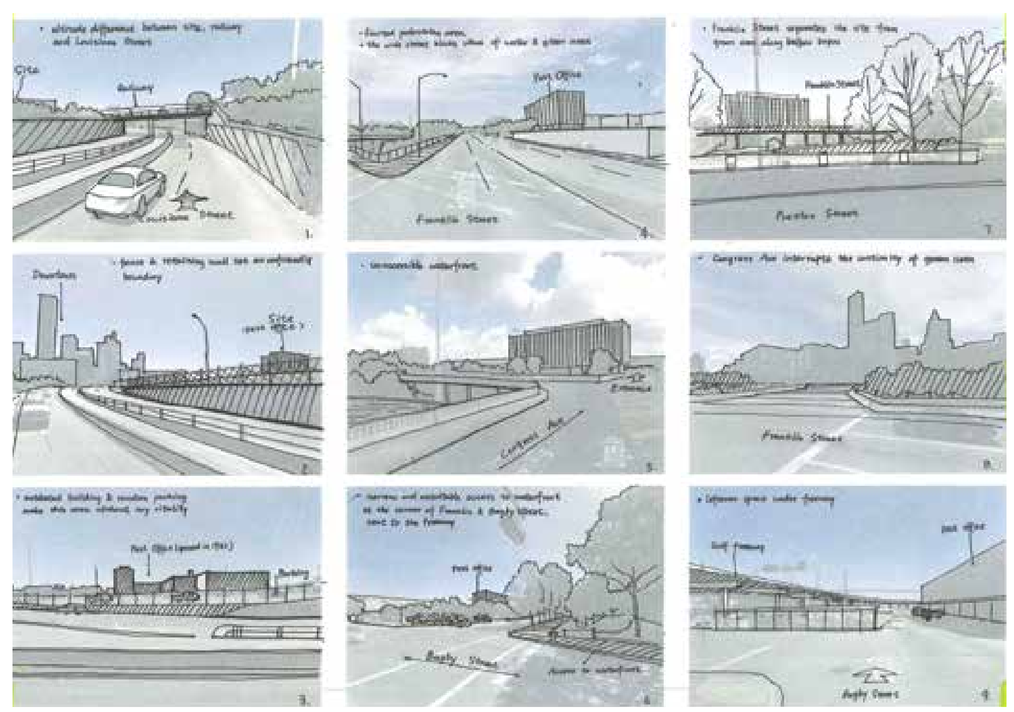


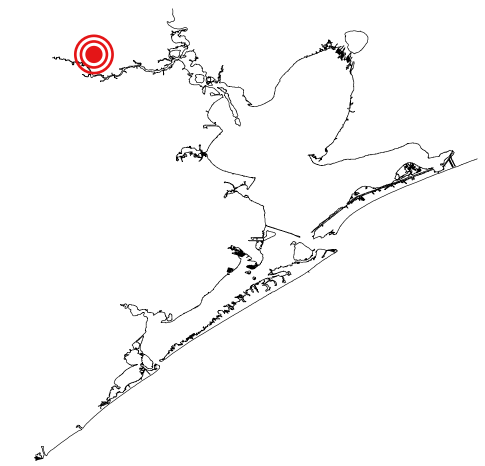
Figure 120. (above) Pedestrian and cycling bridge design.

Figure 121. (top right) Street view analysis sketch design.

Figure 122. (bottom right) Bird's eye view of cultural building complex.

Song-Ya Huang

RECYCLING HOUSTON



This project focuses on two critical challenges facing the metropolitan Houston area: flooding and urban sprawl. Due to the combination of flat terrain and heavy rainfall, Houston experiences regular flooding. Storm water cannot be contained or discharged to waterways fast enough because of the high percentage of impermeable surfaces and insufficient sewage systems, especially in post-war suburbs.

The aim of the project is to redevelop existing underperforming suburban areas into mixed-use neighborhoods with a high water storage and discharge capacity. To achieve integrated solutions that improve the water system while simultaneously intensifying the area, several strategies are developed in different locations and on different scales. The project proposes the re-development of the complete watershed and additional design interventions to redevelop and plan suburban areas, for example guidelines for water storage.

Year: 2015
Location: Houston, Texas, USA

First mentor: Han Meyer
Second mentor: Nico Tillie

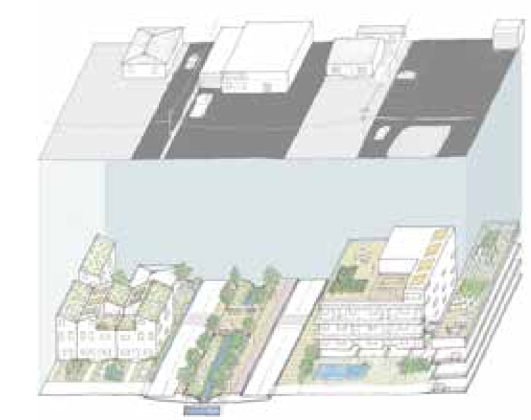


Figure 123. Intervention; secondary greenway.

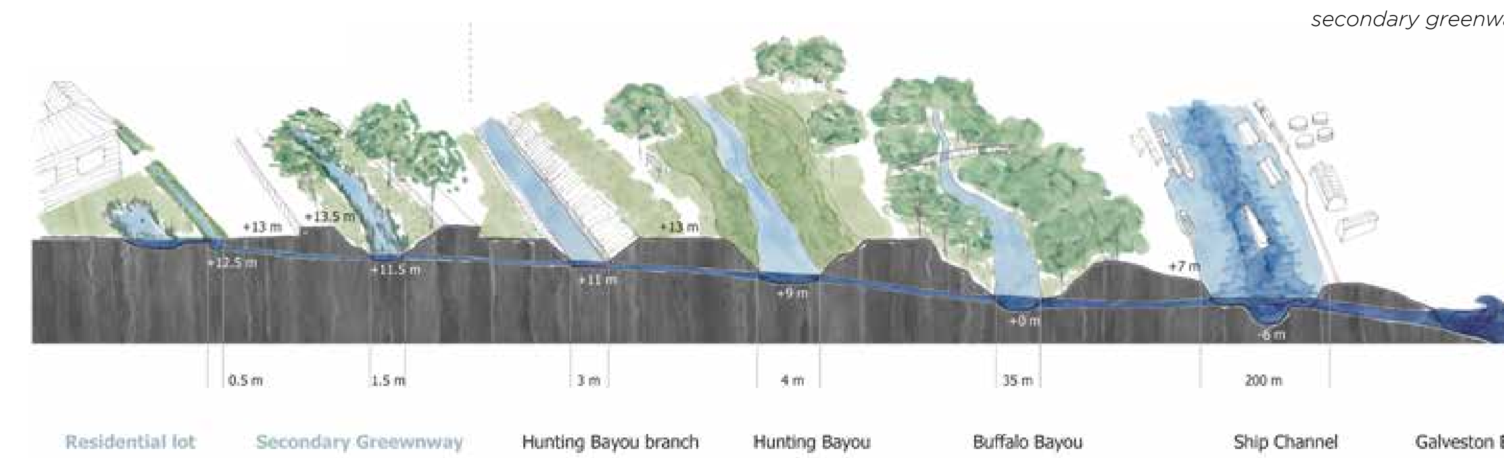


Figure 124. Existing water system and two added layers to support this system: residential lot and secondary greenway.

Figure 125. Water tool-boxes for residential lot, secondary greenway, and bayou.

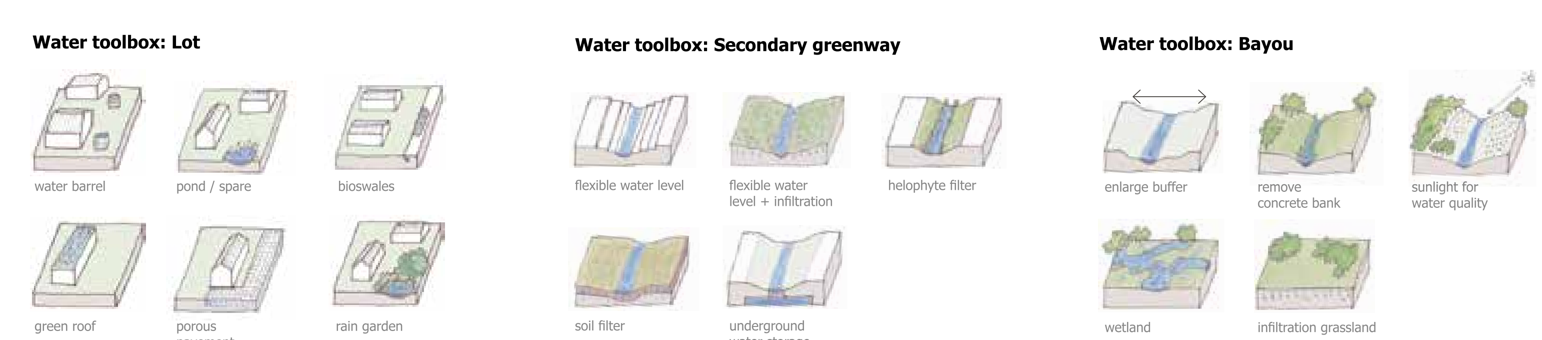


Figure 126. Characterizing images of frames for communicating salience of flood risk.

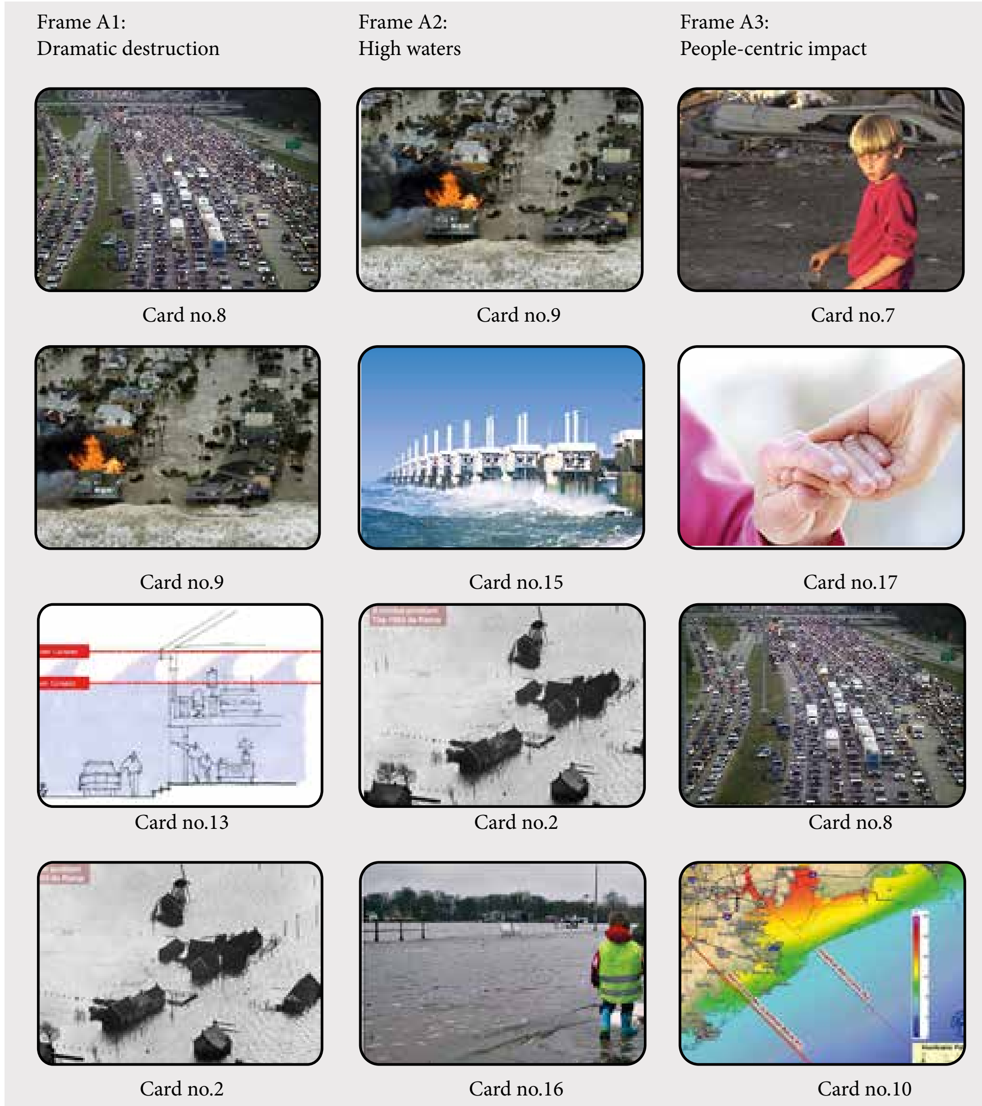
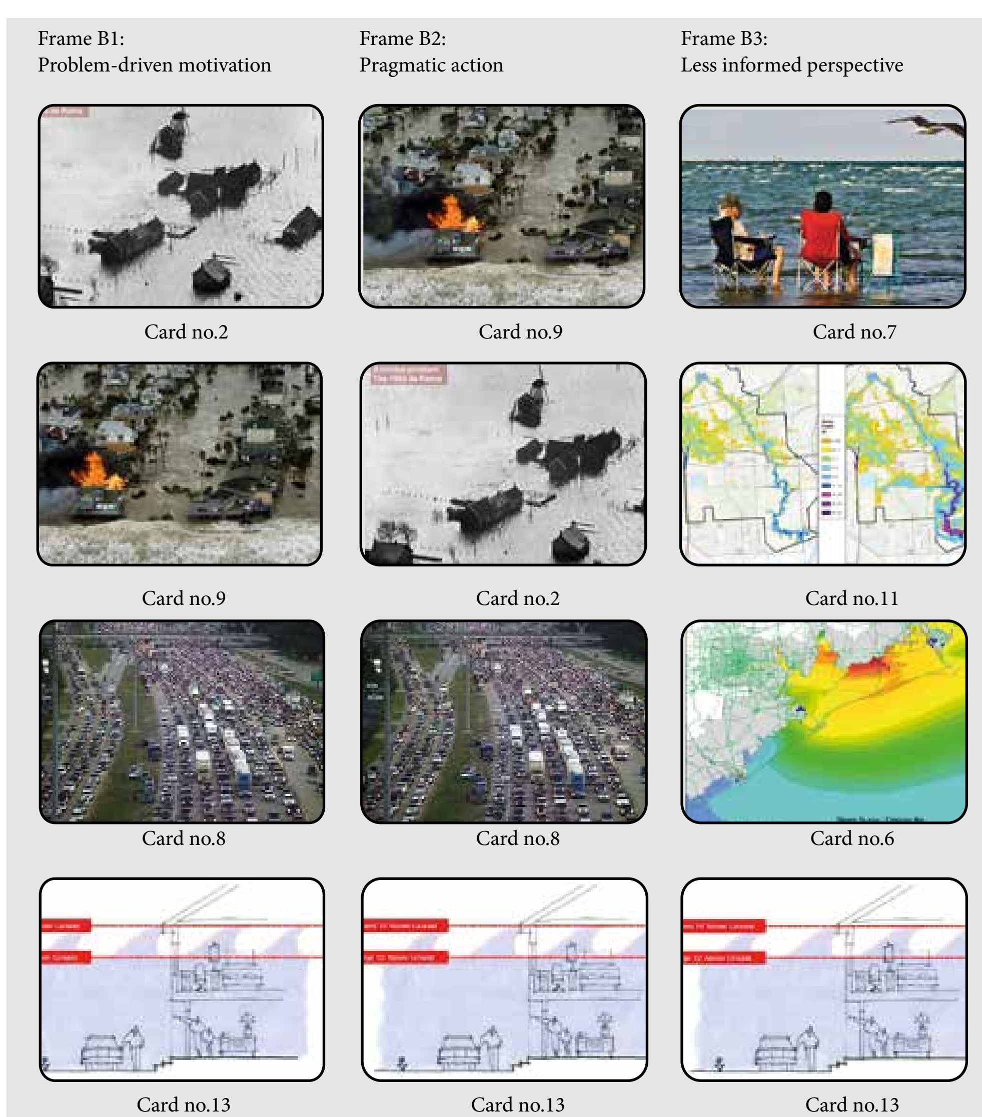


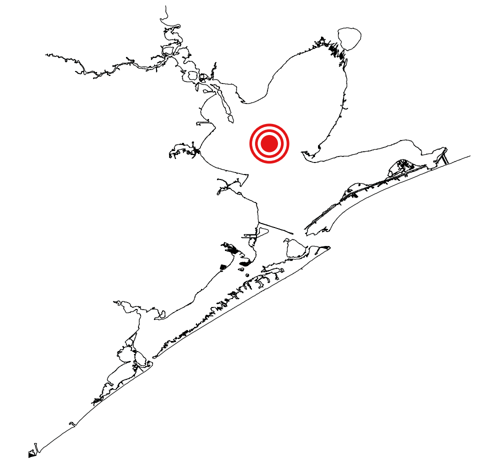
Figure 127. Characterizing images of frames useful for increasing perceived need for flood risk mitigation.



Denise Yam

FRAMING FLOOD RISK

PUBLIC COMMUNICATION ON FLOOD RISK



Year: 2015
Location: Galveston Bay Region, Texas, USA

First mentor: Bertien Broekhans
Second mentor: Bas Waterhout

In the ongoing shift towards integrated flood risk management, flood risk communication plays an increasingly important role in bridging the gap between different actors. This project seeks to understand how images are used in the framing of flood risks in communication between practitioners and the public.

A framework, built on the Construal Level Theory (Trope & Liberman 2010), is developed to describe the relationship between perception and frame of flood risks. Construal Level Theory supports that individuals' perceived psychological distance to floods determines their construal level of floods, which serves as a heuristic for decision-making processes. Externally, communication to individuals can be seen as frames consisting of different messages and representations. Congruence between frame and construal level of floods increases the strength of framing effects.

The framework is applied to communication of flood risks in the Houston Galveston Bay Region. Flood risk frames used by flood risk practitioners are contrasted against frames perceived by the public. Affective images concretizing the destruction and consequences of floods are found to better convey flood risks to the public. For communicating the salience of flood risks, three frames – dramatic destruction, high waters, and people-centric impact – were derived, each characterized by different types of affective images. Another three distinct frames – problem-driven motivation, pragmatic action, and less informed perspective – were found to increase the perceived need for flood risk mitigation actions.

Yet more frames could be uncovered in the larger population. Thoughtful use of the images and framing, including the alignment of practitioners and the public's flood risk frames, can improve flood risk communication.

Figure 128. Conceptual framework. describing the relationship between perception and framing of flood risks.

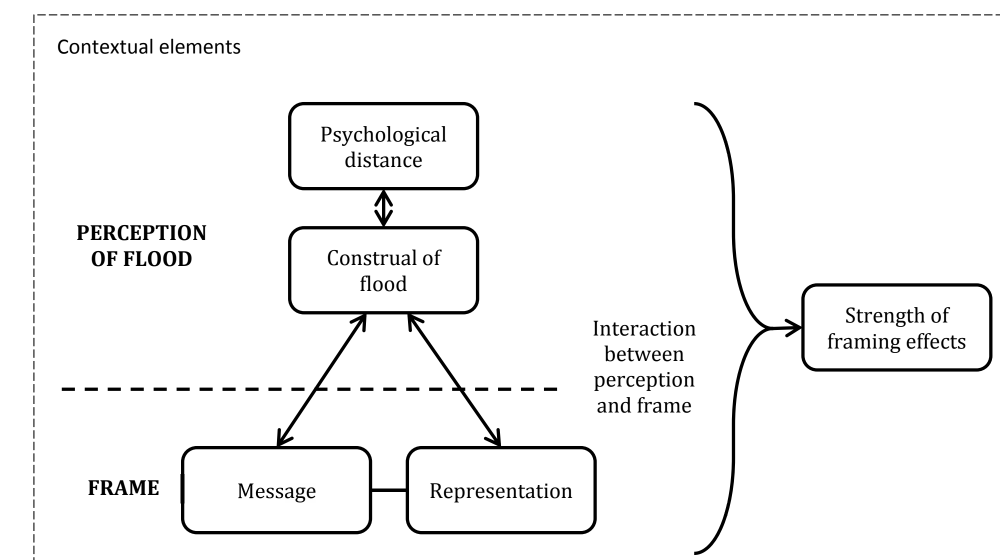
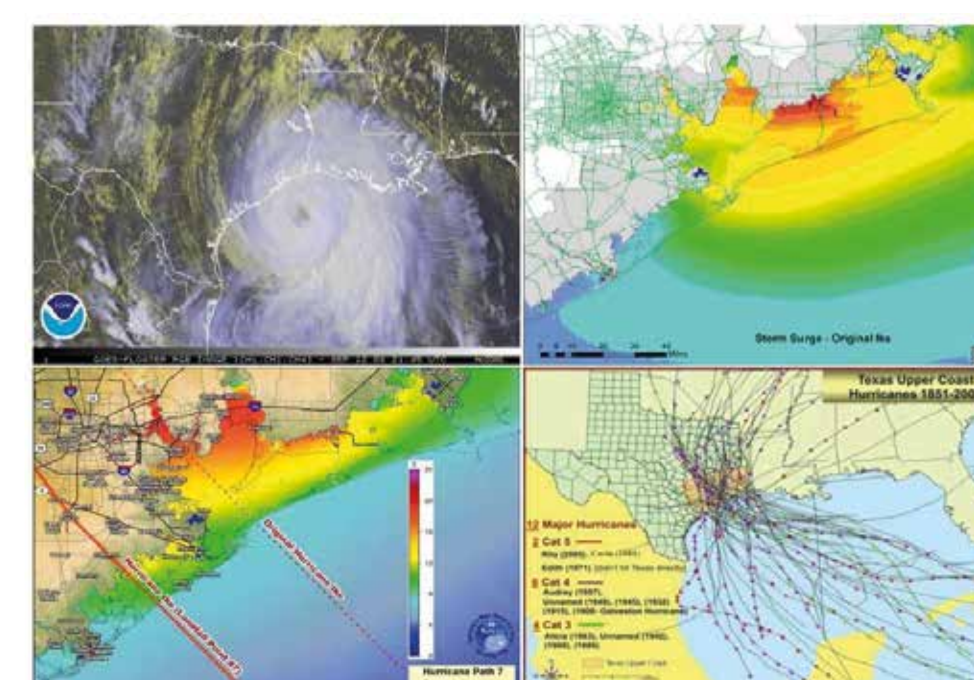
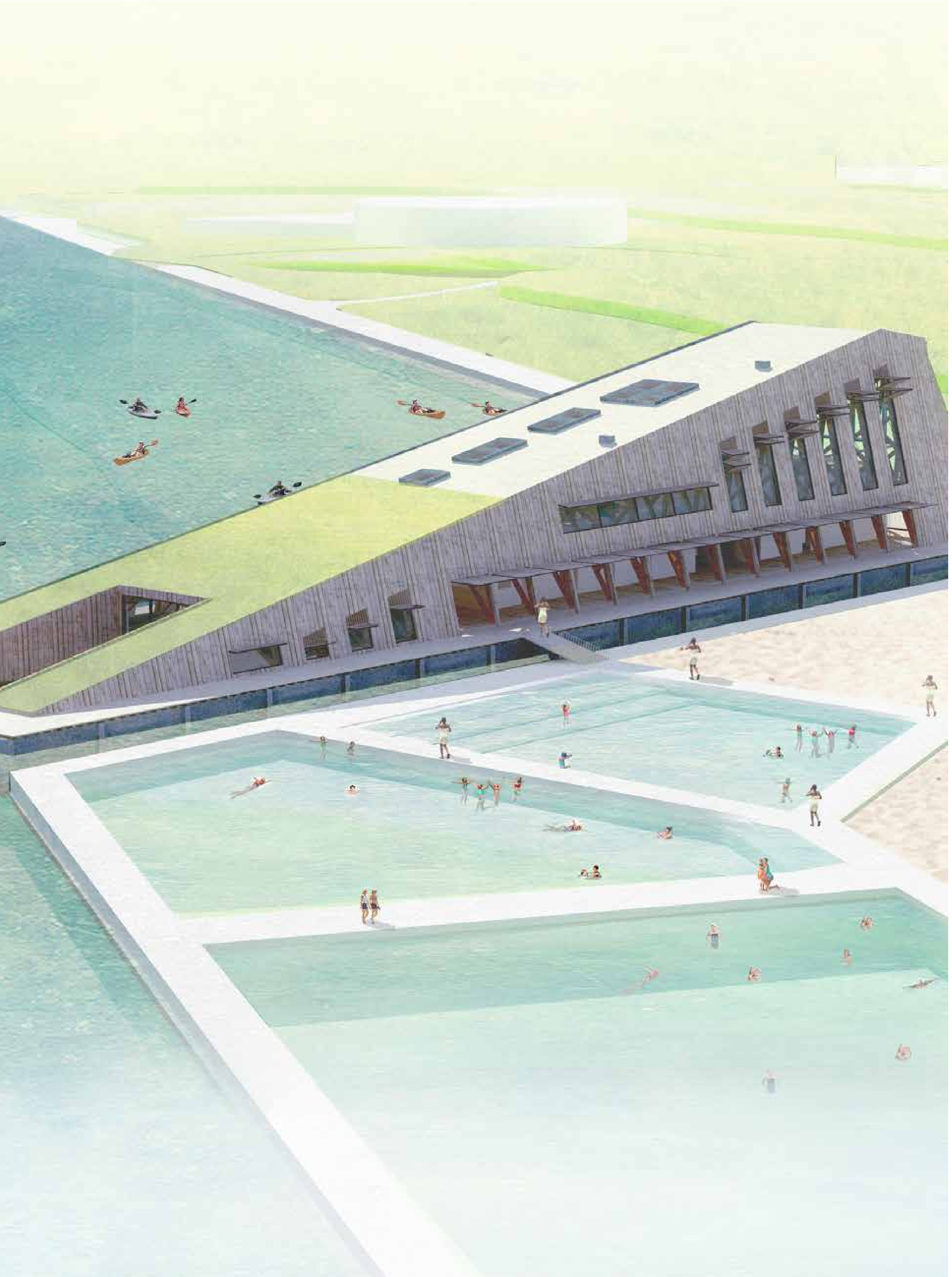


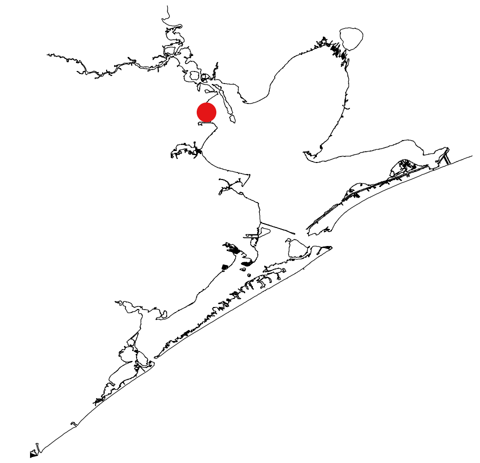
Figure 129. Images with the greatest differences in ranking between frames B1 and B2.





Tsai Hsun Ho

AN AMPHIBIOUS AND FLOATING RECREATION COMPLEX ON SYLVAN BEACH, LA PORTE



Year: 2015
Location: La Porte, Texas, USA

First mentor: Esther Gramsbergen
Second mentor: Koen Mulder

Figure 130.
(left page) Bird's eye view. from the north.

Figure 131.
The strong shell and skeleton of the building. View from the south.

This project is located in La Porte, Texas, a small town only 30km from downtown Houston, situated on the north end of Galveston Bay. That is why it is called La Porte – 'the door' in French. The beach park of La Porte, Sylvan Beach, is one of the few areas in the upper west side of the bay that has public access. This means that the park has long been an important recreational space. Until the Second World War, Sylvan Beach used to be a vibrant tourist attraction, featuring pavilions, cottages, hotels and restaurants. It attracted not only tourists from Houston or Galveston, but also visitors from all over the nation.

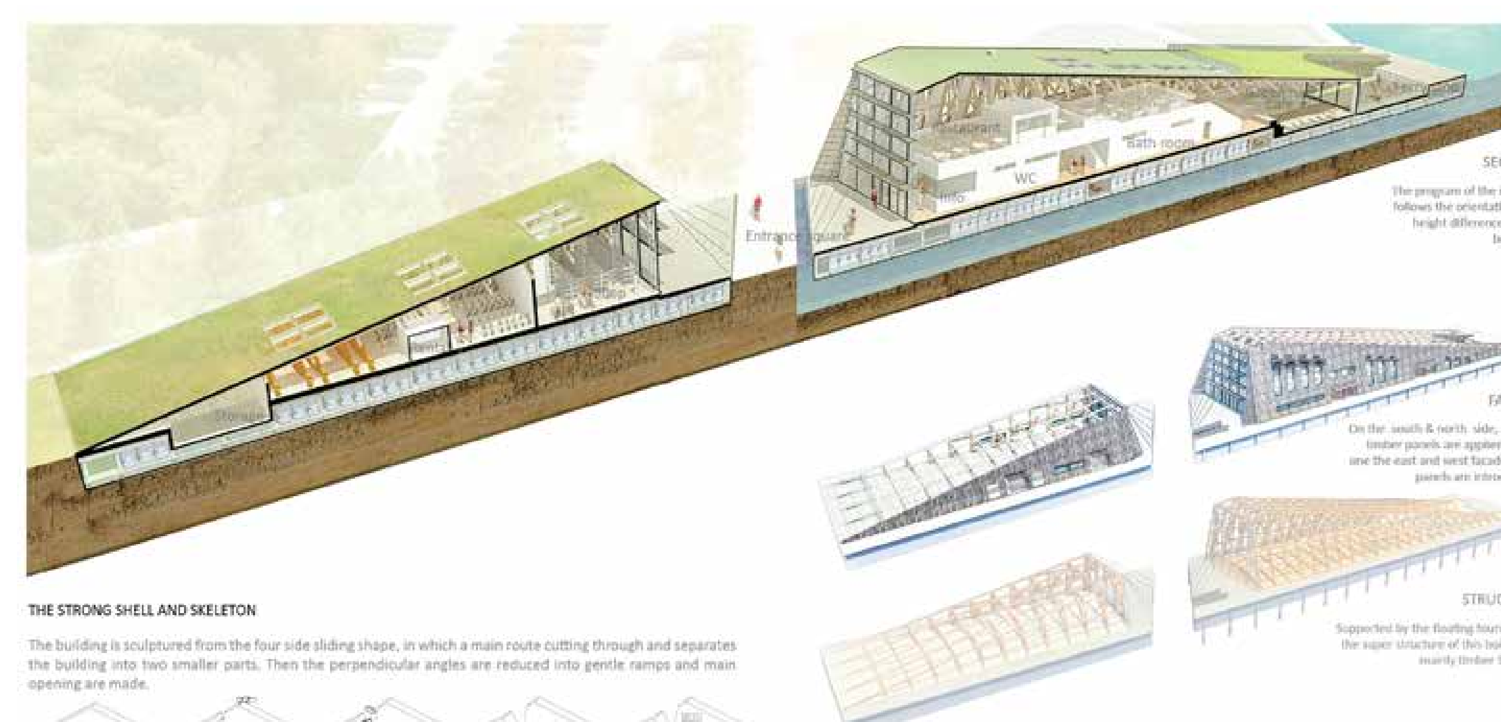
Galveston Bay is surrounded by sub-tropical marshes and prairies on the mainland. The water in the bay is a complex mixture of seawater and fresh water, which supports a wide variety of marine life. The beauty of Galveston Bay attracts people; however, most of the western bay's waterfront is private property and industrial sites. This means that the shore and the western Bay are barely accessible to the general public, and as a result, many people neither know nor care about the area. To improve the relation between individuals and the Bay, we designed a waterfront recreation complex and visitor's center that is hurricane resilient and improves the quality of the waterfront. The project provides people opportunities to enjoy the outdoor life, get to know this valuable environment, and ultimately to protect it.

To build in this area, we have to consider the constant threat of forceful hurricanes. There are two primary problems to building at Sylvan Beach Park, both natural forces - water and wind. When constructing a building at the waterfront, tidal fluctuations are always an issue. The level of water can change within a matter of minutes. Especially in the case of a hurricane, wind set up can raise the height of tide several meters. Apart from that, the strong wind forces of a hurricane are a significant problem. To respond to the tidal fluctuations of the Bay and the potential flooding and strong winds during storms, this project looked for solutions such as floating, amphibious architecture, wind resistant architecture, and other relevant strategies.

The foundation of a floating building is similar to that of a ship. The aim is to provide buoyancy and at the same time support the building's superstructure. Steel frames and trusses are used to construct the sub-structure. Steel sheets cover the outside of this steel foundation, which creates a waterproof air tank that provides buoyancy. The heavy foundation gives the building a low point of gravity, which keeps it steady in high waves and prevents it from tipping over in high winds.

Because the building slopes towards the water with a sliding shape, the structure supporting the building has to address the height difference. To achieve this, we applied a wooden truss structure system. Because of the strong winds associated with hurricanes, a set of wind bracings is placed every four to five trusses. The cables provide a visual continuity between the two buildings, but more importantly they also provide a very strong force to confront the wind.

To give the building a strong and seamless shell, the facade is protected by two systems: a system of folding louvers and a float-away door. The louvers have three functions: they can be folded at the top of the windows without blocking the view, and they provide a sun shading system that can be adjusted according to the angle of sunlight. During hurricanes, the louvers provide strong protection for the glass panels. The float-away door is a tilt door with a motorized door-system, which can be lifted overhead, leaving a clear space below.



Han Meyer

URBAN DELTAS - AN INTERNATIONAL ISSUE

INTRODUCTION

The position of the Netherlands as a highly urbanized delta region is by no means unique in the world. Far from it. In fact, all around the world, deltas are sites of strong urban and economic growth. What is unique about the Netherlands, however, is the high level of flood protection, which has ensured that no serious flooding disaster has taken place for over sixty years. Most other urban deltas lack such protection systems and have to contend with high levels of vulnerability.

For Delta Interventions, TU Delft's multi-disciplinary graduation studio, this was a reason to focus on urbanized deltas in regions beyond the Netherlands. It organized two collective studies, one on New York (2013-2014) and one on Houston (2014-2015). In addition, various students chose to do individual design-driven assignments on delta regions beyond the Netherlands, such as the Mississippi River Delta and the Mekong Delta.

The vulnerability of these deltas was revealed by the flooding disasters and near-disasters that recently took place. In 2005, New Orleans on the Mississippi River was hit by Hurricane Katrina. Many levees in and around the city gave way, a large part of the city was flooded, and more than 1,800 people lost their lives. A few years later, in 2008, Hurricane Ike swept across the same region and almost resulted in a massive disaster for the city of Houston. Then, in 2012, Hurricane Sandy hit the East Coast of the United States, leading to flooding in New York, among other places. Similar disasters have not occurred in recent years in the Mekong Delta, where the vulnerability to flooding has a more insidious character: in this region, a number of smaller and medium-sized floods occur every year. Due to increasing urbanisation and industrialisation, the consequences of this flooding are becoming more and more serious, and a need has emerged for more structural solutions.

Although urbanized deltas have a common vulnerability to flooding, this is not to say that the solution should be the same everywhere. Studying the specific situations of international deltas reveals physical-spatial and societal contexts that are often very different from those in the Netherlands; different kinds of solutions are therefore required

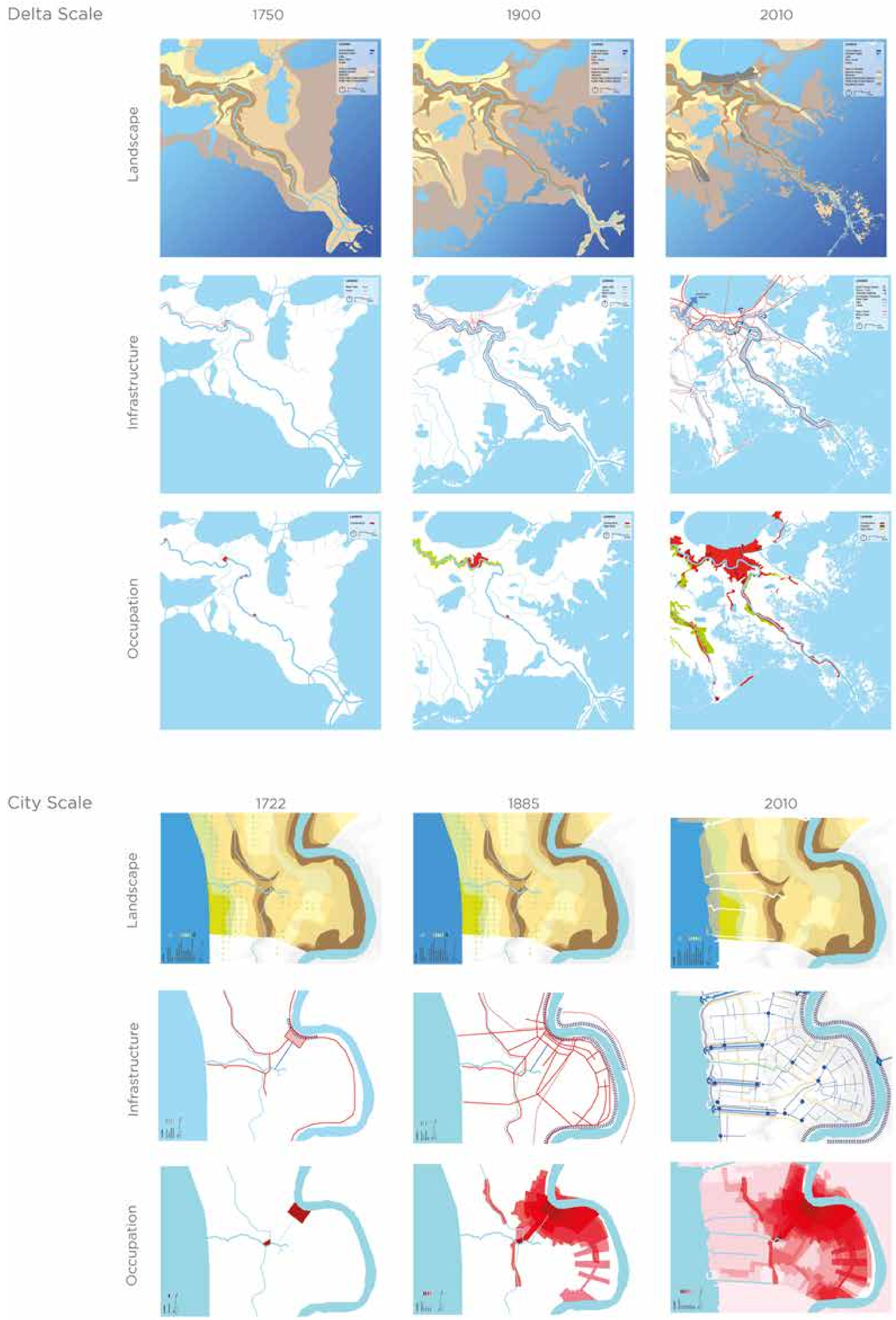
The Netherlands is unusual in that it is precisely the low-lying delta land that has seen a high degree of urbanization. This is a situation that we also encounter in the Mekong Delta, where – curiously enough – roughly the same number of people (c. 20 million) live in an area that is the same size as the Netherlands (c. 40,000 km2). The major difference, however, is that the Mekong Delta is also the world's largest rice-producing region. Small-scale flooding is actually beneficial to the paddy fields as a form of irrigation. The majority of the population lives in houses built on dikes or on piles, alongside the many canals used to transport agricultural produce. However, some smaller and medium-sized urbanized centres, such as Can Tho and Cao Lanh, are finding it increasingly difficult to deal with the frequent flooding. The question is whether it is possible to develop tailor-made solutions that both allow people to live safely in these cities and guarantee the continuity of the agricultural economy.

To a certain extent, the Mississippi River Delta is also comparable with the Dutch lowlands. The Mississippi River Delta is a very young delta region, largely formed by sediment that was transported by the Mississippi for thousands of kilometres and deposited in the estuary. In the middle of what is still a very sparsely populated and largely 'wild' delta, the city of New Orleans forms an urban enclave, surrounded by a system of levees that proved to be inadequate during Hurricane Katrina. Many of these levees have since been improved, but New Orleans continues to face problems. Since the city's rapid expansion in the 20th century, urban growth has led to the draining of the marshland around the older parts of the city that were built in the 18th and 19th centuries. While it was possible to build on the marshlands, drainage also led to a high degree of subsidence, meaning that enormous pumping capacity is needed in order to keep low-lying parts of the city dry during what are sometimes extremely heavy downpours, with up to 20 centimetres of rainfall in a single day. This subsequently creates a need to pump even harder, meaning that the ground level sinks even further, and so on. It is now recognized that this development has to be stopped and that new forms of urban development along with new forms of water management are needed. How this might be achieved is exactly the design question.

Strictly speaking, the city of Houston is not located in a delta, but it is situated in low-lying land that was formed from the silt of a series of smaller rivers that flow into the Gulf of Mexico. The coastline itself consists of a series of elongated islands, comparable to the Dutch Wadden Islands. There is a certain similarity between Galveston Bay, a large lagoon behind these islands, and the position of Houston on Galveston Bay, and what was previously the Zuiderzee and Amsterdam. The major difference is that there is practically no tidal flood protection in Houston and the surrounding area, while during hurricanes there is a risk of waves rising eight meters above the average sea level. In this case, the question is whether an intervention comparable with the Afsluitdijk would provide an adequate and feasible solution, or whether other measures should be considered. Like New Orleans, Houston also faces the problem of extreme rainfall, meaning that large parts of the city are also frequently flooded. Houston is one of the wealthiest and fastest-growing cities in the United States. The question is how the use of smart interventions might allow this growth to be combined with greater security.

New York is not a delta either, strictly speaking, nor is much of the city on low-lying ground. The city mostly lies on older, higher land that was formed during the Pleistocene. Despite this, in the 19th and 20th centuries large areas along the Hudson River were filled in and marshlands were drained, creating low-lying areas that proved extremely vulnerable to flooding during Hurricane Sandy. Many of these parts of the city also found themselves facing economic decline, following the departure of port businesses and industries. In addition, the coastal area lying directly on the Atlantic Ocean was badly affected. For both types of area, the task is to combine better flood protection with new prospects for economic development and a strengthening of the quality of the beach culture of the coastal area.

The solutions that emerge for international cities are often anything but the application of 'Dutch' concepts. On the contrary, analysing these foreign deltas frequently leads to completely different types of solution, which in turn can lead to fresh and innovative perspectives on the situation in the Netherlands.



Daniel Raymond

NEW ORLEANS - THE URBAN BAYOU

BALANCING NATURAL PROCESSES AND URBAN DEVELOPMENT

Year: 2011
Location: Mississippi River Delta, New Orleans, USA

Mentors:
Han Meyer
Willemijn Wilms Floet
Steffen Nijhuis
Thorsten Schuetze
Henk Mihl

The city of New Orleans, like many major global cities, is located in a delta environment at the edge of land and water. Over the past 300 years, New Orleans has embraced the strategy of a defensive war against water: trying to keep the water out by constantly building higher levees, installing bigger pumps, and erecting stronger flood walls. The Urban Bayou project takes another approach, exploring the possibilities of creating a different relationship between the built and natural environments.

To do this, it was first necessary to understand the historic context of the city and its location in the Mississippi Delta. A 3x3x3 layer analysis was conducted, which separately studied the three layers of landscape, infrastructure, and urban development, over three different time periods and on three different scales. By pulling these layers apart and understanding their separate progression over time, it was possible to make correlations and draw conclusions about how human development has influenced the delta landscape, and vice versa.

As a result of this analysis, we propose interventions in New Orleans, including once again allowing water to act as it naturally would, which means providing more space in the urban fabric for water storage during major storm events, and allowing tidal fluctuations and open water connections to Lake Pontchartrain. This strategy was tested through a mixed-use infill development along London Avenue Canal, where housing blocks and building typologies directly interacted with the water, creating unique environments for housing, recreation and nature. This design strategy not only creates a more resilient city, but also strengthens the identity and urban structure of New Orleans.

Figure 132. (left page) 3x3x3 Layer analyisis summary.

Figure 133. (top right) The urban bayou - masterplan.

Figure 134. (bottom right) Architectural elevations.

Fei Chen

DANUBE - FLUX WATERSCAPES

THE TRANSFORMATION OF SOUTH BRATISLAVA

Year: 2014
Location: Bratislava, Slovakia

First mentor: Inge Bobbink
Second mentor: Anne Loes Nillesen

South Bratislava is built on an alluvial plain formed by the Danube River. In the heart of this area, the right bank of the Danube has urgent needs for transformation and improvement. The river originally had a meandering shape. Over the centuries, the river's course was repeatedly straightened, in order to improve navigation. And to answer the threat of floods, the banks were raised higher and higher above the river. In addition, when the city urbanized further, the smaller creeks in the area were buried in underground culverts.

The river dynamics and ecological system were gradually damaged by these changes, making the banks unable to adapt to seasonal water changes and making the waterfront inaccessible. How can we respond to this disconnect between water and humans, and recreate a dynamic water landscape? This regional transformation plan includes a transformation of the Danube riverfront, improvement of an inner city creek, greening of the city's suburbs, and construction of a blue river bypass.

The research design considers the character of the right bank of Bratislava, primarily guided by the water dynamics. Two main types of dynamics are identified: temporary flow fluctuations and longer morphodynamic processes. However, water processes also influence social processes both locally and in the wider area. The river and its water landscape preserve the memory of how the city was founded and developed; together they offer possibilities to revive this collective cultural memory. Using water as the basis for our design forced us to consider the overall process and the proposed changes at different scales. The flexible character of the water landscape makes it possible to address social safety, while at the same time protecting the natural environment, and creating recreational possibilities.

The title of this design is Flux Waterscapes, flux referring to continuous change. Flux waterscapes can adapt to the changes of water flow and social needs. The design framework is based on the water processes. First, a flexible meandering bank is created, which can adapt to water changes and recall the collective memory of the old riverfront. Then, the urgent need for recreation is address, by adding parks and public spaces. In addition, new transportation routes are added, connecting to the existing public transport system. The whole design aims to maximize the potential of existing waterfront, such as the heritage elements and the wonderful open view which the waterfront presents. Besides this, some parts of the waterfront can be given temporary functions, attracting visitors to events, festivals or concerts.

On the local scale, the design creates a new waterfront area for the whole city that strengthens the connection between both riversides. Also, the waterfront is connected to the inner city by means of a linear park along an old creek. The creek design both serves as a water basin, able to deal with different water levels along the waterfront, and also offers new recreational opportunities. On the regional scale, two flood bypasses are created in the city's suburbs to mitigate flood problems; this also helps recall the now erased historical waterfront of the former socialist city on the right bank of the river.

Of course, money is always an issue. The whole project represents a huge landscape and civil engineering intervention, which needs the cooperation of different levels of government and multiple private companies. The goal of this design is to call the attention of the public and local government to Bratislava's urgent water problems. This can start a discussion which will lead to an answer to the urgent problems which the region faces.

Figure 135. (left page) By-pass preventing flooding of the Bratislava city center.

Figure 136. (below left) Waterfront adapts to fuctuating water level.

Figure 137. (below right) In winter, the retention ponds can be used for ice skating.

Figure 138.
Waterfront park with different water levels.

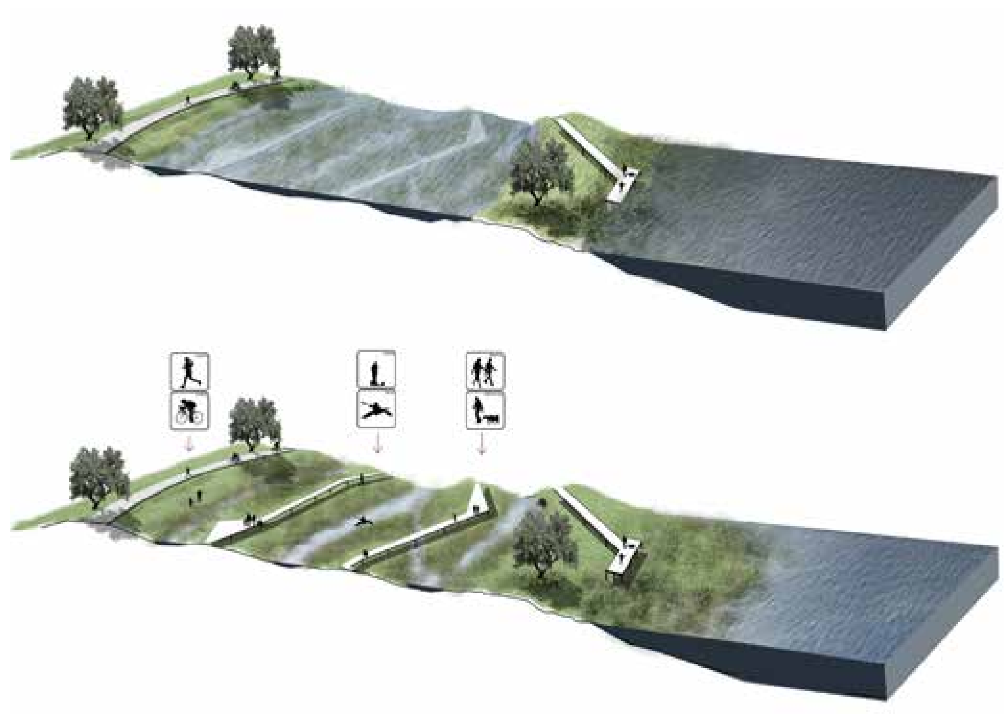


Figure 139.
Linear waterfront park.along the creek at higher and lower water levels

Figure 140.
Retention wetlands, used as a recreational area.

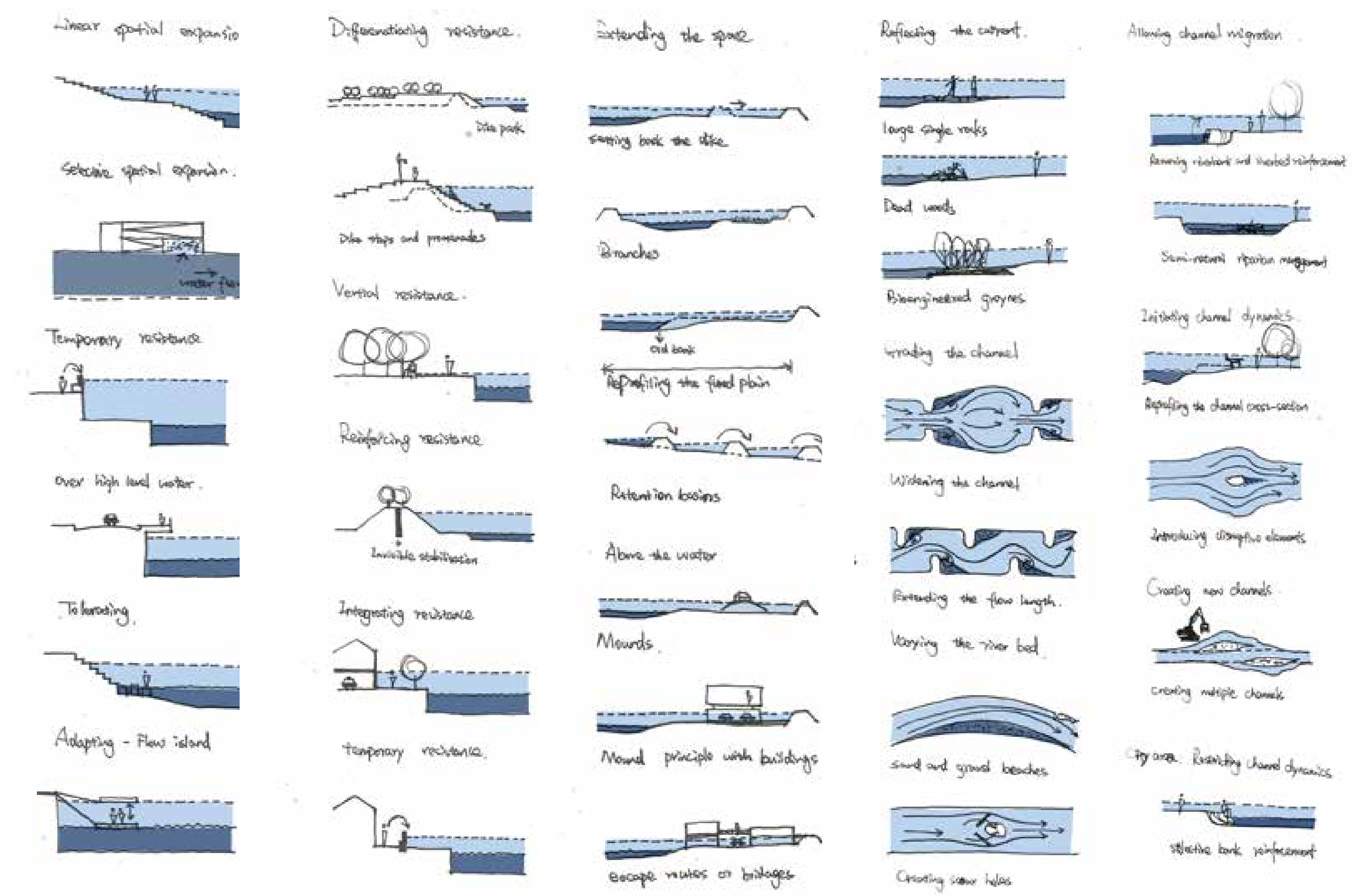


Figure 141.
Waterscapes design principles including flow fluctuations and morphodynamic processes

Figure 142.
Figure 143.
Impressions of the waterfront park.

Vera Konings

VIETNAM - CAN THO, HOW TO GROW?

FLOOD PROOF EXPANSION IN A RAPIDLY URBANIZING DELTA CITY

Year: 2012
Location: Can Tho, Mekong Delta, Vietnam

First mentor: Han Meyer
Second mentor: Steffen Nijhuis

The Mekong Delta in southern Vietnam is one of the world's most complex delta areas, facing two significant challenges. Not only is the area experiencing a rapid transition from a traditional to a modern, globalizing society, resulting in severe social, cultural and economic changes, the delta area is also vulnerable to an annual cycle of flooding and drought. The city Can Tho, located in the heart of the Mekong Delta, is a prime example of these challenges.

Looking at the historic spatial development of the area helps to understand the combined social, spatial and hydraulic issues. At the level of the Mekong Delta, human interventions have transformed the delta landscape from a water based network to a road based society. At the level of Can Tho city, the main challenge is the loss of rice fields due to the pressure of urbanization. The small levees between the fields have been transformed into roads, and paddies are being filled up with housing, as a result of which creeks and green spaces are disappearing. This has resulted in the loss of the cultural relation with the water and has increased the city's hydraulic problems.

This project proposes a sustainable urban growth strategy for Can Tho, allowing it to expand and develop economically. A gently sloping delta dike would surround the urban area. The dike would provide protection against flooding, improve the community's spatial quality, and restore the relation between city and river. The remaining rivers, creeks and rice field structure would form the framework for urban growth, supplying fresh water during the dry season and providing temporary water storage during heavy rainfall. Shifting from viewing water as a threat towards viewing water as an opportunity provides the basis for the sustainable expansion of cities in the Mekong Delta.

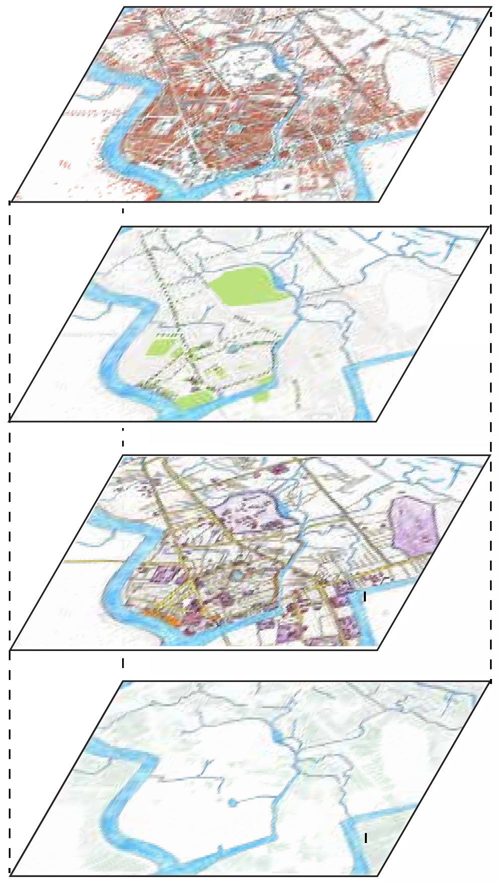


Figure 144.
(Left page)
Impression Can Tho, situation in 2012.

Figure 145.
(left) Layers of Can Tho (top to bottom): presenting: the urban area; green areas and water network; public and private areas; and landscape structure.

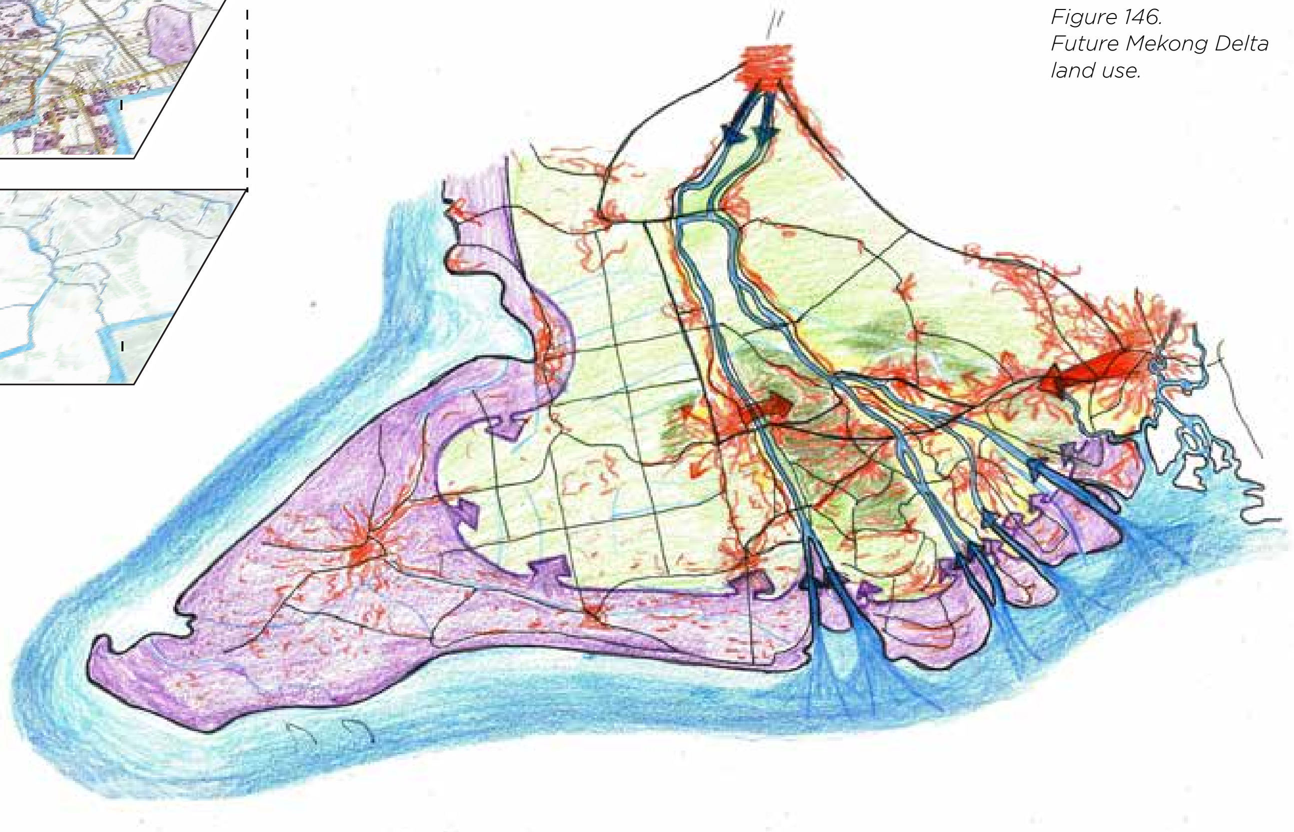


Figure 146.
Future Mekong Delta land use.

Figure 147.
Waterfront locations at normal (right image) and high (left limage) water levels.

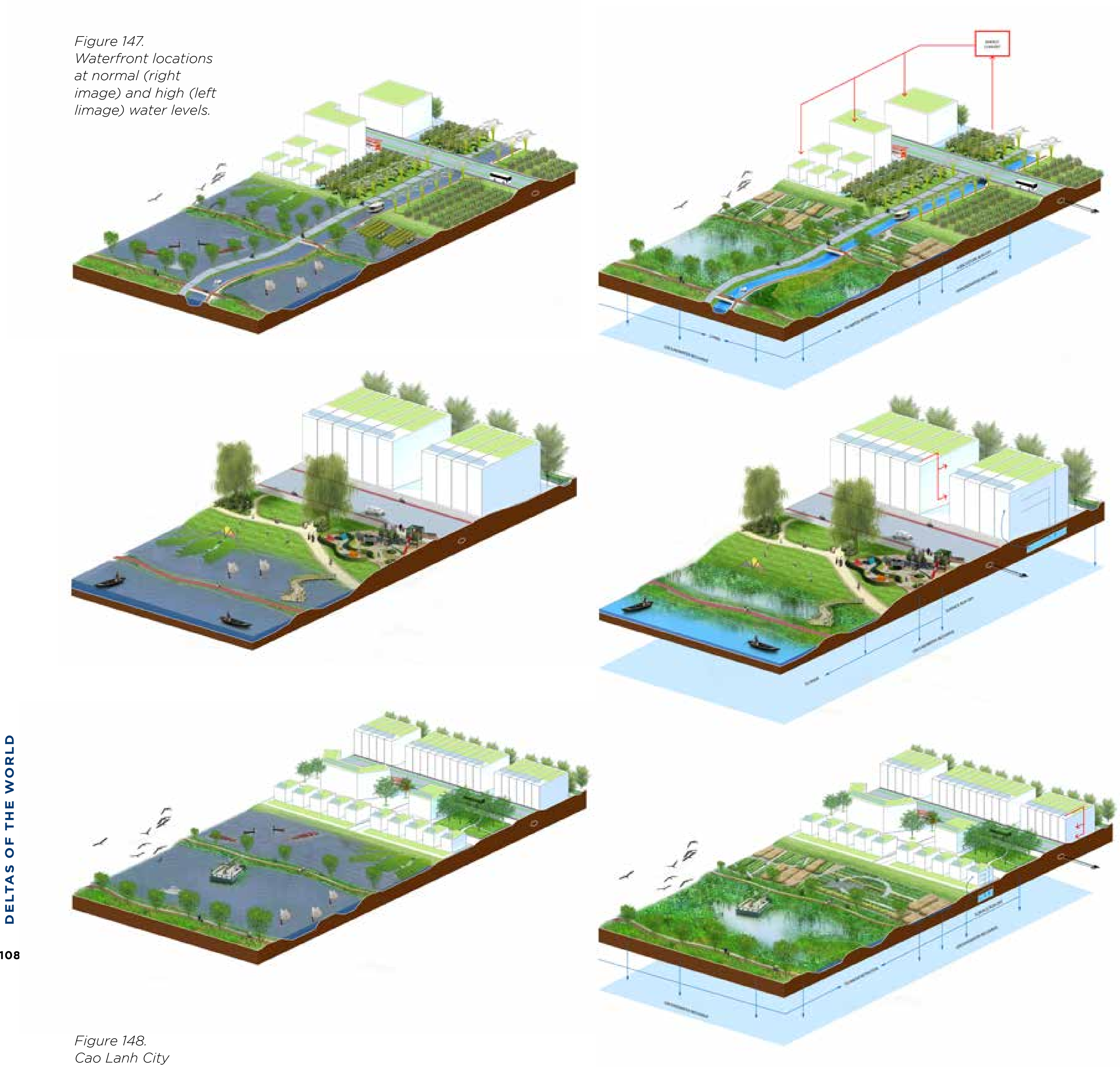


Figure 148.
Cao Lanh City district master plan until 2050.

Le Thu Trang

VIETNAM - FLOOD ADAPTIVE CITIES

TOWARDS CLIMATE CHANGE ADAPTION AND URBAN DEVELOPMENT

Year: 2013
Location: Cao Lanh, Mekong Delta, Vietnam

First mentor: Han Meyer
Second mentor: Steffen Nijhuis

The Mekong Delta in South Vietnam is by far the nation's most productive region. It occupies a large tropical wetland with many important functions: it provides forest commodities, regulates the water balance, conserves biodiversity, and offers tourism activities. For three hundred years, people in the Mekong Delta have generally adapted their lives to the presence of rivers and floods by different strategies, often called 'living with floods'. However, over the last decades, economic liberalization has led to new planning modes, permitting progressive land and water reclamation. Combined with the negative ecological impacts of urbanization and industrialization, this has significantly reduced the natural forests, wetlands and other natural habitats of the delta. Increasing economic assets and growing cities demand higher dikes, bigger flood defenses, more urban surfaces and fewer wetlands. In times of climate change, the current development planning in the Mekong Delta causes both environmental and social concerns.

This project aimed to answer the question: How can a new form of urban development for the Mekong Delta provide protection from flooding, improve both the environmental and the spatial quality, while also providing economic value for the inhabitants?

First, we investigated the complex system of Mekong Delta cities. Then, we answered the research step by step through a triple layer approach, analyzing the different layers at different scales. The three layers are the nature layer, the infrastructure layer and the urban layer. A historical analysis showed how the different layers of the Mekong Delta have developed and integrated over the past 300 years. The approach then shows the current state of the Mekong Delta, and how water should be dealt with in the future

This formed the basis for a planning strategy for cities in the Mekong Delta that applies the theory of Transit Oriented Development in combination with water management. This approach addresses three main issues:
- how cities and human settlements grow and adapt to flood events;
- how wetlands and waterways are preserved;
- how inhabitants benefit socially and economically.

This strategy promises to provide inhabitants a safe, compact and attractive living and working environment, one that is protected by high levees, connected by public transport, surrounded by a natural delta landscape, and which also provides diverse economic values.

This new approach to urban development could lead towards more sustainable development in the Mekong Delta. In big cities, such as Can Tho City and Cao Lanh City, it could solve existing problems of over-crowding, poor living conditions, and loss of the natural landscape. In suburban and rural areas, it could stop unintended urban sprawl by adding compact urban nodes with commercial activities, agricultural services, affordable housing, etc. Moreover, this strategy also ensures that urban development both respects the unique delta landscape and works within the concept, 'living with floods'.

Cities such as Cao Lanh City and Can Tho City urgently need fresh water storage and water purification systems that can help to provide fresh water in the dry season, and separate clean water from floodwater in the rainy season. Wetlands represent the main feature of the designed water system. Beneath the wetlands, an efficient water treatment system will ensure that reclaimed water is purified; above ground, it will create a balanced ecosystem, with flowers, aquatic plants, and fish.

The proposed water system is considered on three scales:
- Building scale: This considers the actual constructions for storing water, harvesting rain water, and recycling grey water.
- Urban scale: Bio-swales and green surfaces provide water runoff, and permeable paving reduces runoff. These elements are also intended to remove silt and pollution from surface runoff water in urban areas.
- Landscape: Water is reused for agriculture, purified in various natural systems, and wetlands are used to store rainwater and floodwater.

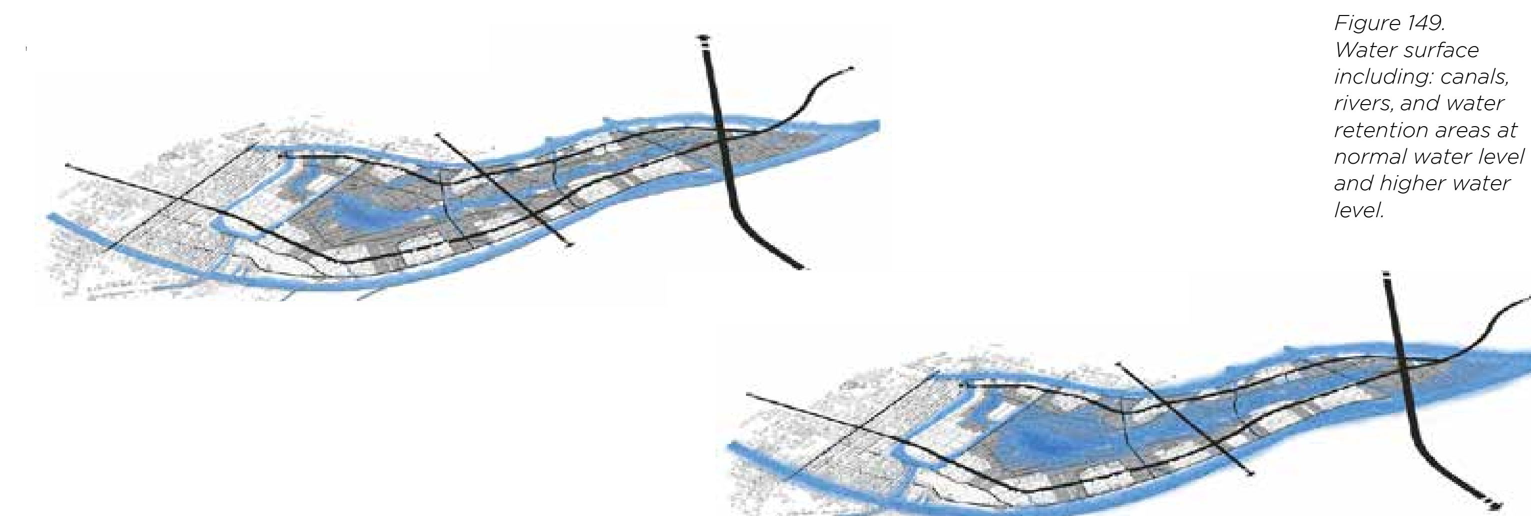


Figure 149.
Water surface including: canals, rivers, and water retention areas at normal water level and higher water level.

Jochem Hamoen

LONDON - WEST SILVERTOWN

DOCKLANDS LIGHT RAILWAY STATION ON LONDON'S FLOODPLAIN

Year: 2012
Location: London, United Kingdom.

First mentor: Anne Loes Nillesen
Second mentor: Jan van de Voort

Population growth and flooding of low-lying areas are two key urban challenges which the city of London faces. These two challenges are inevitably connected to each other, as is seen most prominently in the east of the city.

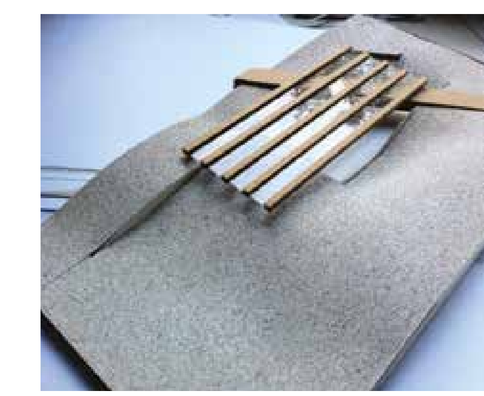
Silvertown is a strip of brownfield land between the Royal Docks and the River Thames. It is one of the most subsided and lowest-lying areas along the floodplain and is prone to both tidal and fluvial flooding. Silvertown is located in East London, an area where the largest population growth and densification is expected to occur in areas most at risk of flooding. Due to rising sea levels and increased precipitation, the Thames Barrier will offer insufficient protection from 2031 onwards, and a strategy for the area is urgently needed.

This project offers a show case of ways to deal with the dynamics of urban growth in relation to natural and ecological systems. The project is developed in three layers. At the base, a composition of wide and segmented levees with a variety of topographies takes advantage of the large tidal range, increasing the connection of the site with the river, while also offering improved protection of the hinterland.

In the middle, the elevated railway connects all the levees, acting as a raised backbone for pedestrians and cyclists. Finally, a set of high density buildings was developed to allow the permanent use of the floodplain. These three layers merge at the new West Silvertown station. This hub is spatially incorporated into the levees, is partly positioned on the flood plain, and uses water as a primary element.

Figure 150.
(left) Masterplan of the flood proof waterfront.

Figure 151.
(right) Model of the landscape entering under the roof of the station.



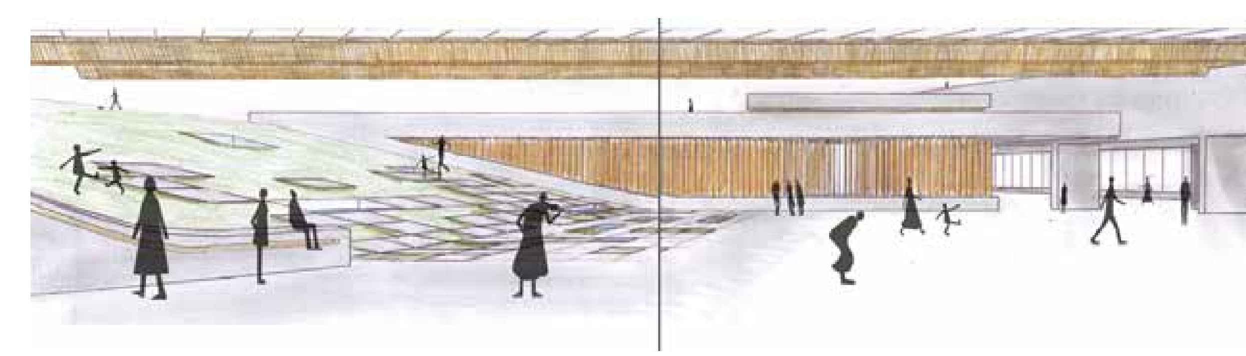


Figure 152.
(left) Interior view of the station, where landscape enters the building.

Figure 153.
(right) Interior view of the entrance, including roof construction.

Nienke de Korte

ARGENTINA - METROPOLIS MEETS WETLAND

This project stems from the problems of urbanization along the coastline of the Paraná Delta in Argentina. Rapid urban growth has severely reduced the coastal area of the delta, creating various ecological and hydraulic problems and challenges. In the project, we made an urban master plan and designed amphibious, self-supporting housing for a lower income community. The houses are amphibious so that they can float during flood events, in this way respecting the natural system. Clustering the amphibious houses around public spaces and a public building will create different communities.

The communities can easily grow by attaching more floating houses. Moreover, the owners can also easily expand their houses since these are specifically designed to be extended with prefab elements. The houses are made of recycled, or recyclable, local materials like bamboo and PET bottles.

Year: 2014
Location: Paraná Delta, Argentina

First mentor: Anneloes Nillesen
Second mentors:
Maarten Meijs
Diego Sepulveda Carmona

Figure 154.
(above right)
Community social housing built in clusters of four houses.

Figure 155.
(above left)
Interior-exterior connection.

Figure 156.
Impression of community.

Hamed Khosravi

IRAN - TEHRAN HAS A COAST

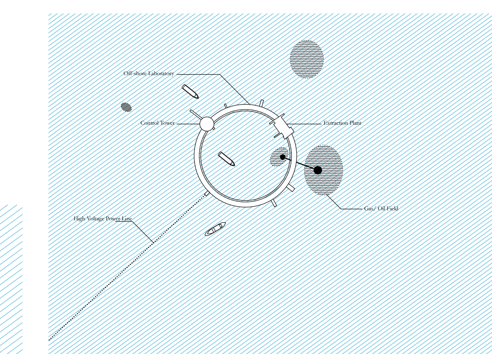
URBAN ARCHIPELAGO 2050

The construction of a new highway and a 120-km tunnel under the Alborz Mountains between Tehran and the Caspian Delta Region opens up opportunities to develop the Tehran-Caspian Delta as a new sustainable urban delta region. The highway and tunnel are expected to be finished in 2050 and will decrease the traveling time between Tehran and the Caspian Sea to 90 minutes. We hypothesize that, in 2050, this will trigger a move of Tehran's population to the Caspian Delta Region.

This project identifies a series of islands in the Caspian Delta region to serve as new urban centers; in addition, it proposes reclaiming land in shallow areas of the Caspian Sea (less than 10 meters deep). This will in fact create an archipelago. This archipelago is a modular form, which can be repeated, forming a growing hierarchical system; the basic form is shaped like Tri-Wing Island, with a center and three linear urban districts, each one containing a park and a harbor. The urban clusters can be linked to an energy production plant, probably a wind farm, and an agriculture island, thus forming an integrated, sustainable urban system. The access network can be extended by linking each new island at the end of the wing.

Year: 2010
Location: Tehran, Iran

Mentors:
Paola Viganò
Daan Zandbelt



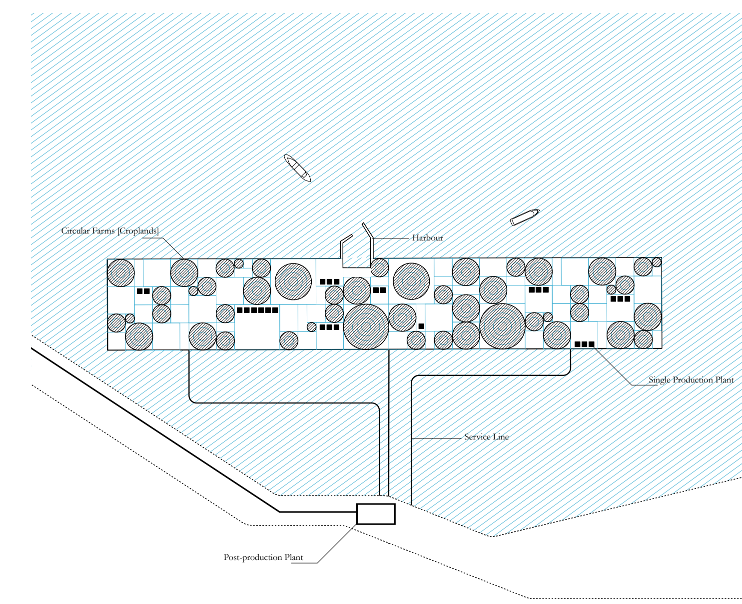


Figure 157.
(right) Agricultural cluster with circular farms (cropland), harbor, post-production plant, main service/product access, and single service plant.

Figure 158.
(top far right)
Off-shore lab with super high way connection, control tower, laboratory, extraction plant, and gas/oil field.

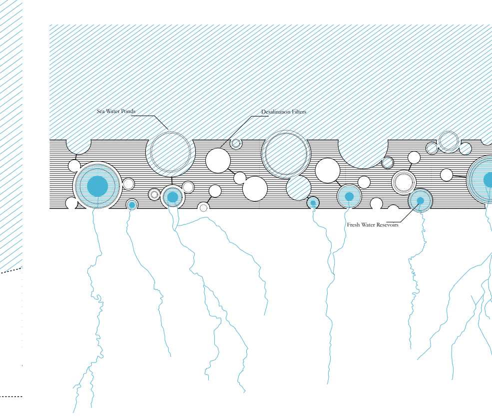


Figure 159.
(bottom far right)
Sea water ponds, desalination filters, and fresh water pools.

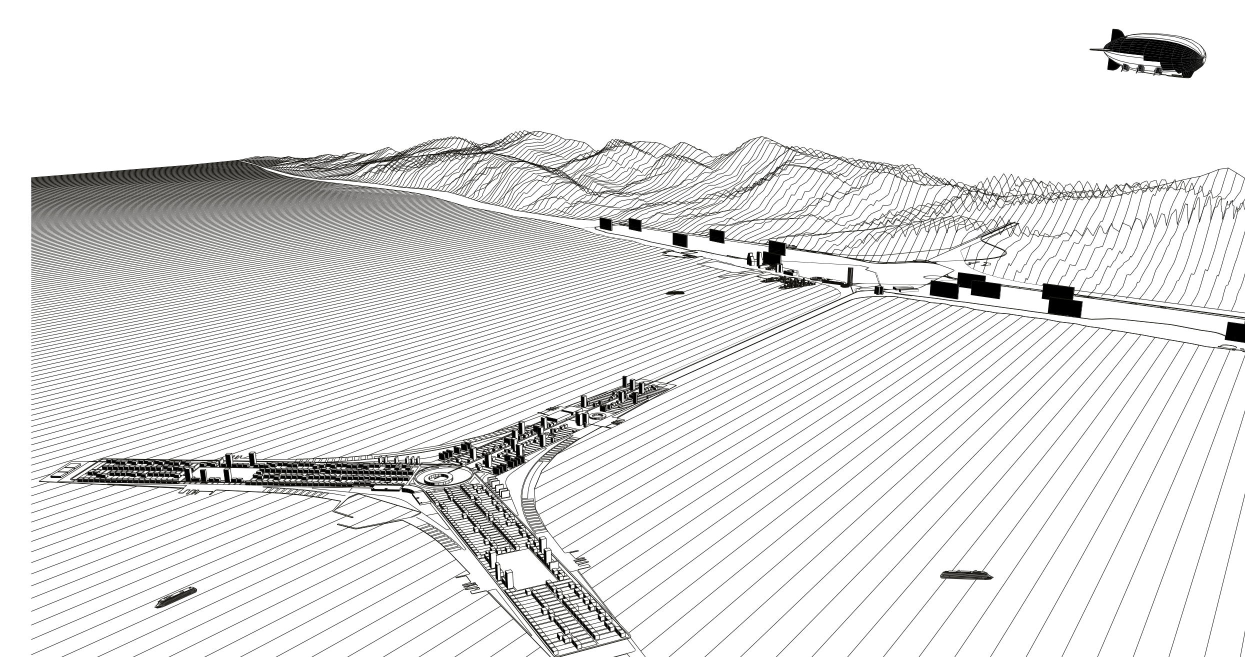
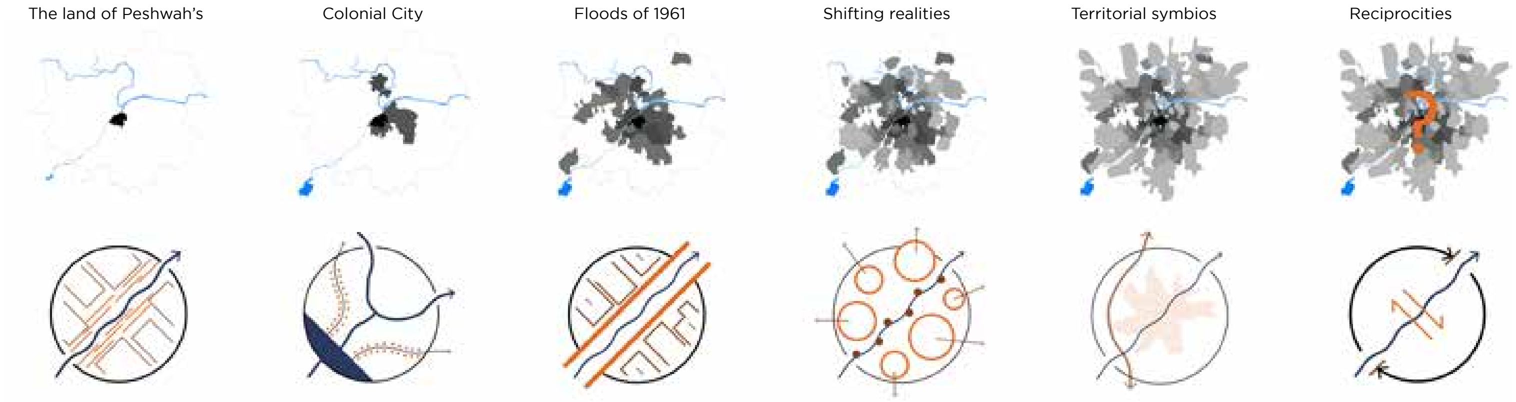


Figure 160.
View from island to coast; the narrow '90min delta' has stretched through the mountains to the sea.

History of urban water development



Postulations

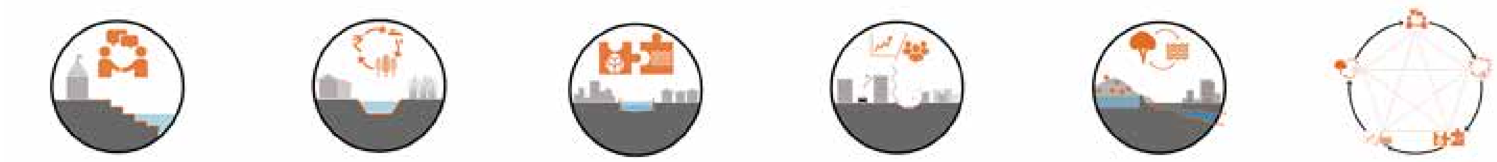
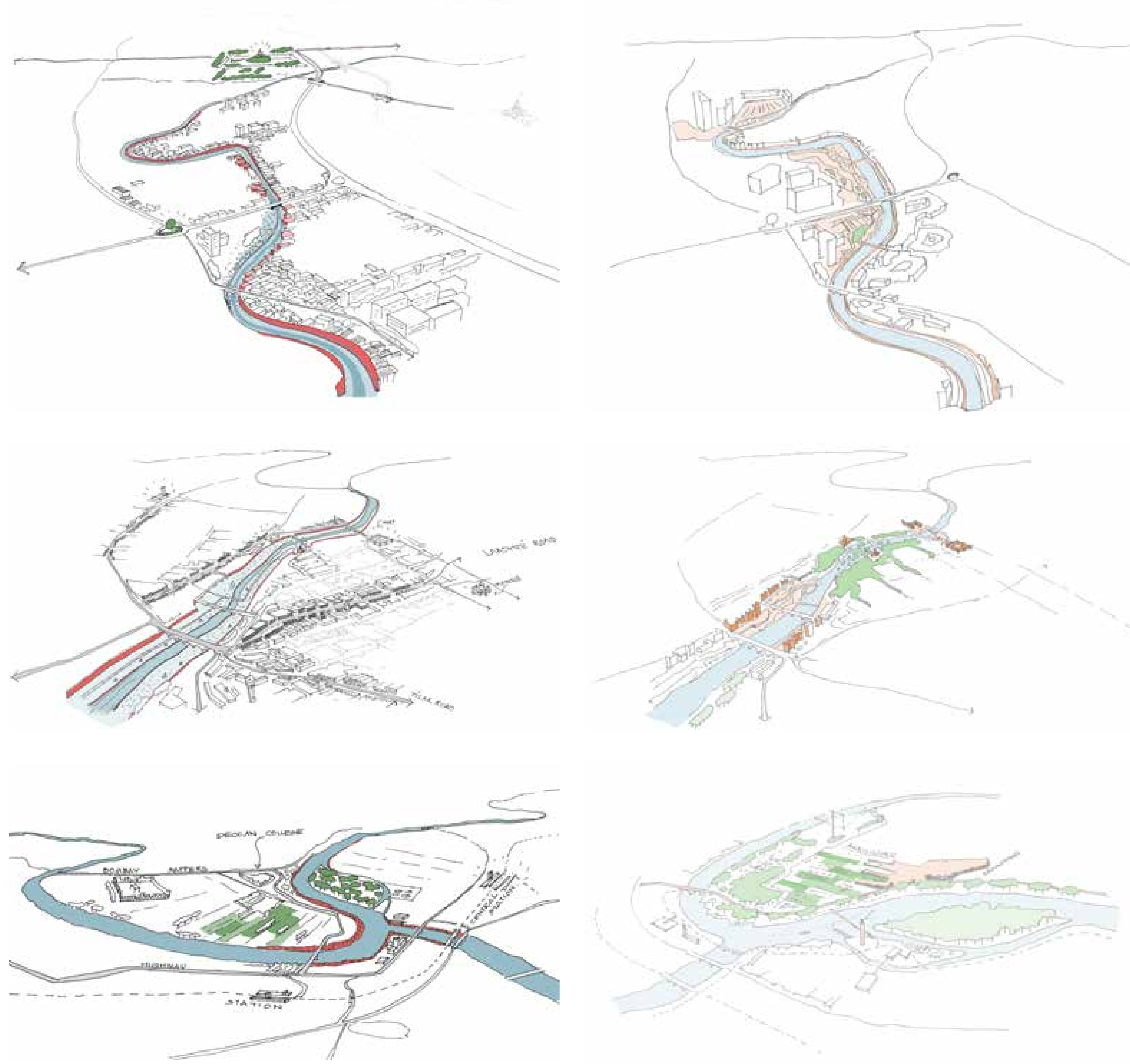


Figure 161. (above) History of urban water development and postulations.

Figure 162. (below) Problematic water front edges in red; and proposed design.



Aditya Deshmukh

LIVING ON THE EDGE

WATER AND THE CITY OF PUNE

Year: 2014
Location: Pune, India

Mentors:
Daan Zandbelt
Stephen Read
Bernardo Secchi
Kelly Shannon
Isabel Castiñeira

The city of Pune in India faces many challenges due to rapid urbanization and population growth. A dynamic balance between the city and nature is urgently needed. As a key element of nature, water plays a major role in this balance. Traditionally, in the Indian context, water was viewed as the source of life and the keystone of the urban environment. However, this important role has been seriously neglected. Which urban processes are responsible for this change?

To understand this, we investigated the historical changing context of water in the city of Pune. This not only highlighted the changing relation of the city with water, but also helped define the problem by comparing the situation over time. We reviewed each major historical period, considering the major transformations that occurred in the city under different political rules. This permitted us to highlight the dominant spatial character of each period, and allowed us to answer our research question, which formed the basis for subsequent analysis and the basis for our design proposals.

By combining lessons learnt from the past with the conflicts occurring at present, we can build for a resilient future. To mitigate the conflict between city and nature, we focus on the reciprocities between Community, Economy, and Ecology. Three design case studies allowed us to test the strategy, addressing the problem not only on three different scales, but also with three different approaches. The first case study is the informal settlement along the Ambil stream: here, vacant underused spaces along the stream will be re-activated by engaging the community. The second case is the riverfront along the historic city center: three different zones are programmed to be developed in a private-public partnership. Finally, the third case considers the confluence of two rivers: using a top-down approach, the existing green areas will be protected from further urban expansion by a combination of regulations and laws.

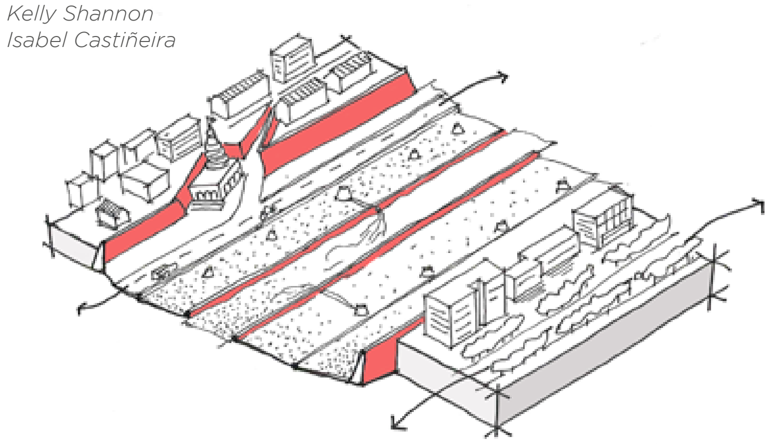
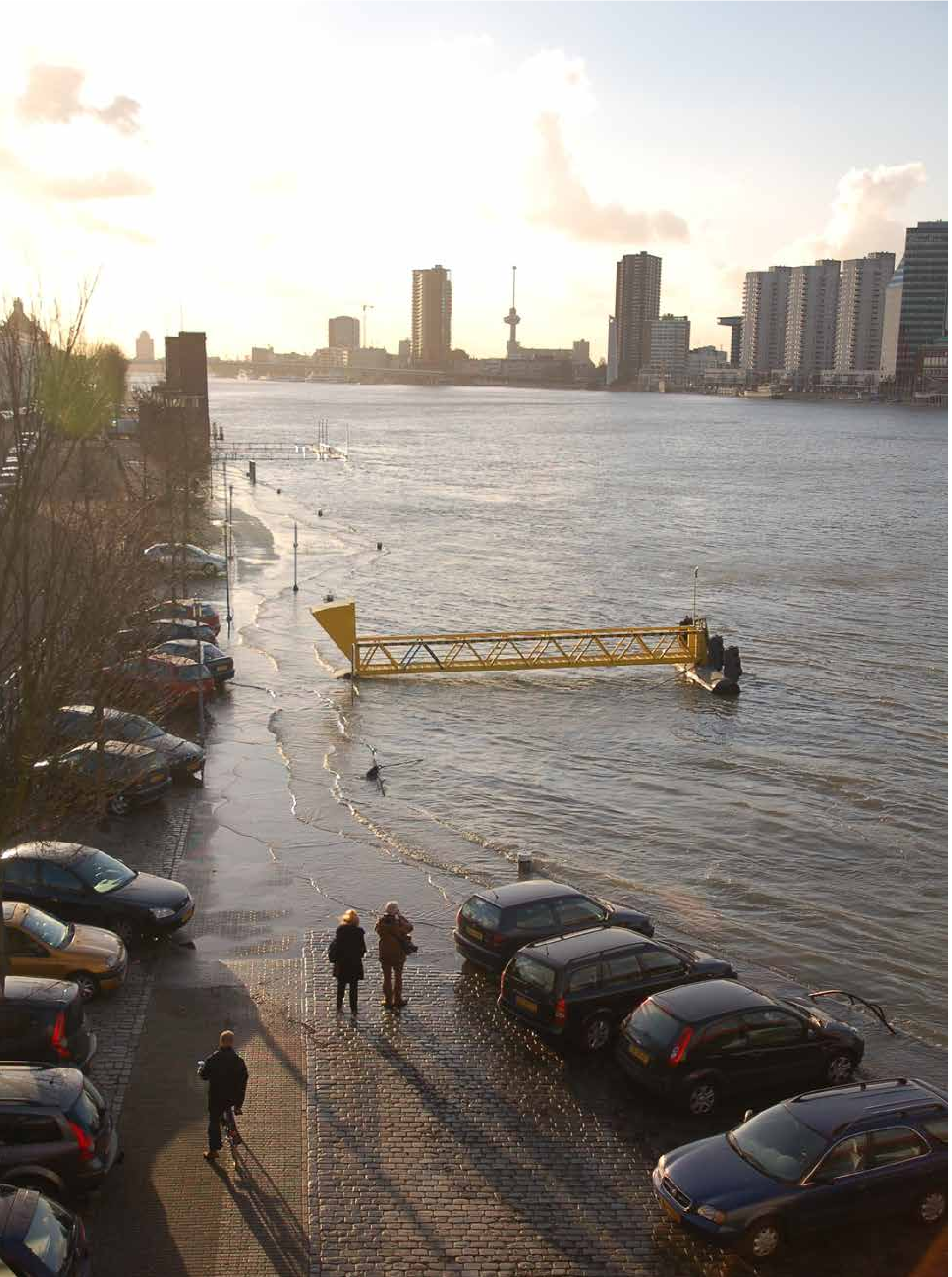


Figure 163. (above) The flood walls (in red) restrict the interaction with water, and between the old and new parts of the city.

Figure 164. (right) Reconstruction of one of the first settlements, with the fort next to the stream.

Figure 165. (bottom left) Original flow of Ambil stream with temples, gardens and a fort along its edge.

Figure 166. (bottom right) Diversion of the stream, leading to densification of the built area.



Anne Loes Nillesen

ASPECTS OF WATER RELATED DESIGN

REFLECTION

Water - specifically designing with water - is the guiding theme of the Delta Interventions studio. When designing with water (as with any other guiding principle), it is essential to understand its behavior and characteristics, and how they can influence the design. Only with a good understanding of water is it possible to make smart integrated designs.

For instance, when designing along flood plains in densely built areas, it might be appealing to use the flood plain in a multifunctional way. To do so, it is essential to know what water levels are typically expected in a given season, as well as the characteristics of the flood water: Is it salt water, is it polluted, will it destroy vegetation? How long will does water typically remain in the flood plain - hours, days or months? Is there sufficient water and flow to carry logs, vessels or silt? All these aspects are important conditions for the design.

The Delta Interventions studio attempts to introduce students to the wide range of characteristics of the water research-by-design. To do so, they are given an introductory exercise that demonstrates the influence water can have on a design.

As part of the exercise, students are first asked to select a built design as a reference project. This can be a building, an urban region, a landscape, or an infrastructural work that is associated with water. The students analyze the design, considering the functional, esthetic and technical relations it has to the water in the environment.

Second, the students identify the different water types in the case they have chosen. For instance, in the Dutch Rhine Scheldt Delta there is a big difference in characteristics between the three types of water: the sea is deep, composed of salt water, and can experience a major surge during storms; the rivers have fresh water, but sometimes experience considerable seasonal fluctuation in water levels and flow; and inland polder lakes have fresh water, and are generally shallow with a controlled water level.

Finally, we ask students to relocate the reference project to areas with the different water types. By applying research-by-design, they investigate and demonstrate how this changed context would influence the functional, esthetic and technical aspects of the design.

Relocating the building can give it a different function. For instance, the accessibility may be limited during certain seasons. Or, at the new location, the building's material may change so that the different water levels leave visible traces on the building shell; in other cases, buildings may be designed so that the water does not leave traces after flooding a public space.

This extended exercise has been very successful in guiding students to explore and unravel the wide range of potential relations between the water and the design. As a result, students have produced more challenging and integrated projects.

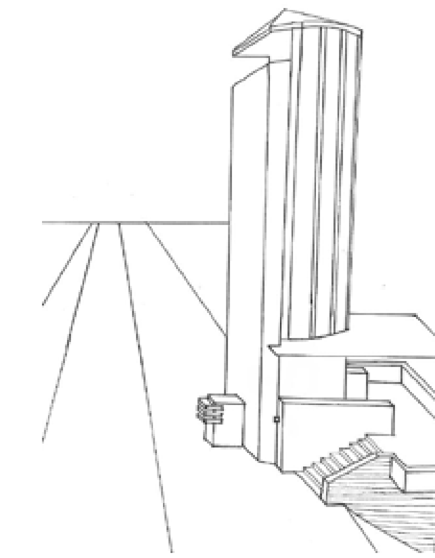


Figure 167. Studio exercise: Sketch of the Dudok monument at the Closure Dike (Afsluitdijk), The Netherlands.

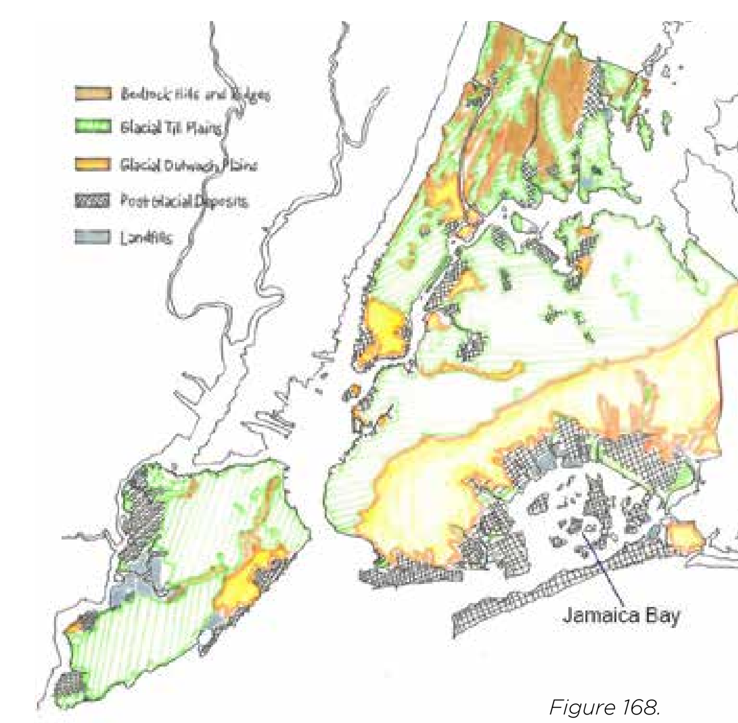


Figure 168. Studio exercise: Analysis map of flood risk in New York, USA.

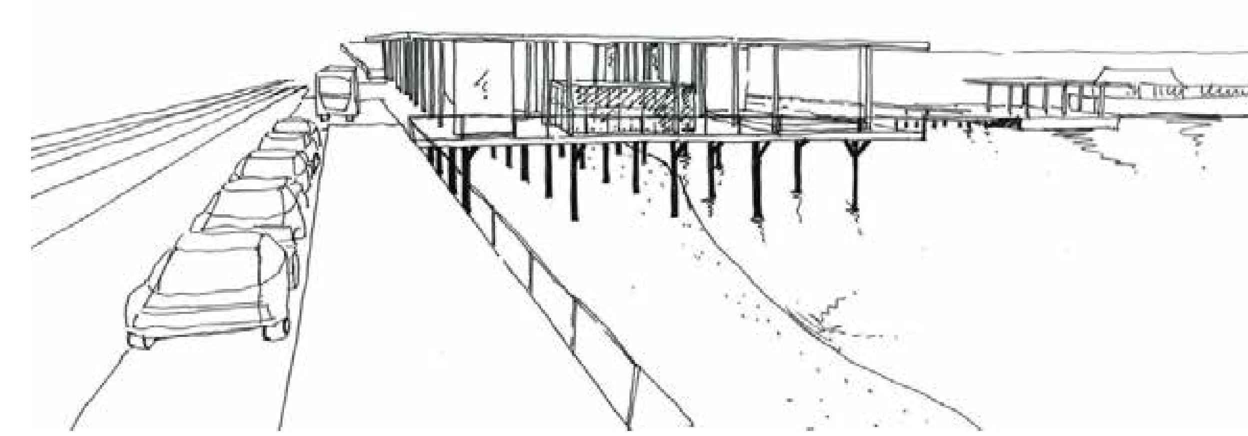


Figure 169. Studio exercise: Sketch of ferry terminal on Naoshima Island, Japan repositioned in Houston Galveston Bay Region.

Han Meyer

THE OPEN DELTA CITY: DESIGNING WITH DIFFERENT DYNAMICS

REFLECTION

In his lecture 'The Open City', Richard Sennett (2006) pleads for an approach in urban design and planning which creates conditions for an evolutionary city. In his view, the current generation of designers and planners is still too focused on the city as a closed system. As a result, many cities become frozen entities, unable to cope with social, economic and physical changes, inducing problems of economic and social stagnation and destruction. Sennett argues that we must regard the city as an open system, which can deal with change and uncertainty and which is able to adapt to unforeseen new circumstances.

This plea is relevant for any city, but it is extremely relevant for delta cities. Deltas have been considered attractive urban locations for centuries, because of the splendid conditions for different economic activities: agriculture, fishing, trade, navigation and port development. In many countries, delta cities are not only flourishing cities but also the national economic engines and the cities with the most dynamic social and cultural life. Delta cities welcome more than goods and money; they are marked by people arriving, leaving, passing or staying, and leaving their imprints on the life in the city. This quality of the delta city, its capacity to deal with permanent economic and social change and evolution, can only be maintained if the city truly functions as an open system.

At the same time, the delta city should be able to deal with the dynamics of the delta itself as a natural environment, defined by the influence of currents, waves, winds, tides and sediment transports from the sea as well as from the rivers. Because of this dynamic character, the natural environment of a delta is an extremely open system, constantly changing and taking different forms. If you make an overview of an evolving delta landscape, with one picture taken at the same spot every hundred years, you will get a movie of a slowly but substantially changing landscape. Currently, accelerating climate change and rising sea levels represent additional factors of change in delta regions.

This means that a delta city has to deal with two different dynamics, one related to environmental processes, the other to societal processes. These dynamics become very complex when they are interwoven with each other, and in deltas they are interwoven. Both environmental and social dynamics have their own rhythms and speed, simultaneously influencing each other and dependent on each other.

Urbanized delta areas require particular attention not only because of climate change and rising sea levels, but because of the speed with which delta cities are growing and expanding. In order to be able to deal with the societal dynamics driving urbanization, as well as with the natural dynamics driving changing environmental conditions, it is necessary for designers and planners to study, understand, estimate and interpret the different dynamics of the delta city. This conclusion was already made by the American landscape architect Ian McHarg in the 1960s. He emphasized the importance of understanding the differences in the speed of change of the landscape versus the speed of change in urban patterns and infrastructure networks. His observation was that systems with a low speed of change (i.e., environmental systems) should be considered the most important in the long term, needing enough space for their low but very substantial dynamics.

When the evolutionary process of change of these systems gets frustrated, for instance by uncontrolled urbanization, serious disasters like floods will be the consequence. McHarg's book 'Design with Nature' (1969) is a plea for taking the fundamental processes of the natural environment as a basis for urban design and planning. As a matter of fact, the process of the formation of the delta landscape, the making of networks of infrastructures and the process of urbanization can be considered as different processes which can be visualized in different series of maps. Studying important historic stages in these different processes, analysing how these layers relate to and influence each other, and developing hypotheses and theories on the important issues in the evolution of the urban delta has become known as the 'layer approach'.

For the new generation of urban designers and planners, as well as for the new generation of civil engineers and policy makers, it is extremely important to be familiar with the complex dynamics of urbanizing deltas. They need to be able to create the conditions for future delta cities to function as open systems, systems which are prepared to deal with the uncertainties in climate change as well as the uncertainties in future societal developments and related claims on land use.

'Building with Nature' and 'Working with Water' are slogans which fit this approach, not only understanding natural processes and paying attention to them, but also considering natural processes as forces which can contribute to a new way of designing, engineering and building the urban delta landscape. To date, several experiments have implemented this approach, like the 'sand engine' at the coast of South Holland. Projects like these can be regarded as experiments in making a new type of coastal or deltaic landscape as such.

An interesting additional aspect of several projects in this book is that students made serious attempts to elaborate this concept of building with nature to create a new type of urban landscape. The discovery of the possibility of designing new patterns for urbanization in the delta landscape by applying a 'layer approach' and 'building with nature' is one of the most exciting results of the Delta Interventions Studio.

Frits Palmboom

RESEARCH, DESIGN, *MAKING* SOMETHING

REFLECTION

Urban design in the context of delta landscapes is quite a challenge. By nature, deltas are highly dynamic environments. Despite all the risks they pose to people, over many centuries they have provided favorable conditions for intensive agriculture and human habitation. Always heavily used, in our time deltas throughout the world are coming under huge pressure from urbanization - while also facing all the threats and consequences of impending climate change.

More than ever before, the creative disciplines will have to consider the factors time and uncertainty in their approach to deltas, to learn to think in terms of strategies rather than simply of spatial solutions. This is the type of mindset we wish to foster among our students at the Delta Interventions Studio, where we help them to develop the skills necessary to think along these lines.

In this context, design is increasingly being viewed as a form of research. That is, as a tool to be used when conceiving 'potential futures', in the investigation of intervention-effect relationships and in the development of more widely applicable instruments and tools.

However, designers should look beyond their own research as well. They need to explore possibilities and develop practical tools. They face the challenge of translating spatial interventions into physical forms and structures, in a manner appropriate to a specific time and place, and of creating a consistent composition which retains some degree of familiarity and comprehensibility while offering enough novelty and originality to attract attention and involvement. Rarely does their task end with the developing of tools - the real test lies in the practical application of those tools to actually *produce something* with such strong inherent value that we forget its back story: the issue it was intended to address, the process of its design, the tools and techniques used in its construction.

Space as a medium
The tasks assigned to spatial planners and urban designers are usually formulated in terms of policy goals, key figures, densities and cash sums. The solutions they come up with are used and manifest themselves in *space.* This has huge implications. Space is not a neutral medium. It has its own realm, its own idiom, its own agency, and evokes its own appreciation. One has to learn to 'read' it: to recognize, to depict, to describe, to conceptualize and to use its intrinsic qualities, its dimensions, forms, structures, patterns and proportions.

Space can also be *celebrated*. Spatial quality and appeal are powerful means to realize broader objectives such as urban regeneration, but ultimately space also represents a *value in itself*. A designer should embrace this, like a craftsman with 'the desire to do a job well for its own sake' (Sennett, 2008).

A designerly way of thinking
Of course, space does not exist in isolation. In deltaic landscapes, in particular, spatial forms result from countless interwoven natural and human processes, and they are in a constant state of flux. At certain moments, however, these processes will solidify into more or less fixed forms or artifacts, which tend to lead a life of their own. Many of these outlast human lifetimes, and directly or indirectly influence other concurrent or future processes. The traces they leave in the landscape form a narrative in space that we need to learn to understand as thoroughly as possible before adding new chapters of spatial interventions.

The designer has to constantly move between the languages of words and images. He or she is continually switching from one medium to the next. And those switches are nothing like the one-way traffic – from words to images, from figures to maps, from problem statements to spatial solutions – that dominates the discourse-driven, formula-dominated scientific world of the technical university. Rather, they represent a never-ending movement in *both* directions. In recent decades, reflection upon this 'designerly' way of thinking has emerged as an academic discipline in its own right. Essentially, the design process asks for a 'co-evolution of solution and problem spaces' (Cross, 2001). Cross and others state that, analysis and synthesis occur simultaneously in design processes. For designers, the evaluation of potential solutions is often more important than the analysis of the problem itself. From the very beginning of the process, their focus is on *reframing the problem* in the context of potential solutions (Schon, 1984).

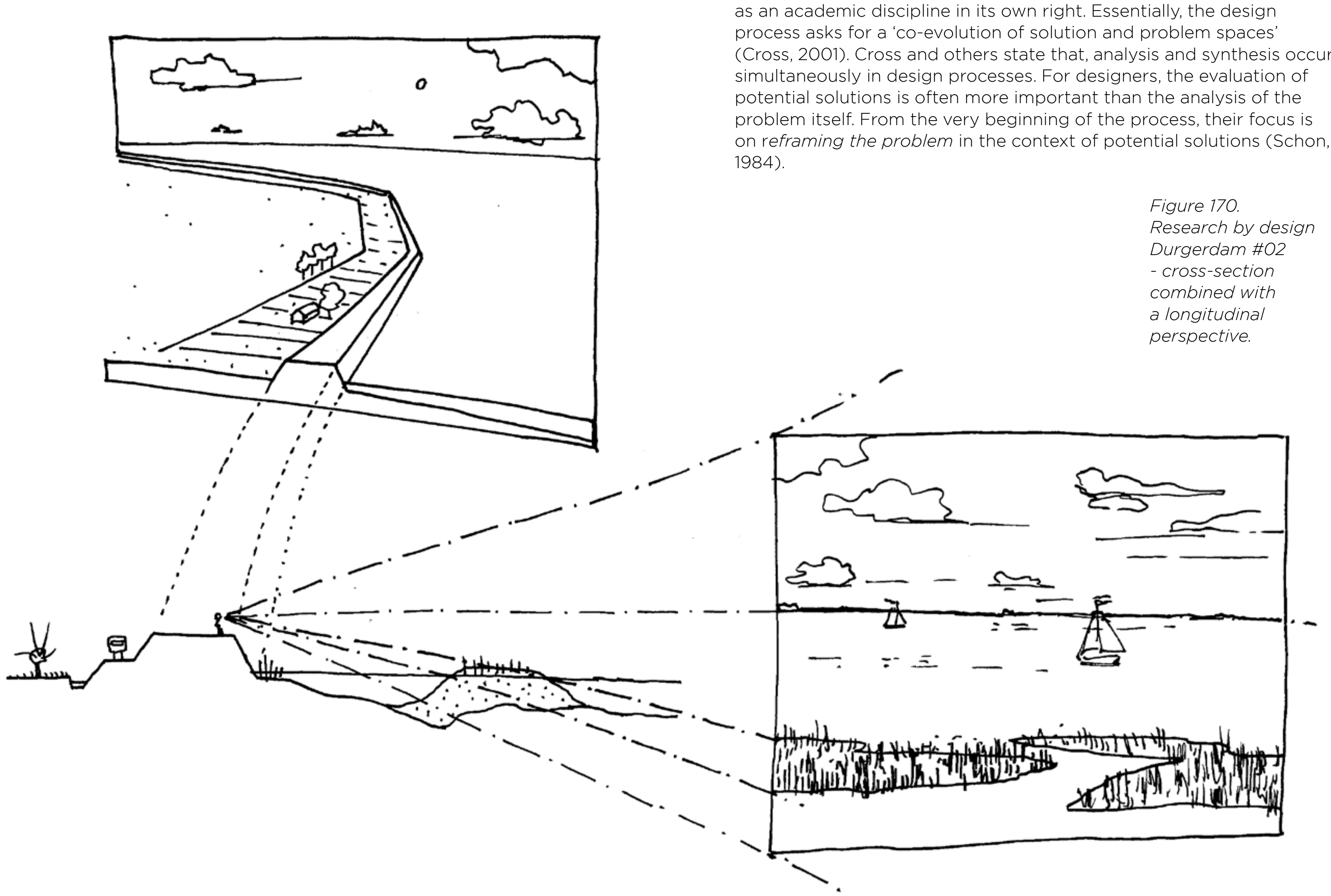


Figure 170. Research by design Durgerdam #02 - cross-section combined with a longitudinal perspective.

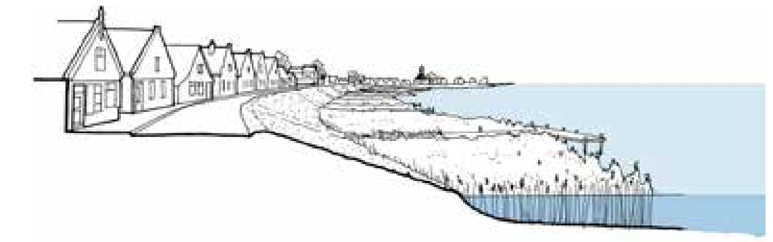


Figure 171. Research-by-design: Durgerdam #01 - spatial section of the boundaries between land and water:

Drawing
To be able to move back and forth effortlessly between abstract problem and spatial solution, drawing qualities are vitally important. As a means of grasping the intrinsic qualities of space, drawing should not be regarded merely as a technique used to express solidified ideas but rather as a way of investigating and conceptualizing spatial phenomena. In this respect, too, delta landscapes present designers with unique challenges. What makes these environments so fascinating is not just their ability to change over time, but also the fact that they combine extreme spatial elements all in one place.

Delta landscapes are characterized by the entanglement of land with water. They are interfaces where the solid meets the fluid, the tactile the endless, the defined the undefined. The delta landscape attracts the eye, but also eludes it. The great expanse and openness of the IJsselmeer region make it hard to discern an overall spatial form, never mind capturing it on paper, and yet much value can be attributed to those very features. Interventions like coastal reinforcement, dyke raising, new shorelines and construction of wind turbines are always controversial, unleashing fierce debate. The art of drawing and visualizing these landscape features can help clarify the situation, contextualize it, and help make a better informed discussion.

Space and place
Rather than an open sea, a vast expanse of water, the IJsselmeer is a 'tamed' inland sea hemmed in by stretches of coastline, headlands and landmarks that constantly loom into view, then disappear again. The value of its open character comes not from total nothingness, not from an 'absence of everything', but from the relative experience of space it provides: the aesthetic of 'almost nothing'.

The way in which we humans experience space is ambiguous. We are torn between two extremes. On the one hand we perceive it in terms of its confines, just as we 'perceive' a room by virtue of its walls: bounded, enclosed, well-defined, manageable and more or less safe. This is the experience of space as 'room' or 'place' (or the German *Raum*). But at the other end of the scale we find unbounded space: endless, abstract and, in its indefinability, potentially threatening. Here, space is synonymous with 'infinity (or the French *espace*).

The relative safety of the manageable 'place' evokes images of the mundane and the picturesque, while we associate the experience of 'infinite' space with the exceptional and the sublime. It is from the combination of the two, the picturesque plus the sublime, that the IJsselmeer region – like many other delta landscapes – derives its aesthetic appeal.

The concepts described here are deeply rooted in the design-driven disciplines architecture, urban planning and landscape architecture, and are constantly being reinvented. Their professional history offers a wealth of examples of how practitioners have approached the relationship between intimacy and vastness.

Seeing, Drawing, Flying
The experience of 'almost nothing' also puts the art of drawing to the test. How do you capture on paper the relationships between the bounded and the unbounded, the defined and the undefined?

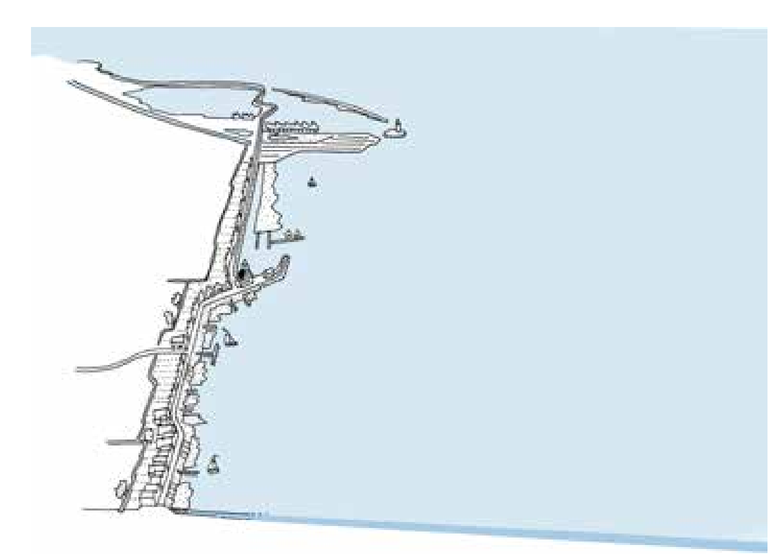
To address this challenge, we offer two support courses alongside the graduation studio. For students of Urban Planning and Landscape Architecture there is 'Seeing, Drawing, Flying', an exercise in viewing, thinking and draftsmanship. This begins with the physical measurement and drawing of a spatial section of the boundaries between land and water: a quay, levee or shoreline (see Figure 171). The surveyed cross-section is then combined with a longitudinal perspective (see Figure 170). By cycling along the boundaries, students gather the data needed to compile a bird's-eye view (see Figure 172). In turn, this material can be combined with cartographic information to 'zoom out' even further (see Figure 173). The student is thus challenged, encouraged and trained to understand, through drawing, the relationships between proximity and distance and between the view on the ground and its representation on the map. The course also reveals how the succession of bays and headlands unfolds along a coastline, and how introverted 'places' alternate with extroverted 'spaces'.

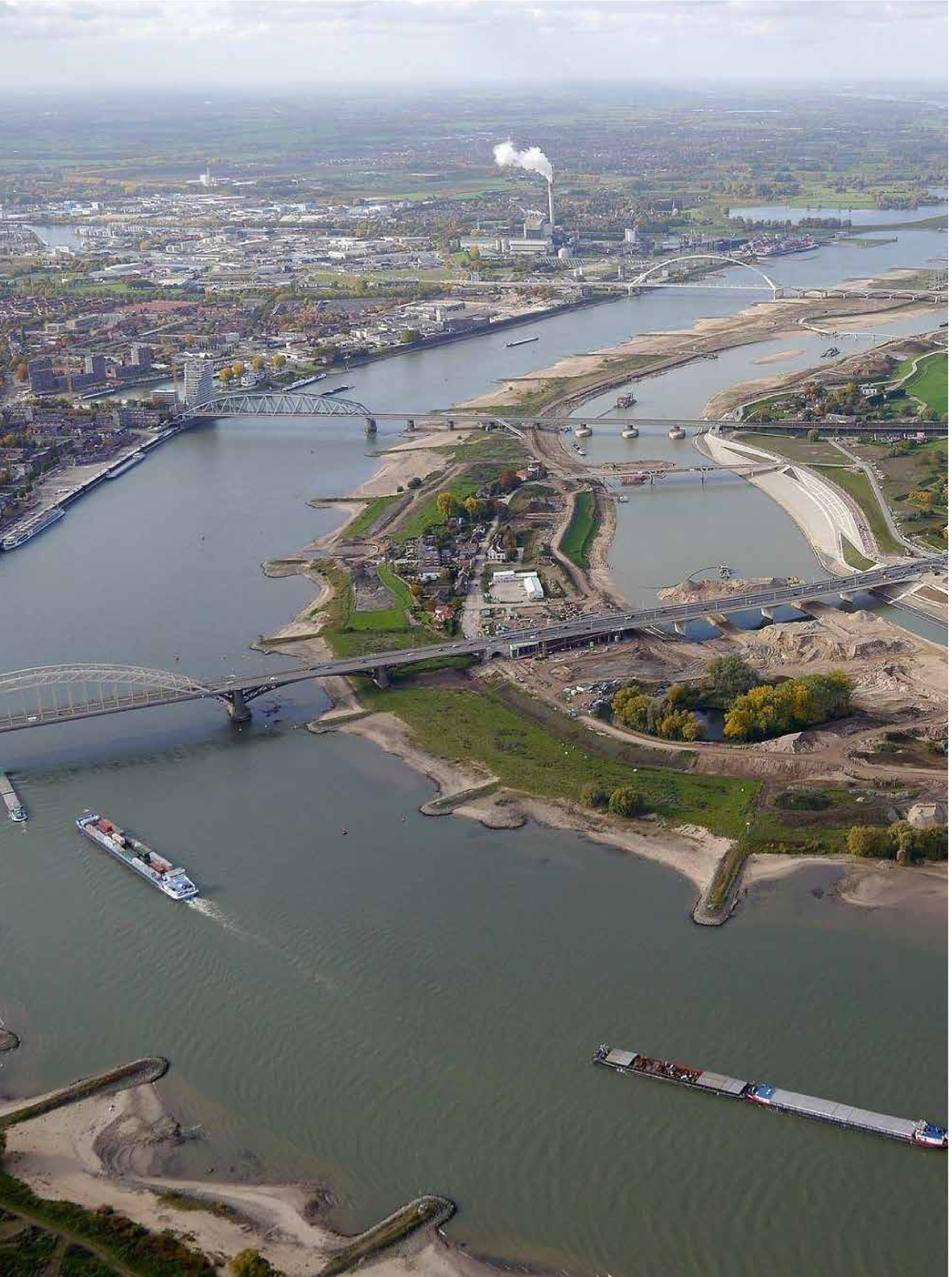
Architecture and the Sea
For Architecture students, we offer the course 'Aspects of Water-Related Design', also known as 'Architecture and the Sea – Making Place, Facing Infinity'. While students of Urban Planning tend to limit their scope to abstract scenarios and strategies, their architectural counterparts like to go directly to the comprehensible scale of the built object – in the process losing sight of the broader context. For them, then, the challenge lies in relating a project on a manageable scale to the vast expanse of the delta.

To this end, we have taken a series of sketches by Le Corbusier as our inspiration. The students are encouraged to produce something similar, starting with the elementary 'space' of a horizon with an icon, before moving down through landscape (picturesque, with depth, a foreground and a background) to an interior 'place' (*localiser le fauteuil,* 'framing the view'). They are also asked to sketch the approach to the building (a *promenade architecturale*) and to analyze the cross-section showing where land, water and building meet. This encourages them, through drawing, to understand the relationships between exterior and interior, between proximity and distance, and between the view on the ground and its representation on the map.

Figure 172. (below left) Research-by-design Durgerdam #03 - bird's eye view.

Figure 173. (below right) Research-by-design Durgerdam #04 - carthograpic overview.





Mark Voorendt

DIALOGUE HYDRAULIC ENGINEERING AND SPATIAL DESIGN

REFLECTION

In practice, the disciplines of landscape architecture/urbanism and hydraulic engineering have become more specialized during the last decades, gradually growing apart. The gap between governance and ecology seems to have become even larger. This leads to discussions about who should take the lead in a design; and, if the design approach is not fully integrated, this can lead to sub-optimal systems. This could lead to less societal acceptance of the solution, as well as to inefficient use of financial resources.

Recent initiatives at the Delft University of Technology aim to bridge this gap. Various research programs aggregate multiple disciplines, like the national and international research programs on multifunctional flood defenses, the Sand Engine, and the BE-Safe program, which investigates methods to assess the contribution of vegetated foreshores to reduced flood risk.

We also encourage students from different backgrounds to work together. The new BSc-minor Integrated design of infrastructures is a good example; another is the involvement of architecture and spatial planning students in fieldwork on coastal engineering. Ecology has become integrated into various MSc engineering courses, such as *Ports & inland waterways* and *Coastal engineering*. In 2015 a massive open online course (MOOC) *Building with Nature* was started. However, one initiative preceded all of this: The inter-faculty Delta Interventions graduate studio already started in 2008 (under the name Climate Adaptation Lab).

Delta 'interventions' refers to changes in natural processes that take place in deltaic areas. Hydraulic engineering aims to formulate and resolve water-related problems in order to contribute to the wellbeing of people living, working and recreating in these areas. More specifically, it deals with societal needs like protection against flooding and droughts, regulating water for agriculture and industry, and providing infrastructure for safe and efficient waterways and ports. In addition, hydraulic engineering considers structures that exploit water and offshore wind power for the production of electricity.

Increased prosperity has contributed to the awareness that a healthy, attractive and sustainable natural environment is of major importance for a livable delta. The Department of Hydraulic Engineering of Delft University of Technology therefore encourages a modern, integrated strategy which considers more than just engineering, where economic aspects, the development of nature, and the multifunctional use of space all play important roles.

Hydraulic engineering combines scientific knowledge with practical experience to design and implement interventions in the natural environment, with the ultimate goal of enhancing prosperity. To design functional, acceptable and affordable solutions, engineers need specialized knowledge about various systems and processes. In addition, they need to ask the right questions: why? (the hydraulic background and problems), what? (solutions to the hydraulic engineering problems), and how? (implementing the solutions).

A good mix of science, technology and design is a pre-condition for successful results. The relevant disciplines must work together in a design team in order to solve the societal, the engineering, and the spatial problems in urbanized deltas.

The Netherlands has a long tradition of intervening in natural processes. This has offered the opportunity to develop new insights and knowledge, resulting in improvements of designed structures and systems. For instance, it has led to the insight that a consistent and strict hierarchy can help to manage and develop landscapes, enhancing the design process and increasing its effectiveness.

Landscape architect Dirk Sijmons distinguishes three layers in spatial design (Sijmons & Venema 1998):
1. Hydraulic engineering and water management;
2. Infrastructural planning;
3. Planning of the built environment.

Sijmons states that in urbanized deltas, first things should be dealt with first. Protecting the land and managing the water represents the primary existential condition for these low-lying areas. However, Sijmons observed that discussions on spatial planning often start at the third layer, neglecting or juxtaposing the other two layers; this turns the logical hierarchy upside down, causing many problems in spatial planning. Sijmons also explains that putting water management first, on the other hand, does not imply that spatial quality is just a luxury; spatial planning is still necessary to achieve primary policy goals like safety and accessibility. The Quality Team of Room for the River showed that striving for spatial quality sometimes led to considerable cost savings and sometimes even sped up slow administrative processes.

To incorporate the expertise and experience of various disciplines, an integrated design approach is needed. Such a design considers the system as a whole and not just as a collection of parts. This kind of approach is believed to be more cost-effective and sustainable. The Delta Interventions design studio offered an excellent opportunity to test and further develop the method of integrated design. Successful and less successful attempts to make a holistic design were studied to find out which design aspects make a difference. This is a specific example of research by design, because here we studied the design process itself.

Since the Delta Interventions graduate studio's inception, hydraulic engineering students have participated in various ways. Practical scheduling and planning issues often determined whether students only participated in workshops, followed part of the Delta Interventions program, or worked together on their graduation project. Early projects include the design of a parachute-shaped screen barrier, and a multifunctional storm surge barrier including a restaurant, swimming pool and other leisure facilities.

More recently, students and staff have participated in the New York and Houston-Galveston projects, which are described in other parts of this book. Their main goal was to find functional, affordable solutions. The students included as many relevant aspects as possible in their designs to evolve ideas and concepts, which they then developed into different strategies to reduce flood risks; finally, they made these strategies concrete, by designing actual systems and structures.

The Delta Interventions graduate studio has shown that an integrated and sustainable design approach works well. It is an excellent example of how people from different disciplines can work together to solve societal problems in a dynamic environment.

Bertien Broekhans & Baukje Kothuis

THE GOVERNANCE OF DELTA INTERVENTIONS

REFLECTION

Political science, public administration, and organization and management studies all contribute to the disciplines of landscape architecture, urbanism and hydraulic engineering. The latter focus on designing water works, buildings or landscapes. Social scientists are fascinated by how these design processes develop and how solutions and designs get realized. In processes of development and implementation, many decisions have to be taken. Such decision-making processes, undertaken by government, market parties, or other networks of stakeholders, often take an unexpected course and develop capriciously. In order to manage the process, governance of design encourages dialogue between disciplines.

To encourage the dialogue, the Delft University of Technology's Faculty of Technology, Policy and Management (TPM) challenges students from different backgrounds to collaborate. The MSc programs Engineering & Policy Analysis (EPA), and Management of Technology (MOT) bring interdisciplinary and international students together. Governance is also taught in other MSc programs like Industrial Design & Construction Management and Engineering (DCME). Graduate students work on the governance of critical infrastructure and technology: the Delta Interventions design studio is a prime example.

Delta 'interventions' imply changes to the existing socio-technical system of water management. Waterworks and related interventions interact with each other, with their users, with the people and area they protect or organize, and are defined by instruments like standards (on strength, construction, safety), rules (e.g., policies and laws), and resources like budgets. The governance of Delta interventions deals with the parties, trends, and opportunities which drive these interventions, what influences the implementation of these interventions, and what makes these interventions socially accepted (or not).

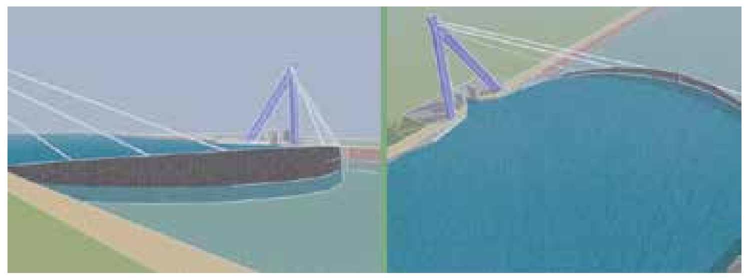
It's in the name: the Faculty of Technology, Policy, and Management of the Delft University of Technology designs roadmaps, decision-support tools, and participatory and value-sensitive design methods that deal with both the technological and the social aspects of delta interventions. In the studio, TPM students study designs by architects, urbanists and hydraulic engineers to learn what factors and values are at stake in these designs; they investigate how interested parties interpret and react to these designs. Sometimes they study historical cases like the Closure Dike (Afsluitdijk) and the Eastern Scheldt Barrier (Oosterscheldekering), but they also investigate contemporary issues in flood risk management as for example those faced in Houston Galveston Bay in Texas (see Yam, page 92 in this volume).

Delta interventions are varied and caused by different factors, many of them common sense. Although technology can enable new solutions for delta problems, motivating and legitimating the proposed solutions is often a matter of governance. A first driver is space. In urbanized deltas, many different groups of people use the same space, encountering each other and each other's interests regularly. Instead of competing for a scarce resource, cooperation can allow more groups (or even all of them) to satisfy their interests. Secondly, deltas face imminent flood. This means that even where flood safety is not the predominant theme in planningnand design, it remains a serious consideration. A third factor is financial: funding pressures urge all parties - governments in particular - to prioritize in a smart way. Finally, addressing flood control can have disturbing effects on other functions, such as environment, community, or equity. A concrete structure that changes the water flow or the current can have adverse, even disastrous, ecological consequences. All these factors play a role in decision-making processes, and thus experts, expertise and the experience of various disciplines is needed.

The Delta Interventions design studio is a great place for students to learn about such processes, and experience the acceptable discomfort of interdisciplinary debate. Of course, involved parties have different interpretations and various perspectives on any particular delta intervention. That reality is the very basis of the designs the students are creating. Their projects provide pathways for adaptive flood risk management and frames that support the understanding and communication of flood risk.

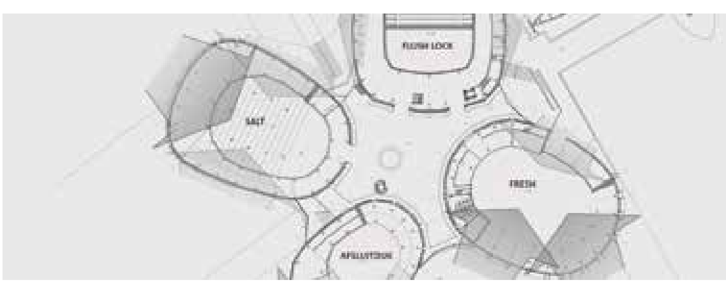
2009-2010

OVERVIEW DELTA INTERVENTIONS MSc PROJECTS



Movable Water Barrier For The 21st Century
F. van der Ziel. - 2009
Mentors: A. van der Toorn; A. Romeijn; J.K. Vrijling
Keywords: fabric · doek · balgstuw · movable water barrier · water barrier · parachute dam · weir · beweegbare kering · stuw · Dyneema

Multifunctional Waterdefending Architecture – A Spa In Vlissingen
S.R. Jaspers. - 2009
Mentors: A.L. Nillessen; A.K. Larssen; J. van der Pol; D. Vittner
Keywords:Multifunctional · Water · Defence · Border · Adaptation · Vlissingen · Zeeland · Spa · Sauna · Welnesscenter · Westerschelde



A Multifunctional Energy Centre On The Afsluitdijk
P.A. Raat - 2009
Mentors: A.K. Lassen; S.P. Tjallingii; A.L. Nillesen
Keywords: Multifunction · Afsluitdijk

Floating Olympic Stadium 2028: Olympic Games in the Netherlands
G.V.A. Verhaar - 2009
Mentors: A.L. Nillesen
Keywords:Stadium · Floating · Olympic Games

WaterWonen: Waterbestendig Wonen In Het Nederlandse Landschap
K.P. Heimensen - 2010
Mentors: F. van Dooren; A.L. Nillesen
Keywords: Waterwonen

Waterslot In Het Spui
A. Dijk - 2010
Mentors: A.K. Lassen; T. Rijcken; A.L. Nillesen
Keywords: Waterslot · Spui

Nature Activity Centre – Dordrecht
R.F.A. Postel - 2010
Mentors: A.L. Nillesen; A.K. Lassen
Keywords: Dordrecht · Nature Activity Center · Biesbosch

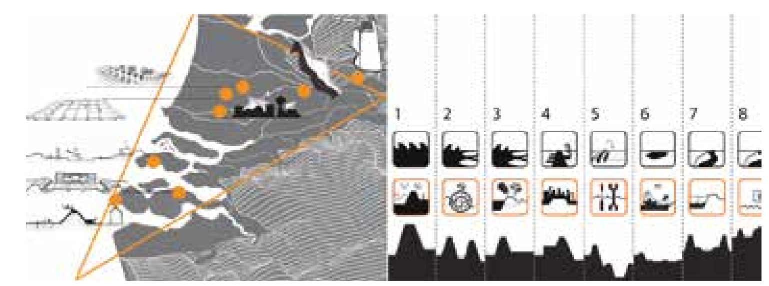
Ecological And Tidal Experience Museum At The Grevelingen Lake
C. Rijsewijk - 2010
Mentors: A.L Nillesen; A.K. Lassen
Keywords: Tidal Experience · Grevelingen

2010-2011

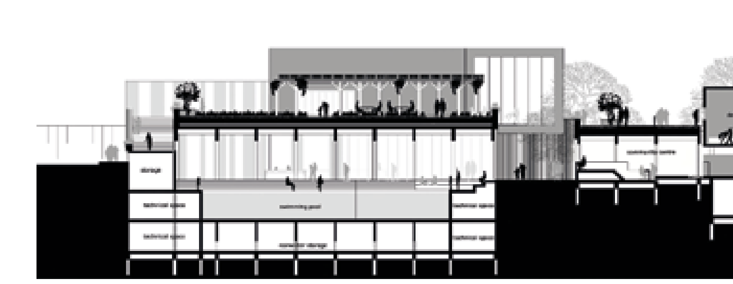
OVERVIEW DELTA INTERVENTIONS MSc PROJECTS

Geothermal Spa: Connect Social, Economic, And Environmental Solutions For Samosir Region In North Sumatra, Indonesia
L. Moniaga - 2010
Mentors: A.L. Nillesen; A. van Timmeren
Keywords: Geothermal · Spa · Indonesia

Social Sustainability – Afrikaanderwijk Rotterdam
J.R. Calis - 2010
Mentors: T. Schuetze; A.K. Lassen; A.L. Nillesen
Keywords: Social housing · Modular · Swimming pool · Atrium



Deltascape Pavilions: Creating A Series Of Pavilions Along A Recreational Route Through The Dutch Delta
M. Hamelink - 2010
Mentors: A.L. Nillesen
Keywords: Deltascape · Pavilion · Water · Landscape Architecture



Community Centre Afrikaanderwijk Rotterdam: Water Storage As A Social Connection
J. van der Klauw - 2010
Mentors: A.K. Lassen; A.L. Nillesen
Keywords: Afrikaanderwijk · Community centre · Skate park

Let's Make A Jump!
H.J. Stoer - 2010
Mentors: R.J. Nottrot; A.K. Lassen
Keywords: Rooftop

The Urban Interior Setting: Towards A Habitable Urban Landscape
Kok, W.J. - 2011
Mentors: R.J. Nottrot; A. Van Timmeren; M.M.E. van Esch
Keywords: Urban landscape · Microclimate · Public space · Urban interior · Climate adaptation · Architecture

Social Practice Theory As Design Approach For Reducting Energy Use For Indoor Climate Management In Dutch Dwellings
I. De Jong - 2011
Mentors: R.J. Nottrot; A. van Timmeren; L. Kuijer
Keywords: Social practices · Dwelling · Sustainability · Energy use

Architecture On Water-base
Y. Jousma - 2011
Mentors: A.K. Lassen; E. van der Zaag; T. Schuetze
Keywords: Sustainability · Floating architecture

OVERVIEW DELTA INTERVENTIONS MSc PROJECTS 2009-2015

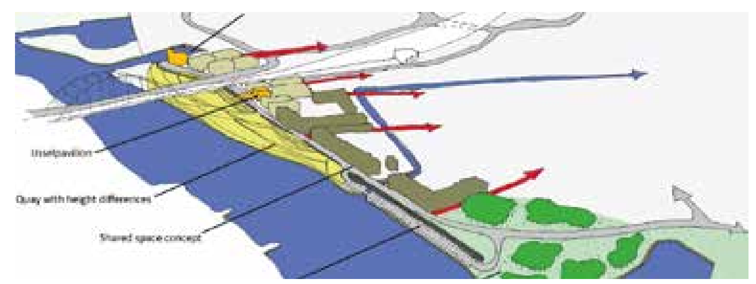
2011-2012

OVERVIEW DELTA INTERVENTIONS MSc PROJECTS

Landmark For Middelplaat Haven
S. Fekri -2011
Mentors: J. Engels; A.A.J. van den Dobbelsteen
Keywords: Energy saved

The Urban Bayou: Balancing Natural Processes And Urban Development In New Orleans
D.G. Raymond- 2011
Mentors: V.J. Meyer; S. Nijhuis; W. Wilms Floet; T. Schuetze; H. Mihl
Keywords: Building with nature · Climate change · Ecosystems · Living with water

Return To The Coast! Creating Vital And Attractive Seaside Towns
M.M. Warmerdam - 2011
Mentors: M. de Hoog; S. de Wit
Keywords: Seaside towns · Regeneration · Multifunctional barrier

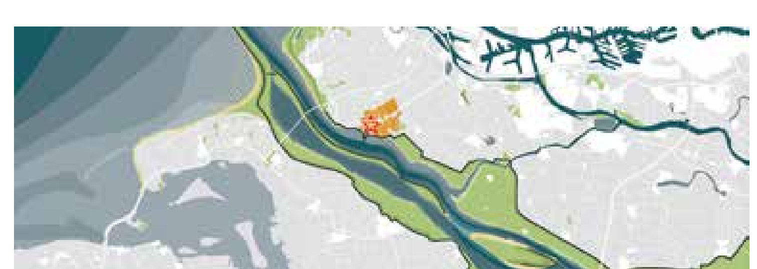


Urban Riverfront Zutphen: Link Between The River And The Urban Public Spaces
L. Hietbrink- 2011
Mentors: V.J. Meyer; S. Nijhuis
Keywords: Riverfront development · Room for the River

Let It Rain
M. van Rijswijk - 2011
Mentors: A.L. Nillesen; I. Bobbink; E. van Dooren
Keywords: Architecture · Landscape · Rain · Water · Climate change · Museum · Restaurant

Green Keys: How Sustainable Principles Regenerate The Westland Spatially
M. Crielaard- 2012
Mentors: A.L. Nillesen ; D. Sijmons
Keywords: Westland · Glass-houses · Horticulture · Climate · Renewal · Water · Recreation · Experience · Resilience · Usability

Working With Extremes: Hard or Soft Approach? 2100 Vision For Settlements On The Southern Bank Of Rotterdam: The Case Of Pernis
S.H. Lee - 2012
Mentors: V.J. Meyer; S. Nijhuis
Keywords: Port decline · Climate change · Hard & Soft approach



Post Dam Era: New Water Defense System Of Haringvliet
S. Shuang Deng - 2012
Mentors: M. de Hoog; I. Bobbink
Keywords: Water defense · Spatial quality · Urban life

2012-2013

OVERVIEW DELTA INTERVENTIONS MSc PROJECTS

Prepare For Impact! Climate Change Adaptation And Spatial Quality In The Dutch Urban Delta
R.P.J. de Kort -2012
Mentors: A.L. Nillesen; V.E. Balz
Keywords: Climate change adaptation · Urban delta · Water safety

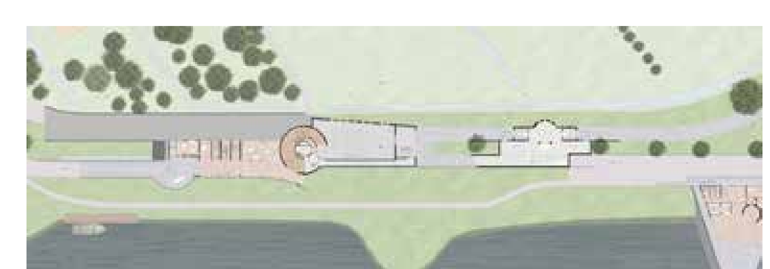
Delfzijl 2030: WADerPROOF
L.R. Papenborg - 2012
Mentors: H.C. Bekkering; J.R.T. van der Velde; A. van der Toorn
Keywords: Social Decline · Delta Intervention · Levee · Urban Regeneration

Towards A Green Metropolis: Designing A Waterfront In Riga, Latvia
V. Prilenska - 2012
Mentors: H.C. Bekkering; S. Nijhuis
Keywords: Riga · Recreational spaces · Recreational space provision · Brownfield site regeneration · Industrial site regeneration

Towards An Open Delta: Research And Design For Sustainable Urban Landscapes In An Open Dutch Southwest Delta
N. den Besten- 2012
Mentors: V.J. Meyer; I. Bobbink
Keywords: Urban Landscape · Krammer Volkerak · Dutch Southwest Delta · Sustainable Design · Research by Design

Can Tho, How To Grow? Flood Proof Expansion In Rapidly Urbanising Delta Cities In The Mekong Delta: The Case Of Can Tho
V. Konings - 2012
Mentors: V.J. Meyer; S. Nijhuis
Keywords: Vietnam · Mekong delta · Flooding · Climate change · Urban design · Can Tho

Maintaining The Waterfront In Vlissingen: Re-stitching The Relationship Between Water And The Urban Fabric
H.J. Breukelman - 2012
Mentors: A.L. Nillesen ; S. Nijhuis
Keywords: Waterfront · Fragmentation · Vlissingen · Spuikom

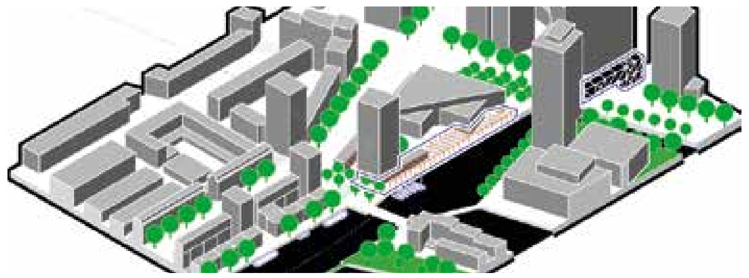


Funeral Center in a Levee-Landscape
D.E.P. Nielen, D.E.P. - 2012
Mentors: F. Palmboom; K.B. Mulder
Keywords: Funeral Center · Funeral architecture · Crematory · Mortuary · Flood Defense

Road to Scheveningen Haven
A. Ikhayanti - 2012
Mentors: M. de Hoog; A. van Nes; W. Hermans
Keywords: Scheveningen haven · Urban design · Water defence · Accessibility · Tourism development

2013-2014

OVERVIEW DELTA INTERVENTIONS MSc PROJECTS



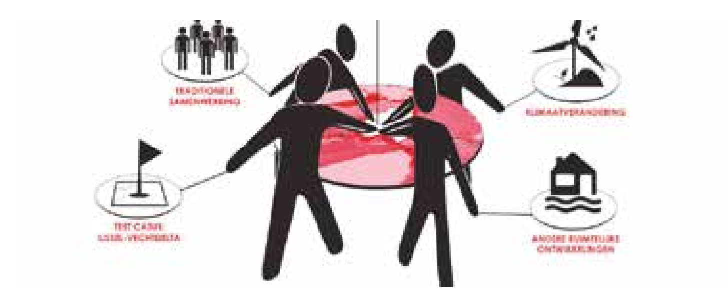
Rotterdam, Waterstad
R.J. Oosterhuis - 2013
Mentors: F.L. Hooimeijer; H.C. Bekkering
Keywords: Waterstad · Rotterdam · Water city · Transformation

Connecting Landscapes: Recreational Networks And Saline Landscapes As Opportunities For A Climate Proof Delta
D.C. Flikweert - 2013
Mentors: I. Bobbink; V.J. Meyer
Keywords: Connecting landscape · Recreational Networks · Saline landscapes · Aquaculture · Climate change · Collective memory

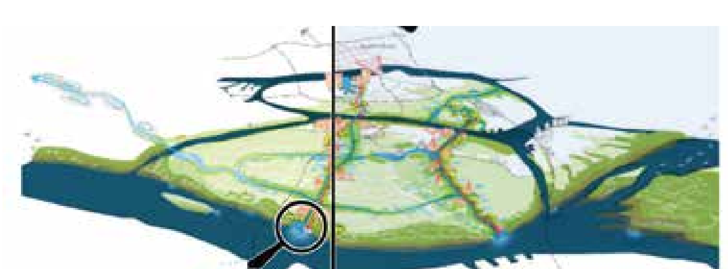
West Silvertown: Docklands Light Railway Station On London's Floodplain
J.E. Hamoen - 2013
Mentors: A.L. Nillesen; J.A. van de Voort
Keywords: Floodplain · Railway Station

Wave in the Waal
M. Remeijer - 2013
Mentors: E.J.G.C. van Dooren; E.J. van der Zaag
Keywords: Interdisciplinary cooperation

The Connecting Waterscape; The Case Of The Maashaven In Rotterdam
K. Kokhuis - 2013
Mentors: P. van Veelen; S. Nijhuis
Keywords: Public space design · Urban harbours · Ecological recovery



The Design As A Process Instrument
S. van Baren. - 2013
Mentors: F.L. Hooimeijer; S. Nijhuis
Keywords: Interdisciplinary cooperation



Safe And Dynamic Rijnmond-Drechtsteden: Rebalance The Natural Processes And Human Interventions Through Integrated FRM
N. Zhao - 2013
Mentors: A.L. Nillesen; S. Nijhuis
Keywords: Integrated Flood Risk Management (FRM) · Spatial planning

Almere 2.0 Floodproof: An Integral Approach To The Balance Between Measures On Different Layers Of Multi-layer Safety
M.S. Vermoolen - 2013
Mentors: F. Brandes; F.L. Hooimeijer; F.W.A. Koopman
Keywords: Almere · Flood proof · Integral approach

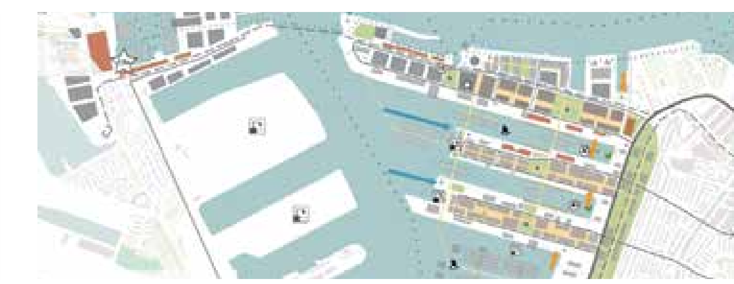
2013-2014

OVERVIEW DELTA INTERVENTIONS MSc PROJECTS

Flood Adaptive Cities: Towards Climate Change Adaption And Urban Development In The Mekong Delta
T.T. Le -2013
Mentors: V.J. Meyer; S. Nijhuis
Keywords: Delta cities · Climate change · Urban expansion · Flood adaption · Sustainable development · Mekong Delta

Keep Calm And Let The Water Come. Enabling water management plans for Southwest Dutch delta to give the nature more important position in order to strengthen area's socio-economic vitality
K. Kozlovskaja - 2013
Mentors: V.J. Meyer; V. Balz
Keywords: Southwest Dutch delta · Grevelingen · Saline cultivation

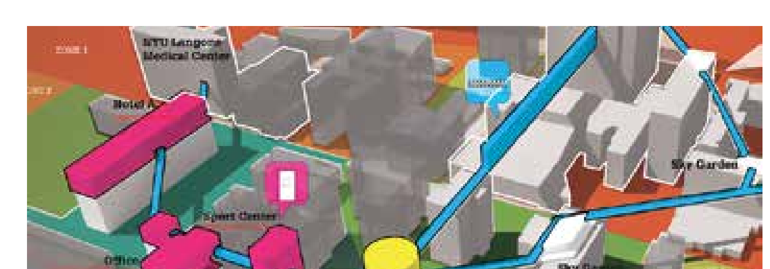
Building With Nature: Balancing The Urban Growth Of Kochi's Coastal Wetlands With Their Ecological Structures
J. Benni - 2013
Mentors: A.L. Nillesen; S. de Wit
Keywords: Coastal · Wetlands · Kochi · Ecological structures · Mangroves · Flood · Urbanisation



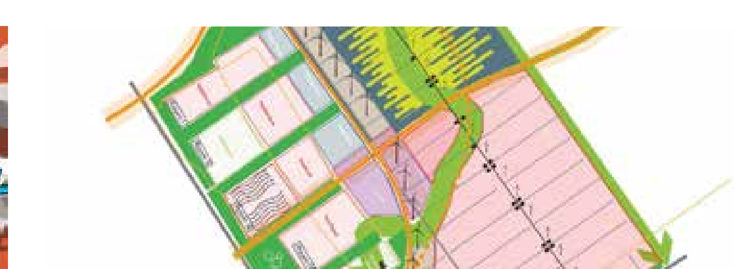
Rethinking The Power Of Water – Creating spatial solutions to integrate flood adaptation and renewable energy systems in sustainable urban delta development
C.T. Lysen - 2013
Mentors: F.L. Hooimeijer; E. Brandes
Keywords: Flood adaptation · Integral approach · REAP · Waalhaven

Closing Doors To Open Possibilities
M. Bakker- 2014
Mentors: A.L. Nillesen; J.A. van de Voort
Keywords: Open · Urban water · Rijnmond

Safe & Attractive
S.Z. Zhan - 2014
Mentors: F. Palmboom; F.L. Hooimeijer
Keywords: Organic Urbanism · Private Commissioning · Oosterwold



PLAN B: An Emergency Evacuation Plan For A Group Of Hospitals In Midtown Manhattan
L. Yi-Hsuan - 2014
Mentors: A.L. Nillesen; M. Meijs
Keywords: Flooding · Emergency · Evacuation



Regulation of Organic Urbanism
R. Jonker - 2014
Mentors: F.L. Hooimeijer; T. Bouma
Keywords: Organic Urbanism · Private Commissioning · Oosterwold

2014

OVERVIEW DELTA INTERVENTIONS MSc PROJECTS

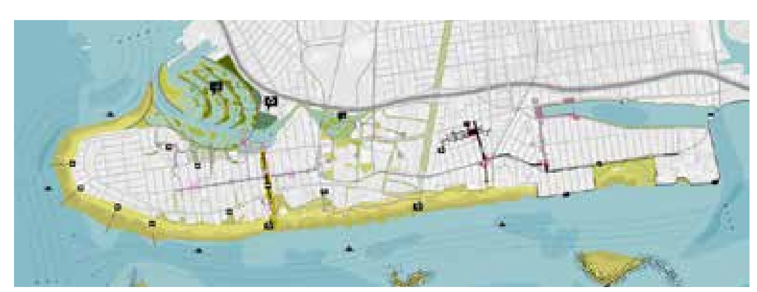
Working Waterfront Newtown Creek – Adaptive Multi-layer Flood Protection On Brownfield Opportunity Areas
L.B. Guschl - 2014
Mentors: F. Palmboom; D.A. Sepulveda Carmona
Keywords: New York City · Waterfront design · Resilience · Flood protection · Climate change · Multi-layer safety · Delta urbanism

Metropolis Meets Wetland
N.Y. de Korte - 2014
Mentors: A.L. Nillesen; M.H. Meijs; D.A. Sepulveda Carmona
Keywords: Delta intervention · Social housing · Parana delta · Lower middle class

Defend and Develop: How spatial interventions for reducing flood risk can contribute to the improvement of the spatial and socio-economic quality for the local residents
K.W. Bouvy - 2014
Mentors: V.J. Meyer · D.A. Sepulveda Carmona
Keywords: Flood risk · Tidal creeks · Integrated strategy

Living over The Sea: A Barrier Building Complex
X. Sun - 2014
Mentors: F. Palmboom; M.H. Meijs
Keywords: Barrier building

Necklace For IJsselmeer
N. Takeshita - 2014
Mentors: F. Palmboom; M.H. Meijs; J.L.H. Breen
Keywords: Tourism · Cross laminated timber · Landscape · Pavilion



Resilient Communities: How a spatial framework can contribute to resilient flood-risk protection, while improving the living quality of communities
B. Willemse - 2014
Mentors: A.L. Nillesen; S. Nijhuis
Keywords: Resilient flood-risk protection · Resilient communities

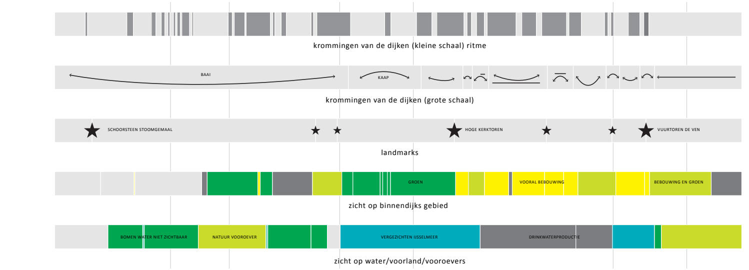
From High Line To Hudson
K.C.S. Kwong- 2014
Mentors: F. Palmboom; M.H. Meijs
Keywords: Waterfront · Intervention · Regeneration · Reconnection

No Hoboken is an island: A testcase for the Dutch approach against flood risk in the American situation
E. Fierinck - 2014
Mentors: A.L. Nillesen; N.M.J.D. Tillie
Keywords: Flood risk · Storm surge · Sea level rise · Dutch approach

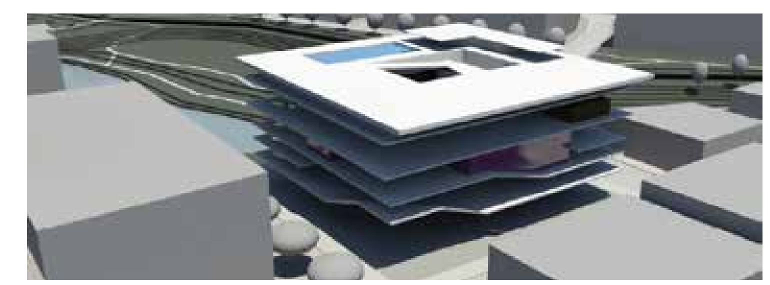
2014-2015

OVERVIEW DELTA INTERVENTIONS MSc PROJECTS

Using The Subsoil In The Urban Design Process
P.C. van der Graaf - 2014
Mentors: F.L. Hooimeijer; S. Nijhuis
Keywords: Subsoil · Design process · Subsurface · Urbanism · Civil constructions · Subsoil potential map

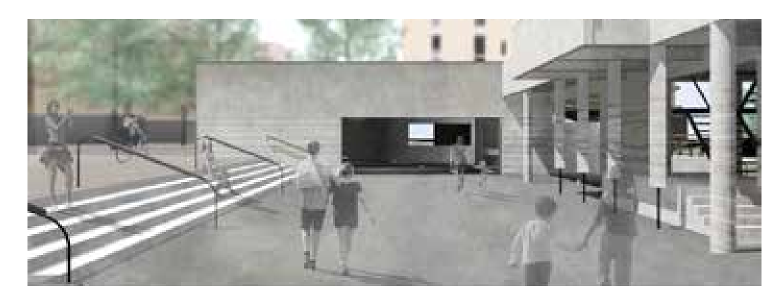


Public Landspace IJsselmeer
K.J.L. Tjokrokoesoemo. - 2015
Mentors: F. Palmboom; I. Bobbink
Keywords: Public · IJsselmeer

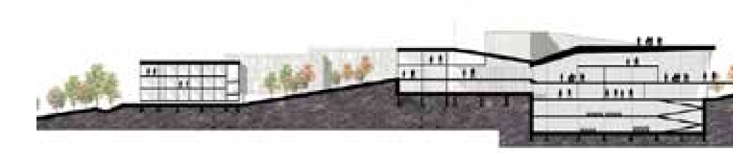


Flood-proof Leisure Center Along The Buffalo Bayou
K. Samson - 2015
Mentors: F. Palmboom; K.B. Mulder
Keywords: Leisure · Buffalo Bayou · Flood-proof

Old Harbour, New Possibilities
S.M. Mooij - 2015
Mentors: A.L. Nillesen; F.L. Hooimeijer
Keywords: Subsoil · Harbour · Flood defence · Subsoil potential map · Urbanism · Design · Mixed use

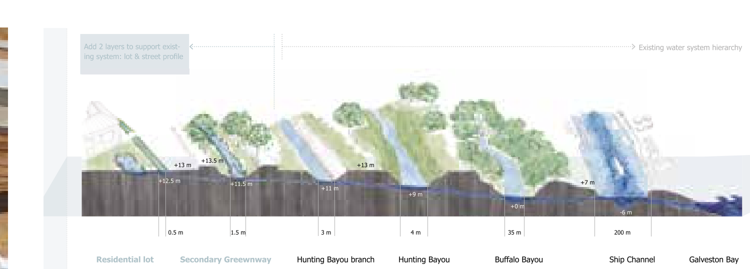


Flood Resilient Housing: The Case In Kashmere Gardens Neighborhood Of Houston
Y. Liao - 2015
Mentors: Gramsbergen, E.H. ; Mulder, K.B.
Keywords: Flooding · Water resilient



Waterfront Rehabilitation Center in Galveston
D. Wang - 2015
Mentors: E.H. Gramsbergen
Keywords: Delta

Downtown Connections: A Cultural Building Complex
Q. Cao - 2015
Mentors: F. Palmboom; K.B. Mulder
Keywords: Flooding · Cultural building



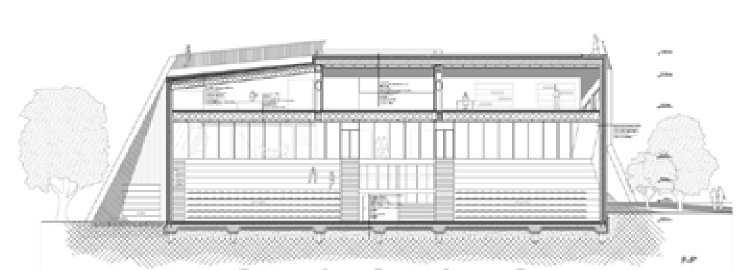
Recycling Houston: Bringing synergy between improving water safety, reducing energy consumption and reinforcing living quality
S. Huang - 2015
Mentors: H. Meyer; N. Tillie
Keywords: Suburban · Flooding · Intensification · Energy consumption

2015

OVERVIEW DELTA INTERVENTIONS MSc PROJECTS

Amphibious And Floating Recreation Complex On Sylvan Beach,TX
T.H. Ho -2015
Mentors: E. Gramsbergen; K. Mulder
Keywords: Floating · Amphibious · Wind resistant building

Living With Water: Extend Urban Life Of Galveston City
F. Liu- 2015
Mentors: A.L. Nillesen · K. Mulder
Keywords: Delta interventions · Water adaptive · Recreational system · Landscape dominate · Flexibility



Broad Channel Stepping Up: Architecture As A Connecting Element In Flood Resilience
W. Boers - 2015
Mentors: A.L. Nillesen; M.H. Meijs
Keywords: Flood risk · Estuary · Resilience · Community

Creative Amsterdam
K. Polyanina - 2015
Mentors: H. Meyer ; A. Romeijn
Keywords: Creative city · Urban water · Delta urbanism · Flexible use

Climate Change Adaptation and Recreational Development in the IJsselmeer Region
J.F. Gaasbeek Janzen - 2015
Mentors: F. Palmboom ; E. Stolk
Keywords: Recreation · Climate change · Adaptation · IJsselmeer

Wadden Ritme: MarkenWadden Centre
M. Janssen - 2015
Mentors: F. Palmboom.; K.B. Mulder
Keywords: Houtribdijk · MarkerWadden

The Floating Future
I.A.H. Theunisse - 2015
Mentors: K.P.M. Aalbers; K.B. Mulder
Keywords: Floating

Urban Ecology in Houston: Creating a soft natural border
S.F. Brakel- 2015
Mentors: V.J. Meyer ; S. Nijhuis
Keywords: Houston · Fragmentation · Ecosystems · Greenways

2009 - 2015

DI STUDIO-MENTORS

Verena Balz *TU Delft, Faculty of A&BE*
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Inge Bobbink *TU Delft, Faculty of A&BE*
Teake Bouma *TU Delft, Faculty of A&BE*
Evelien Brandes *TU Delft, Faculty of A&BE*
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Isabel Castiñeira *Universitat Polytecnica de Catalunya, Barcelona*
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Anne Loes Nillesen *is founder and coordinator of the Delta Interventions Studio at Delft University of Technology Faculty of Architecture & the Built Environment. Anne Loes is owner of Defacto Architecture & Urbanism, Rotterdam, an award-winning office for (landscape) architecture and urban design, specializing in coherent designs and analyses that integrate spatial and technical aspects.*

Han Meyer *is founder and coordinator of the Delta Interventions Studio. He is a professor of Urban Compositions at the Faculty of Architecture and the Built Environment. This chair develops methods for bringing structure and design into the urban space. Future social developments play a vital role in this. A particular area of attention is urbanism in delta areas; Delta Urbanism research is part of the 'Safe, sustainable deltas and metropolis' program.*

Frits Palmboom *is a professor of Urbanism at Delft University of Technology, Faculty of Architecture & the Built Environment. He was appointed to the Van Eesteren chair in 2013. The focus of this chair is on urban planning in relation to the physical conditions of the Dutch delta landscape. Frits is partner at Palmbout Urban Landscapes, Rotterdam. He has been part of the Delta Interventions Studio since 2013.*

Baukje (Bee) Kothuis *is a post doc in the Dutch Science & Technology Foundation STW research program 'Integral and sustainable development of multifunctional flood defenses'. For the multidisciplinary 'Texas-case' in the Houston Galveston Bay Region, she manages TU Delft interfaculty collaboration and delta research cooperation with Texas A&M Galveston, Rice University, and University of Houston. Baukje is owner of Waterworks, Amsterdam, a consultancy and research bureau for flood risk communication and governance.*

REFERENCES

Aerts, Jeroen; Wouter Botzen; Hans de Moel; Malcolm Bowman (2013). Cost estimates for flood resilience and protection strategies in New York City. Annals of the New York cademy of Sciences, 1294, p. 1-104.

Bedient, Phil (ed.) (2012). Lessons from hurricane Ike. College Station, TX: Texas A&M University Press.

Berg, Robbie (2009). Tropical Cyclone Report Hurricane Ike 1–14 September 2008. National Hurricane Center, Miami, FL.

CDC (2013). Connecting Delta Cities, Volume #3: 'Resilient Cities and Climate Adaptation Strategies'; Arnout Molenaar; Jeroen Aerts; Piet Dircke; Mandy Ikert (eds.). www.deltacities.com

Cross, Nigel (2001). 'Design cognition: results from protocol and other empirical studies of design activity.' In: Charles M. Easterman, W. Michael McCraken & Wendy C. Newsletter (eds). Design knowing and learning: cognition in design education. Amsterdam: Elsevier.

Cutter, Susan; Mark Smith (2009). 'Fleeing from the Hurricane's Wrath: Evacuation and the Two Americas.' In: Environment - Science and Policy for Sustainable development. March-April 2009. www.environmentmagazine.org.

Deltacommissie (1961). Report of the Delta Commission. Final Report and Interim Advice. [Rapport van de Deltacommissie. Eindverslag en Interimadviezen]. The Hague: Staatsdrukkerij.

Deltacommissie (2008). Working together with water. A land that lives, builds its future. Conclusions of the Deltacommission 2008. [Samen Werken met Water. Een land dat leeft, bouwt aan zijn toekomst. Bevindingen van de Deltacommissie 2008.] The Hague: Deltacommissie.

FEMA (2008). Hurricane Ike Impact Report – December 2008. Federal Emergency Management Agency.

GHF (2011). Galveston Green Guidelines. Strategies for building projects on the Texas Gulf Coast - Builders, Planners, and Homeowners. Galveston: Galveston Historical Foundation & United States Green Building Council - Galveston County Branch.

Hallegatte, Stephane; Colin Green; Robert J. Nicholls; Jan Corfee-Morlot (2013). 'Future flood losses in major coastal cities'. In: Nature Climate Change 3, 802–806; doi:10.1038/nclimate1979

McHarg, Ian (1969). Design with Nature, New York: Natural History Press.

Nillesen, Anne Loes (2015). 'A rich diversity of building blocks for a comprehensive flood risk strategy.' In: Baukje Kothuis; Nikki Brand; Antonia Sebastian; Anne Loes Nillesen; Bas Jonkman (eds). Delft Delta Design. Houston Galveston Bay Region, Texas, USA. Delft: Delft University Press, TU Delft Library.

NOAA (2011). The deadliest, costliest, and most intense United States Tropical Cyclones from 1851 to 2010 (and other frequently requested hurricane facts). Eric Blake, Christopher Landsea, Ethan Gibney; NOAA Technical Memorandum NWS NHC-6.

OSD (2014). Texas Population projections 2010-2050. Austin, Texas: Office of the State Demographer. Retrieved from osd.texas.gov

Palmboom, Frits (2014). De Delta Paradox. Stedenbouw in delta landschappen. Intreerede, June 11, 2014, Delft University of Technology.

Regional Plan Association (2013). Building coastal resilience, using scenario planning to address uncertainty and change. New York-New Jersey-Connecticut: RPA & Lincoln Institute of Land Policy.

Schön Donald (1983). The Reflective Practitioner: How Professionals Think In Action. New York: Basic Books.

Sebastian, Antonia (2015). 'Flood mitigation in multi-hazard coastal environments.' In: Baukje Kothuis; Nikki Brand, Antonia Sebastian; Anne Loes Nillesen; Bas Jonkman (eds). Delft Delta Design. Houston Galveston Bay Region, Texas, USA. Delft: Delft University Press, TU Delft Library.

Sennet, Richard (2006). 'The Open City', London/Berlin, published at https://www.richardsennett.com/site/senn/UploadedResources/The%20Open%20City.pdf

Sennett, Richard (2008). The Craftsman, New Haven: Yale University Press.

Sijmons, Dirk & Hans Venema (1998). = Landschap. Amsterdam: Architectura & Natura Press.

TEEX (2010). Hurricane Ike Impact Report. College Station: Texas A&M University. Texas Engineering Extension Service - Knowledge Engineering. www.thestormsource.com. Retrieved Dec 13, 2015.

Trope, Yaacob; Nira Liberman (2010). Construal-Level Theory of Psychological Distance. In: Psychological review, 117(2), 440-463.

USACE (2012). Clear Creek, Texas. Flood Risk Management. Final General Re-evaluation Report. Galveston: United States Army Corps of Engineers – Galveston District, Southwestern Division.

USDC (2001). Tropical Storm Allison Heavy Rains and Floods. Texas and Louisiana, June 2001. U.S. Department of Commerce/NOAA.

Wahl, Thomas; Shaleen Jain; Jens Bender; Steven D. Meyers; Mark E. Luther (2015). 'Increasing risk of compound flooding from storm surge and rainfall for major US cities.' In: Nature Climate Change 5, 1093–1097.

Zane, D.F., T.M. Bayleyegn, J. Hellsten, R. Beal, C. Beasly, T. Haywood, D. Wiltz-Beckham, & A.F. Wolkin (2011). 'Tracking deaths related to Hurricane Ike, Texas, 2008.' In: Disaster Medicine and Public Health Preparedness Journal. Mar 2011; 5(1):23-8.

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