



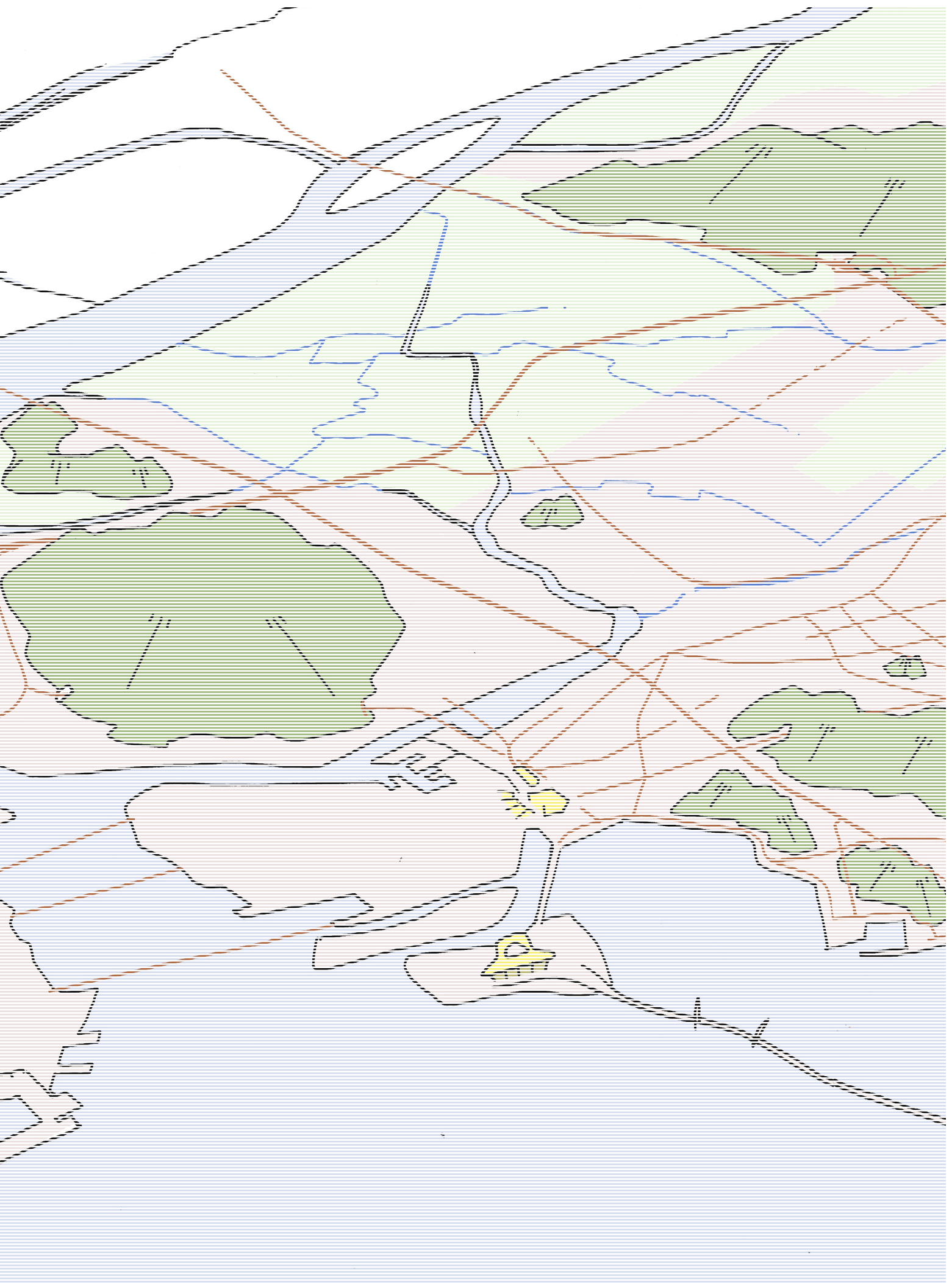
Consulting report for guidelines, principles and process for a resilient Zhuhai

May 2019

Kasper Spaan, Marcel van der Meijs, Marieke van Nood



Europe-China Eco-Cities Link
中欧低碳生态城市合作项目



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Preface

Strategies for the sustainable development and growth of Zhuhai must integrate adaptation planning in order to reduce vulnerabilities to expected and unexpected impacts of climate change. Under the request of Zhuhai Housing and Urban Planning Development, the Europe-China Eco-Cities Link (EC-Link) project supports with the revision the overall guideline for urban planning and city development in Zhuhai. This activity is aimed to establish new norms and standards that give the basis for the further cooperation on the implementation of pilot projects of different kinds in urban areas.

World Waternet and Palmbout Urban Landscapes, collaboratively wrote a consulting report that showcases the Dutch approach and shares new findings in the form of strategies and case studies. The report is complemented with guideline revision suggestions. These suggestions will be further elaborated in a workshop hosted by World Waternet and Palmbout Urban Landscapes.

Waternet is the only water company in the Netherlands that covers the whole water cycle, providing safe, clean and sufficient supply of water. World Waternet was founded to help combat global water challenges. The foundation offers sustainable, integral solutions to worldwide water issues.

Palmbout Urban Landscapes produces spatial designs for the domains of urban planning, landscape and exterior space. Generating visual images is the quintessence of their design approach. They visualize both the embedment of the project in the larger scale of city and landscape, and its elaboration in terms of typology, details and materials.

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LIVING WITH THE BAY, LONG ISLAND NEW YORK (USA) THE GEORGE APARTMENT BUIDLING, AMSTERDAM (NL) STEIGEREILAND, AMSTERDAM (NL) COASTAL BOULEVARD, SCHEVENINGEN (NL) ROOF GARDEN ZUIDERSPOOR, ROTTERDAM (NL) HOUTAN PARK, SHANGHAI (CH)	
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1. Introduction

Climate change has already had significant influence on human and natural systems. It is generally accepted that even with substantial mitigation efforts and actions, adaptation will be necessary. Extreme weather will be the new normal and cities in low elevation coastal zones face the combined threat of sea-level rise and storm surges.

Urban planning and urban design have a critical role in the global response to climate change. At strategic and planning level, cities should revise master plans to reflect any significant changes in landscape and natural resources, as well as related climate risk. Other activities might include development of new strategies and policies. Zhuhai is poised to revise its general urban planning which requires an upgrade of urban resilience in a systematic way.

1.1 Zhuhai's challenges

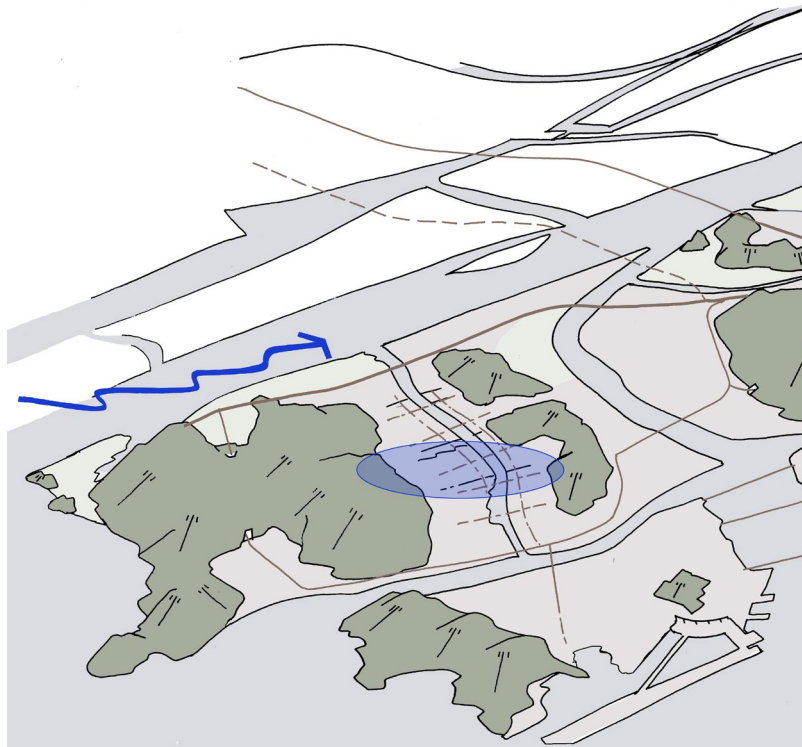
Zhuhai, one of EC-Link's pilot cities, is a typical, fast growing city. It has experienced significant production growth and unprecedented land-use changes in the last three decades. Hills, plains and waters account for 58%, 25.5% and 15.9% of the total land area, respectively.

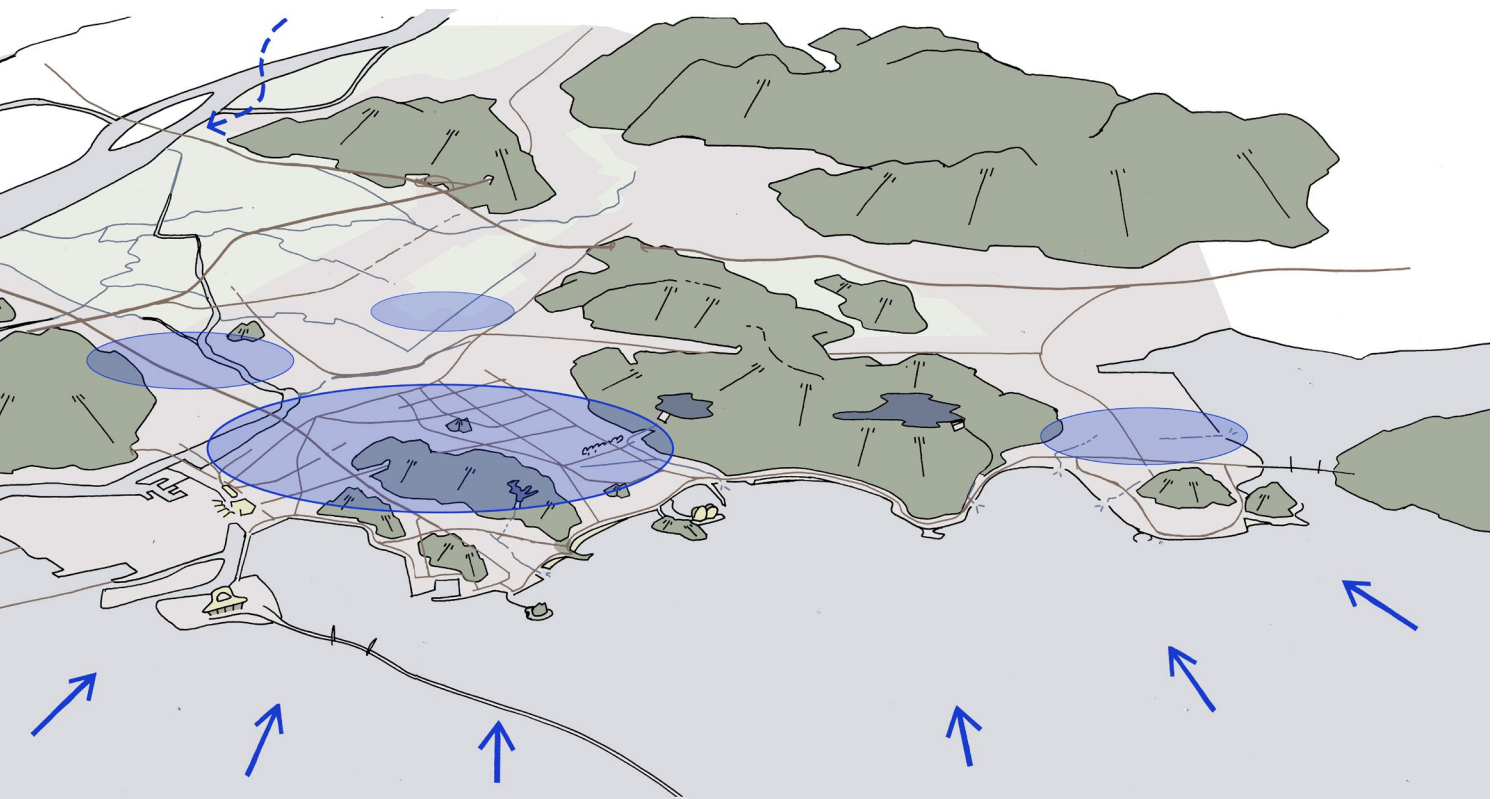
To protect the city, Zhuhai seeks to identify the best practices of storm management, water management and urban resilience governance. With a coastline stretching 690 km and under the influence of tropical hurricanes during summer, the city is exposed to high risks of extreme weather disasters such as typhoon, heavy rain storm and floods. These threats were epitomized by Typhoon Hato (August 2017), which inflicted direct economic losses exceeding 20 billion yuan on the city.

Based on three visits in 2018, the following challenges on resiliency have been observed:

- A central ambition on resiliency and climate change parameters.
- Differentiating between water problems and climate issues.
- Understanding the relationship between drought and climate change.
- An integrated vision on climate and urbanization challenges.
- Creating and monitoring high-quality datasets.

To tackle these challenges, the government of Zhuhai has placed climate adaptation as a core objective of urban planning and resilient design. See Appendix I for possible challenges for Zhuhai concerning climate change.





2. An integrated approach to climate adaptation

The Netherlands is known for its knowledge and expertise in the field of watermanagement, and the country is renowned for its integrated approach. An integrated adaptation to climate change involves a radical transformation of the way that we think about change. From something that we simply respond to and objectively manage, to something that we consciously create.

When integrating climate adaptation measures with other sectors (e.g. ecology, urban development, traffic) they will positively contribute to the safety and wellbeing of citizens, but also add quality to the environment.

2.1 "Analysis, Ambition, Action" methodology

An integrated approach can be based on the "Analysis, Ambition, Action" steps. In order to effectively tackle undesirable effects, it is important to first map out the challenges in a specific area (Analysis). This produces differences between urban and rural areas, between built-up and undeveloped areas, between elevated and low-lying areas, between sandy soils and peaty areas. The next step involves the formulation and embedding of goals (Ambition). These goals will be substantiated through measures (Action).

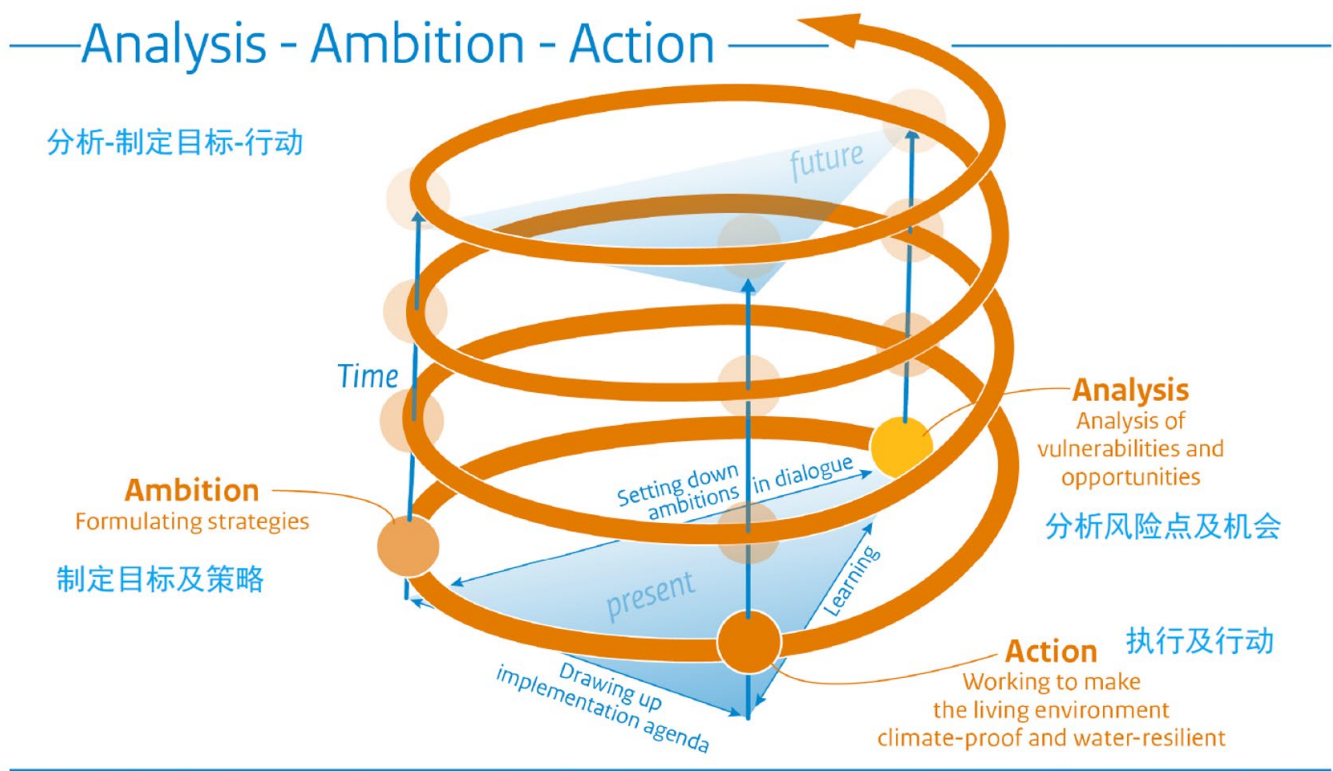


Figure 1: Methodology of the long-term and systematic address of water logging, heat stress, drought, and the impact of coastal and urban flooding (Delta Programme Commissioner).

2.1.1 Analysis

Climate change impact should be broken down into environmental stressors. For instance, flooding can be caused by:

- extreme rainfall;
- inundation of rising water levels due to rainfall;
- failing/collapsing levee systems;
- sea level rise;
- flood surge;
- overtopping waves.

For each type of flood, specific models are available to create a virtual stressed environment. In addition to this, for each type of flood stress, specific measures are available to reduce impact or stress.

2.1.2 Ambition

For each type of climate stress and its primary effects, an ambition should be set concerning allowable frequency of damage or impact. A common, shared ambition is important for success and should focus on the available measures. For instance, when a system of connected levees doesn't have an equally set standard, a breach might occur at the weakest point, causing the system to fail.

Ambitions might be challenged and altered when costs are relatively high and the benefits low. In this case, a conscious deviation should be agreed upon.

2.1.3 Action

At this stage it is important to design relevant tools and guidelines (e.g. technical guidelines) that help implement adaptation solutions in the actual urban planning and design practice.

Program goals should be a translation of the ambitions into a set of projects. The projects can be sketched from toolboxes or pilot projects. These tools are then used to decide on relevant measures.

Measures sorted by area and type

以区域和类型进行排序的措施

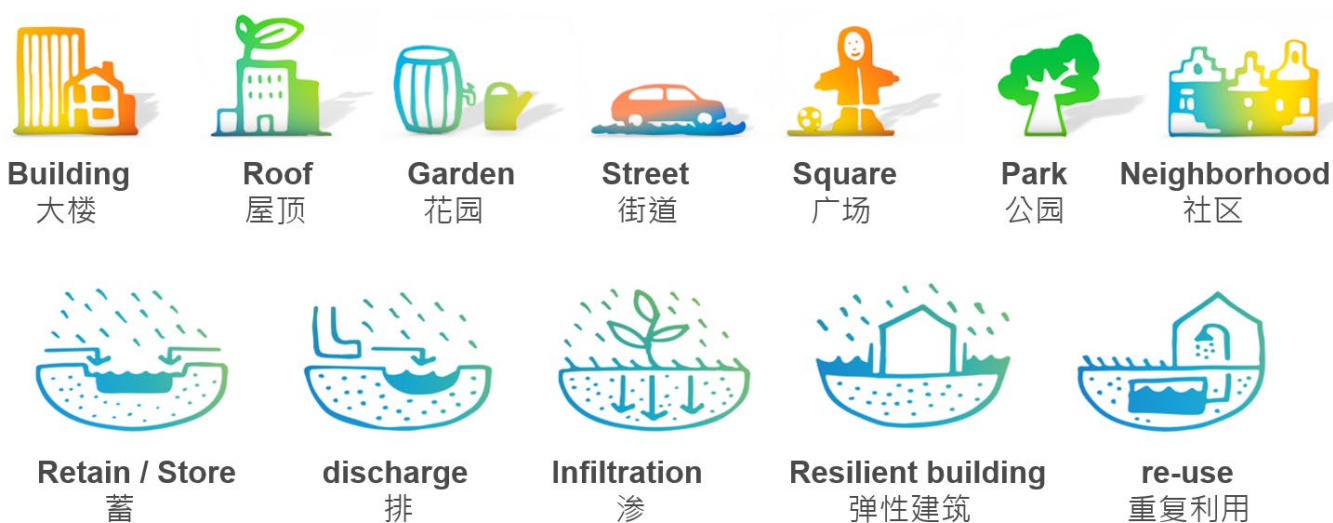


Figure 2. Amsterdam Rainproof measures (actions) sorted by area and type.

2.2 Iteration, integration & level of scale

2.2.1 Iteration

Climate adaptation is an iterative process, from scoping the problem, to analysing the options and alternative adaptation strategies, to implementing adaptation plans. The iteration process is necessary to:

- require new insights from finalized projects on costs and effectiveness;
- be able to adapt to changing challenges (increasing climate stress);
- adapt to new techniques or functions that can add new parameters in the analysis and toolboxes.

2.2.2 Integration

The exiting challenge in defining the relevant projects and measures for a climate robust cityscape is in the integration. Only when measures are combined with other functions (and investments) a logical solution can be found (spatially, economically, timely). This integration is a design challenge where:

- safety and quality in solution should be combined;
- multiple disciplines should be involved in different levels of scale;
- a central, multisectoral ambition is needed;
- projects should always have several advantages in addition to water security/safety.

2.2.3 Level of scale

Geographies of a city vary greatly. Extreme weather events caused by climate stress have a spatial footprint. Actions that simultaneously reduce greenhouse gas emissions and build resilience to climate risks should be prioritized at all urban scales. At a macro scale, the riverine discharge and flood surges should be met with levee systems and storm surge barriers. At a micro scale, the typology of retain, store and discharge could help keep city blocks dry.

From a strategic perspective, a spatial approach addressing different themes at different spatial scales is needed. In addition to this, there is a need to look more closely at what extreme events mean for specific (local) locations. Only then the relevant measures on the right level of scale can be found.

Defining the right set of climate adaptive measures is not about choosing the right scale, it is about a comprehensive set of measure on all relevant scales.

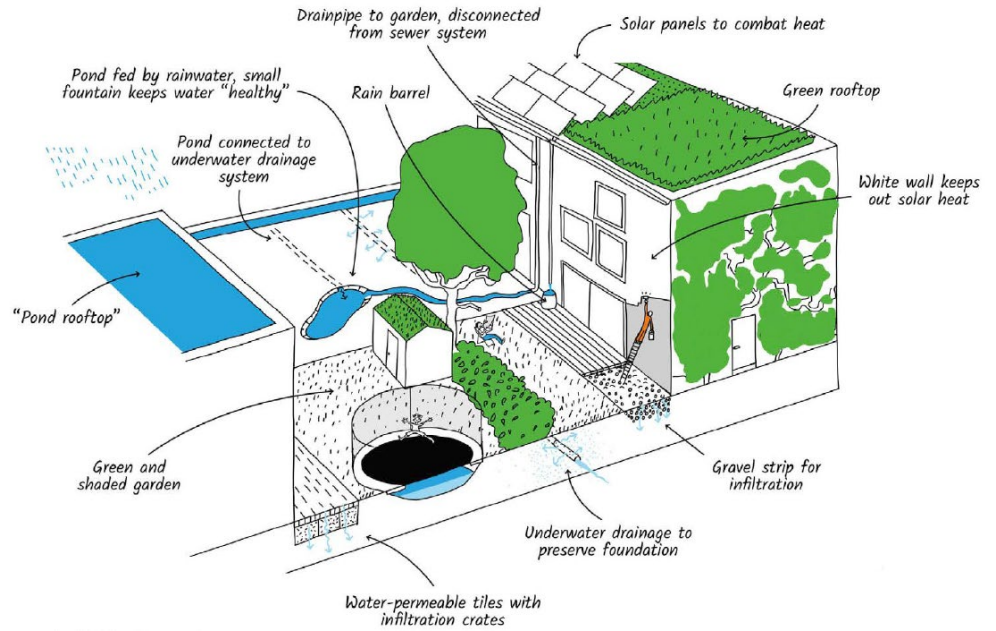


Figure 3: Measures at building/plot scale.

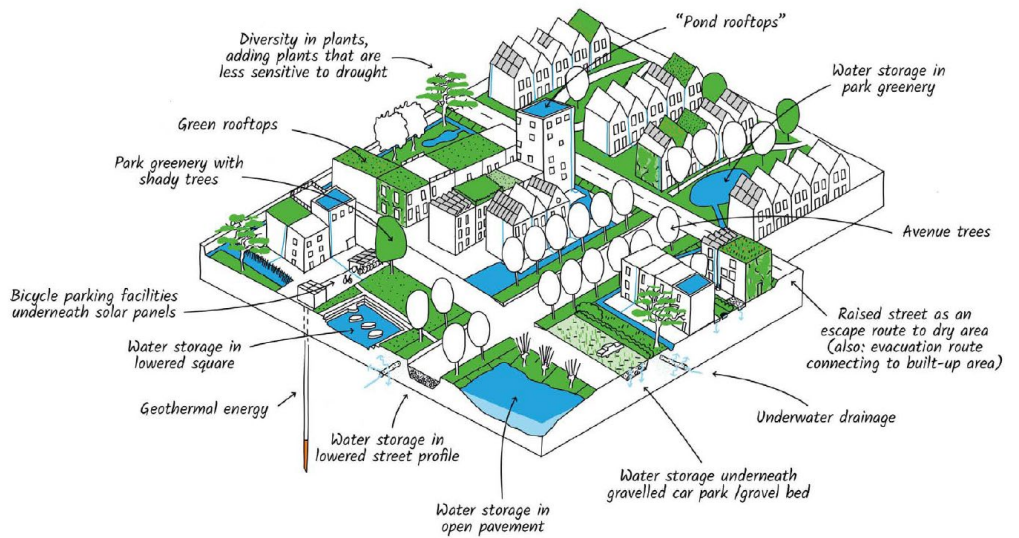


Figure 4: Measures at neighbourhood scale.

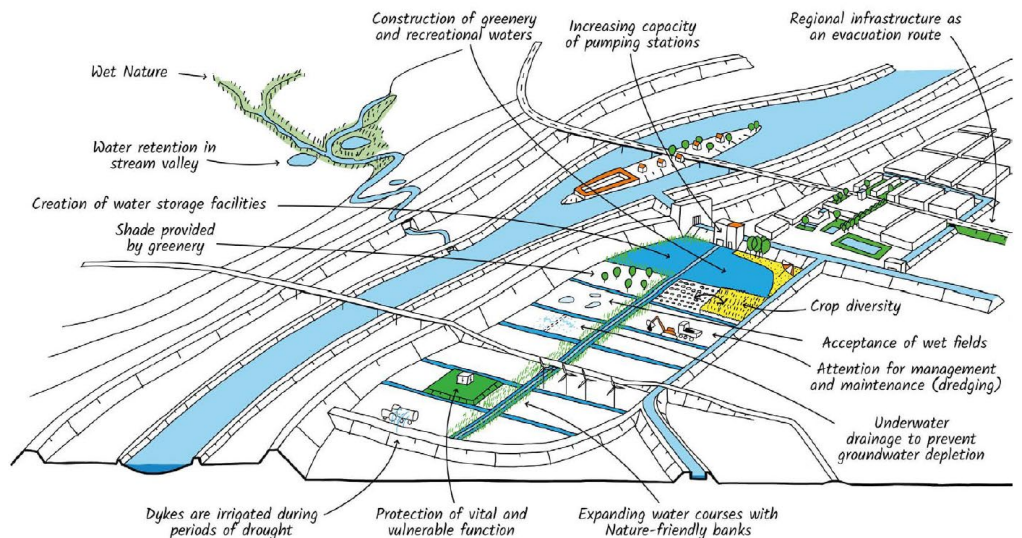


Figure 5: Measures at regional scale.

2.3 Design led approach

A design-led approach integrates a wide spectrum of needs (biodiversity, urban planning, agricultural development, public realm) and combines them with the requirements of an area, location or region. Combining fields of expertise with flood measurements, will lead to an innovative approach to water management and flood protection. All disciplines involved can contribute to the key role in the processes of water management and flood protection. Several benefits can be achieved using the design-led approach.

Higher quality spatial solutions

The holistic approach can deliver higher quality solutions. This can contribute enormously to the quality of the surroundings, towns and villages through which rivers flow. The integrated design of flood defences for public rivers can potentially transform dirty backwaters of urban areas into healthy green areas and desirable places to live. Organizations can improve the quality of the surroundings and generate acknowledgement for their contributions.

Environmentally-sustainable solutions and improved water quality

The delivery of sustainable principles and the integration of biodiversity measures are features of integrated design that are not fully represented in the current approach of organizations. There is potential to deliver all these extra measures as part of a new approach.



Water square: combining water storage with green space, social resiliency and cost benefits, Spangen, Rotterdam

Cost benefits

The integration of sustainable solutions for flood protection, the development of long-term alternative solutions, as well as the benefits of integrated users, are all reasons why the application of design thinking can lead to significant saving for the organization, or across the range of organizations involved, over the long term.

Higher levels of collaboration with external stakeholders and other governmental bodies

The need for a multidisciplinary approach that embraces new alliances and collaborations with external stakeholders is essential to allow projects to happen for a design-led approach. The shared approach promoted by design thinking allows a greater level of participation. Public Government and engineers can play a key role in increasing levels of collaboration with external stakeholders and other governmental bodies.

Societal benefits

Application of design thinking has the potential to create huge societal benefits above and beyond flood protection. It will enable organizations to coordinate and encourage the development of multiple benefits, including the development of amenity networks, recreational spaces, new nature areas, and green amenity spaces.



River edge park: combining flood safety, ecology and a green space for the city, Houtan park Shanghai (Turenscape)

3. Recommendations: guidelines and principles for a resilient Zhuhai

Main strategies used by urban planners and designers to facilitate mitigation and adaptation in cities are reducing waste, heat and greenhouse gas emissions through energy efficiency, transit access, and walkability; modifying form and layout of buildings and urban districts; use of heat-resistant construction materials and reflective surface coatings and increasing vegetative cover. The Dutch approach has led to new and innovative approaches discussed in this chapter.

3.1 Comprehensive urban water strategy

A comprehensive urban water strategy includes the principles of retention, storage and discharge at all levels of scale.

Retain

Retention means that precipitation is held where it falls. This can happen on ground level, on (green/blue) roofs or through infiltration in the soil. Retention strategies act like a sponge by slowing rainwater down. This slower rate of flow gives more time for the drainage to do its job.

Store

Store strategies temporarily take excess water out of the drainage system. This water can later be returned once the system has recovered capacity.

Retain

Discharge

While retain and store address water going in, discharge strategies address water going out, removing water from the system. Additional pumps, and alternative drainage routes, increase the rate in which this can occur. Discharge does not only have to prevent floods.

Resist

Finally resist is an essential part of the resiliency strategy. Keeping water out urban area's or buildings is a basic principle to reduce stress and damage on the urban infrastructure. This principle works on the different levels of scale (regional, neighbourhood, building). Where levee systems are the basic principle on the larger scale, making explicit choices on the scale of the building (height of base level, wet-proofing or dry-proofing) is crucial for resilient development.

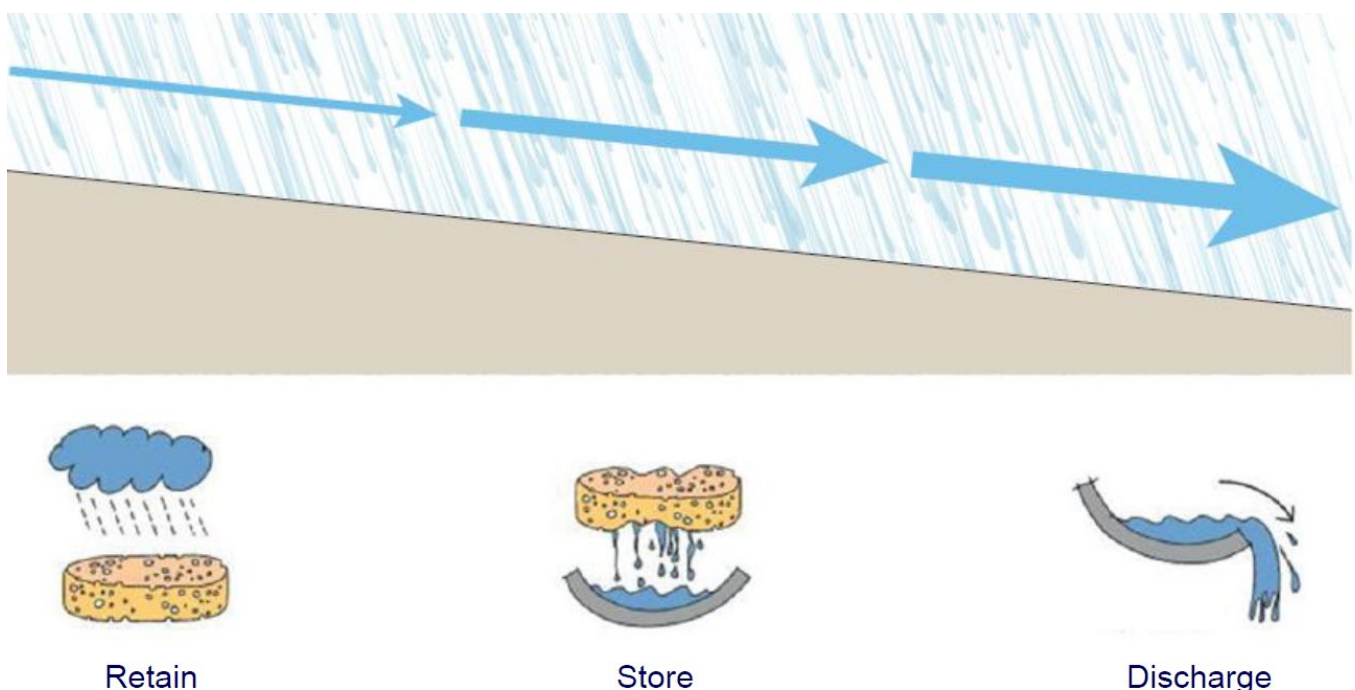


Figure 6. Basic Dutch water management principles.

3.2 Multifunctional levee design

Population pressure on coastal areas determines the need for multipurpose levees, which are structures that combine flood protection with other necessities of a population. Multifunctional levees aim to solve spatial issues and merge new structures in harmony with the existing environment. A multifunctional approach generally leads to higher acceptance. Examples of multifunctional levees are parking garages in quays, houses whose façades retain water and wind turbines on dikes.

Investments in multifunctional levees asks for a clear vision and an integrated approach. Multifunctional levees often have atypical structural elements that require an approach that is different from the traditional one. The lack of official standards or guidelines requires a more detailed scoping study to estimate whether the levee is sufficiently reliable.

The realization of multifunctional levees often implies a complete redevelopment and redesign of the urban waterfront. Uncertainties caused by demographic changes and climate change require flexible design concepts. It is necessary to develop construction methods and design that enable easy replacement or adjustment with minimal destruction or demolition.

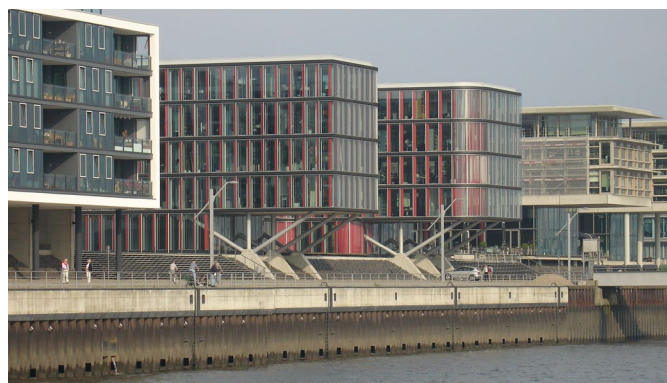


Figure 8: Integrated flood protection measures in Amsterdam (above) and Hamburg (below).

Revision of Technical Guidelines Chapter: 2 Land Use Classification and Urban Land Use Planning, Chapter 4 Urban Transport Infrastructure 5.9.5 Urban flood control, waterlogging prevention and tide prevention, Chapter 7 The Utilization of the Underground Urban Space and Chapter 9.1 Ecological Protection

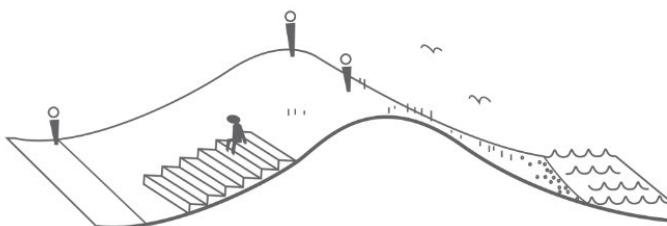
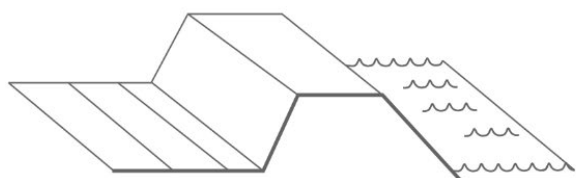


Figure 7: Left: Levee providing flood safety but blocking the view and no additional benefits. Right: multifunctional dike with multiple uses providing views and ecological benefits.

3.3 Integrated flood protection

It is estimated that, by 2050, the number of people living in flood-prone areas will be around 15% of the global population, assuming business-as-usual developments. Applying integrated flood protection measures can add quality to the environment and if implemented well, increase the overall quality of life.

Integrated measures do not only involve levees, storm surge barriers and dams, but also flood-proof construction methods, spatial development, ecology, traffic plans, etc. An integrated flood risk strategy should be based on a careful exploration of options, taking into account various types of measures. In order to implement them, and to avoid making a problem worse or pushing it to another jurisdiction, it is important to understand the:

- type of flood;
- source of flooding;
- probability of flooding;
- vulnerability of assets.

In addition to this, flood resilient constructions and buildings have become an essential component of the integrated approach to flood risk management. Flood resilient construction strategies are categorized into three types; avoidance (elevation), water exclusion (dry proofing), and water entry (wet proofing). The avoidance approach is the most commonly adopted approach, mainly through elevation and landscaping systems.

- Flooding maps based on floods of annual, 10 and 100-year probable flood events are a key tool in the prescription and design of flood defences and water management.
- Smart design principles with a focus on resilience instead of robustness include: heightened building levels (see Figure 7), floodproof (focus on waterlogging) facades and waterproof technical systems.
- For specific functions (critical infrastructure, hospitals, safety shelters) extra attention on the functions during stress events or calamities.
- Design and construction of new buildings as well as adaptation of existing buildings to make them resilient to flooding play an important part in mitigating the damage caused by flooding.
- Planning and implementation of integrated flood protection measures requires close cooperation between the various social actors and a clear division of responsibilities between government, private companies and citizens.

Revision of Technical Guidelines Chapter: 5.9.5 Urban flood control, waterlogging prevention and tide prevention, 6.7 Architectural Design Codes



Figure 9: water resistant construction methods in the center of Dordrecht, The Netherlands (© Robin)

3.4 Blue-Green building design

In a busy city with a high density, the roof landscape provides space for a multifunctional use. The introduction of circular water principles on the level of building plots can contribute to a successful resilient city approach.

Water carrying roofs are meant as a measure for climate adaptation and improvement of the biodiversity. On blue-green roofs extra (blue) water can be stored under the green plant layer, while plants continue to evaporate during heat and drought. As a result it stays cooler in the buildings and neighbourhood and the houses and their surroundings are thus better protected against heavy rain, drought and heat. This also allows a wider variety of plants to grow, increasing biodiversity.

Blue-green roofs can have a 'smart flow control', using sensors. It enables the roof to retain or discharge water based on the weather forecast. The roofs can be linked together in a network, allowing a new level of micro water management at neighbourhood and building level.

- Green roofs are vegetated roofs. These can be extensive; for example a grass roof. An intensive green roof is often accessible and contains a broad mix of plants.
- Roofs on high rise buildings are suitable for biodiversity; they are unreachable and provide overview for hunting animals and shelter for prey.
- Harbours and industrial areas are characterized by a functional structure and organization. Building are often surrounded by pavement, necessary for logistics. By greening roofs here, the ecological potential of the harbour can be increased.

Revision of Technical Guidelines Chapter: 6.7 Architectural Design Codes, 6.8 Green Building Planning and Design Guidelines



Figure 10: A Blue-Green (retention) roof in Amsterdam to increase the sponge effect of the city.

3.5 Critical and vulnerable infrastructure

Climate change may lead to an increased risk for critical and vulnerable infrastructure. It is important to quantify potential increases in risk, with the aim to reduce future vulnerability. In order to implement effective adaptation strategies, it is essential to understand the existing risk and the possible future risk. This can only be achieved through detailed analysis and quantitative modelling of existing networks, incorporating uncertainty and variability. Better information can impact the perceived costs and risks for private- and public-sector decision makers.

The resilience of modern infrastructure systems in the face of climate impacts is integral to maintaining thriving communities. Yet, many infrastructure systems such as energy, telecommunications, food etc. are often privately owned, and it can be challenging for governments to engage with these sectors in an integrated, mutually beneficial way on adaptation planning issues.

Interdependencies between different infrastructure systems, including weak links or points of potential failure are shown, the results of which are shown in Figure 8. An example of an interdependent system can be seen by following the lines from the 10 kV substation. If the substation goes out of service due to an extreme flood event, it would disrupt electricity supply to the booster pumping station, which in turn would stop the inflow of wastewater into the sewage treatment plant, lead to potential backflow of wastewater into various facilities in the city, and contaminate clean surface waters.

3.6 Awareness strategy

The implementation of climate resiliency measures might face resistance or little commitment from local stakeholders. Resiliency measures will be more common in maintenance, restructuring and development. Therefore a general awareness program on climate change and relevant and necessary measures is considered essential. Structure, tone and impact of the awareness strategy should be developed from a local perspective. Multiple target groups and stakeholders should be involved for a broad acceptance. A fitting strategy is essential with inclusion of broader municipal ambitions and themes, for instance The Green City, The Liveable City etc.

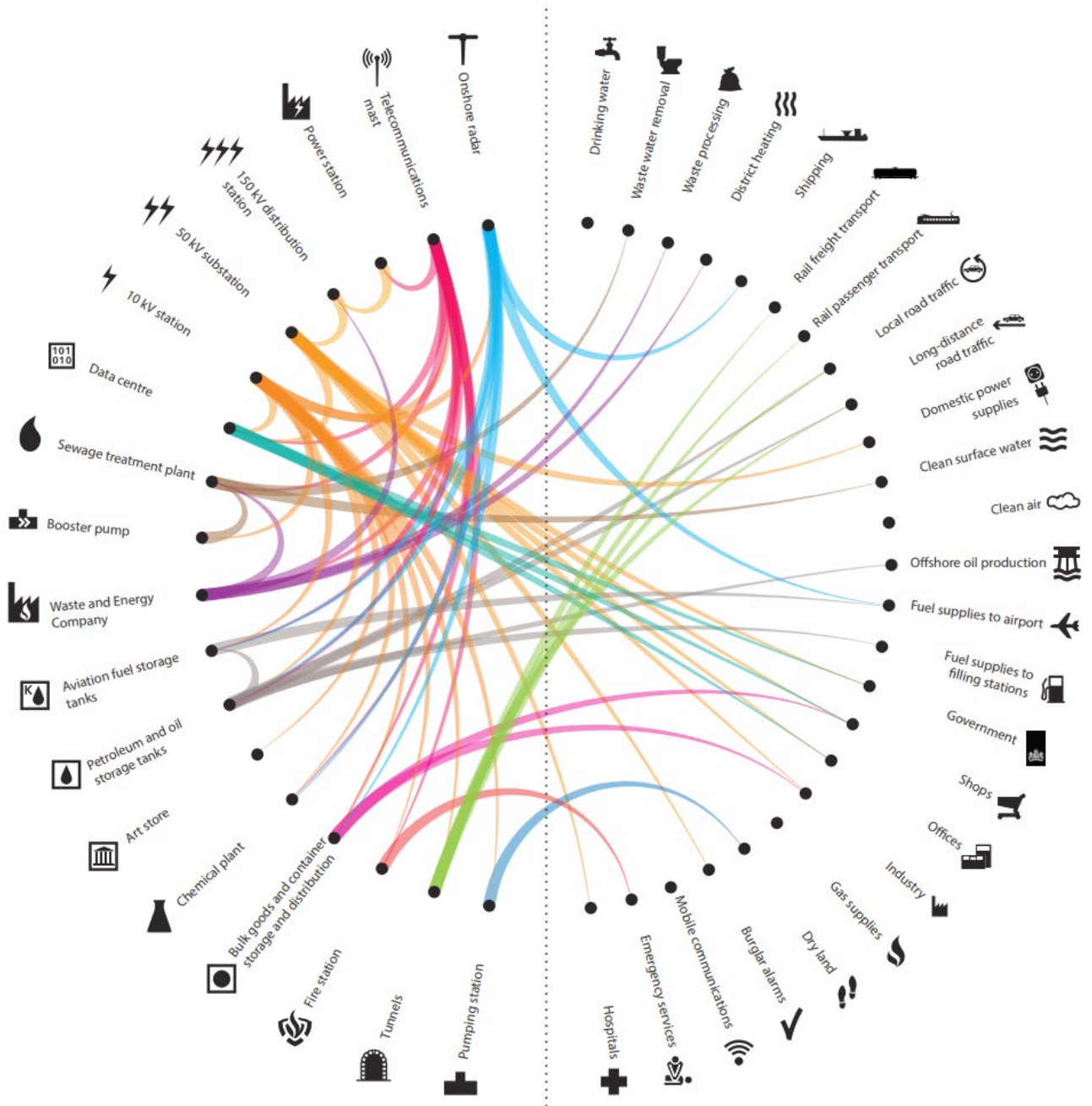


Figure 11: Amsterdam Westpoort Harbour District Pilot Study, Interdependencies graphic show relations in vulnerabilities between different sectors and systems due to climate stress.

4. Solutions

In this chapter, specific solutions – following the recommendations from the previous chapter – will be elaborated. This showcases how climate resilient measures can be incorporated in technical guidelines.

4.1 Landscape typology mapping as a methodology

Landscape typology is important when landscapes are exposed to dynamic influences like land use change and urbanization. Typology mapping may be done either by dividing larger units into smaller ones or by grouping smaller units into larger wholes. Typology mapping is used to search for general features distinguishing the landscape from the surroundings, however uniting it with landscapes of similar features. A landscape typology map helps to better understand the problem.

Landscape typology mapping also helps to provide insight into the level of vulnerability of an area. If the area inland of the coastal infrastructure is vulnerable - meaning that failure of the infrastructure could easily result in loss of human lives, extreme property damage or the destruction of unique and sensitive ecosystems - the infrastructure strategy must be robust to prevent for such consequences.

4.2 Custom made toolbox for Zhuhai

In a design led approach the combination of safety and quality is important, Solutions are not solely based on engineering, but improve urban and landscape conditions. This approach integrates a wider spectrum of needs to include other requirements such as biodiversity, urban planning, agricultural development, public realm etc. into a single unified vision.

Investment in flood safety measures is expensive, they take a lot of time and, if executed properly, last for a long period. This justifies an approach that is also beneficial to the city or landscape on a day to day basis. For Zhuhai we worked on making this method visible. To find the correct solutions for flood measures we made a first setup or sketch for a custom-made toolbox for Zhuhai.

We first look at the total landscape in bird's-eye view. This shows us the distinctive challenges together with landscape and urban typologies (Appendix II). In this overview we recognize different landscape typologies in Zhuhai:

- delta landscape between the Pearl river and the fluvial system of the Modaomen Shuidao;
- low lying agricultural landscape, sedimentation that formed a delta;
- urbanized, low lying, areas, sedimentation between mountains;
- mountains, green areas;
- coastal zone at the edge of the Pearl River.

Combining these different landscape typologies with tools and references in the toolbox (Appendix III), allows us to work towards a set of customized tools that combine quality with flood safety.

5. Suggestions for Zhuhai Urban Planning Technical Standards and Guidelines

The following paragraphs can be integrated in the Zhuhai Urban Planning Technical Standards and Guideline (version 2015).

Chapter 1. General Guidelines

Zhuhai is characterized by a rich variety of landscape typologies. The green woody mountains, the low lying - mostly agricultural - areas and polders, the oceanside, the rivers and the densely built lower lying neighbourhoods of the city. Urban development should enhance this variety of landscape typologies. Quality of the environment is equally important to safety and sustainability in relation to climate change in the development of the city.

Chapter 2. Land Use Classification and Urban Land Use Planning

Land use classification should be considered in relation to climate stressors. Low lying areas are more flood-prone than the elevated urban areas. Critical functions should be planned in areas with a lower climate stress. Elevated standards for flood defences (levee systems and at building scale) should be considered for low lying vulnerable areas with high risk impact.

It is important to combine analysis with urban typology mapping and land use classification. For each class name or class code, a specific accepted level of climate stress and relevant mitigating measures should be connected.

- Example: Residential buildings in flood zones (elevation < x m) need a specific layout of the technical structures that shields them during a flood.
- Example: No medical facilities can be built in the flood zone, unless base elevation is above standard future flood line including the road system

Chapter 3. Public Facilities

Public facilities can be categorized into vulnerable or less vulnerable facilities. A standard with focus on flood-proof of climate robustness should be considered. For specific facilities (example hospitals, powerplants, data centres) the robustness of the location should be considered leading.

Chapter 4. Urban Transport Infrastructure

Transport infrastructure is characterized by its network design. In this design, the different chains or elements in the infrastructure function should be analysed for its network capacity. Failing terminals (flood vulnerable) can influence the whole system, a typical example of system specific interdependency.

Chapter 5. Municipal Engineering and Disaster Prevention Facilities

This category can often be labelled as vital and critical infrastructure. An extra focus on resiliency is necessary. The placement of vital facilities in the urban fabric and in relation to the vulnerable flood zones should first be considered. A heightened level of robustness is relevant. Extra costs are often relative in relation to the possible damage that can occur during a flood or climate related stress.

Chapter 7. The Utilization of Urban Underground Space

In a densifying urban environment the creation of underground structures is a standard mean. These underground structures are vulnerable for flooding and require extra attention to resiliency and robustness of the programmed functions. Examples are the placement of back-up systems, technical installations for the building function and computer servers.

Chapter 8. Special Control District

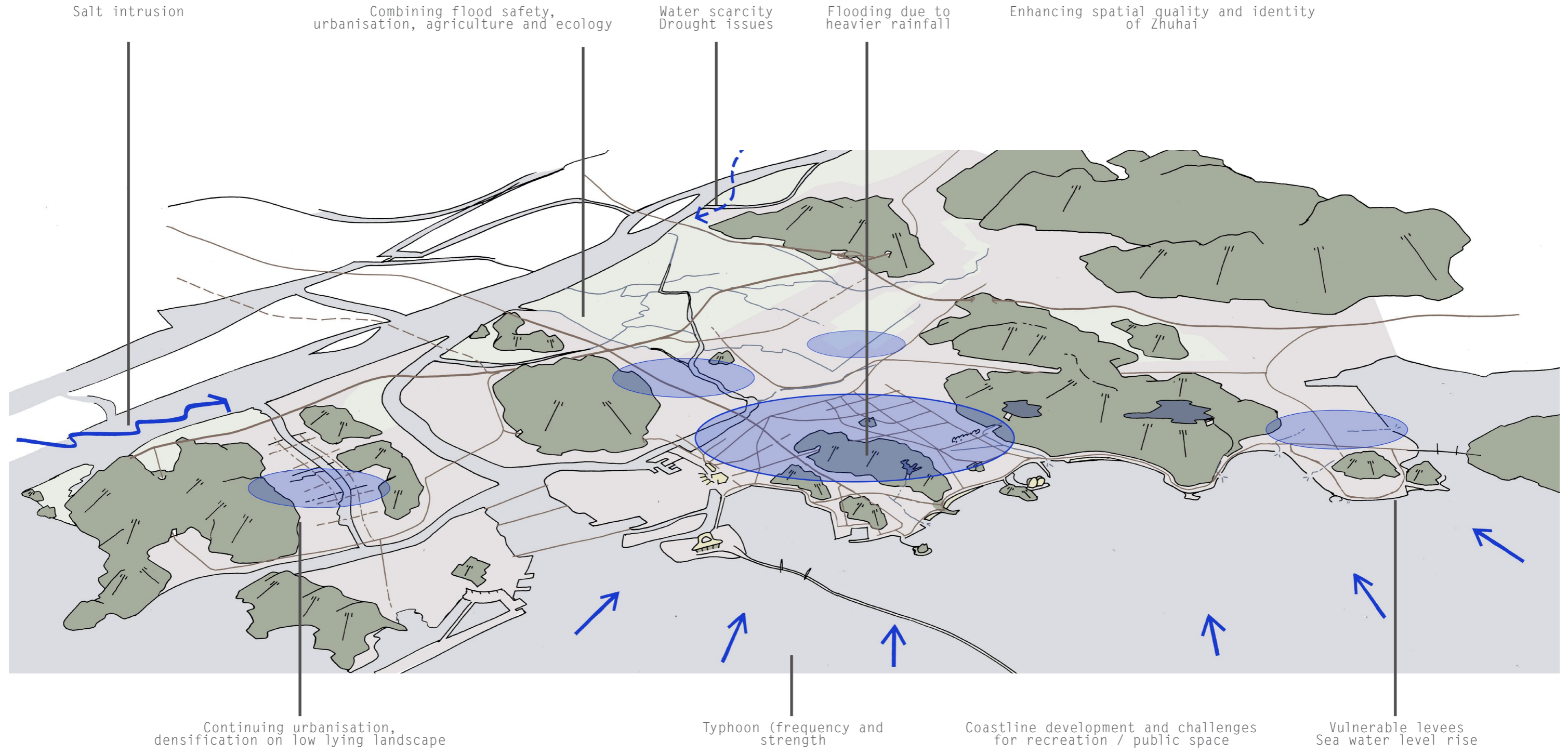
A focus on Special Control Districts is a start for a urban typology mapping. In the Special Control District, attention is addressed to the development of certain functions. A climate stress analysis for each district can help in planning the right measures concerning the ambition on climate resiliency.

Chapter 9. Ecological Protection and Historical Inheritance

In the protection of ecological functions changes in riverine discharge and accompanying salt-influx should be considered. An important ecological function of healthy riverine and coastal ecosystems is that they can provide a robust area that can decrease the impact of flood surges and overtopping of waves.

Appendix I, Challenges

Possible challenges for Zhuhai concerning climate change



Appendix II, Safety and Quality

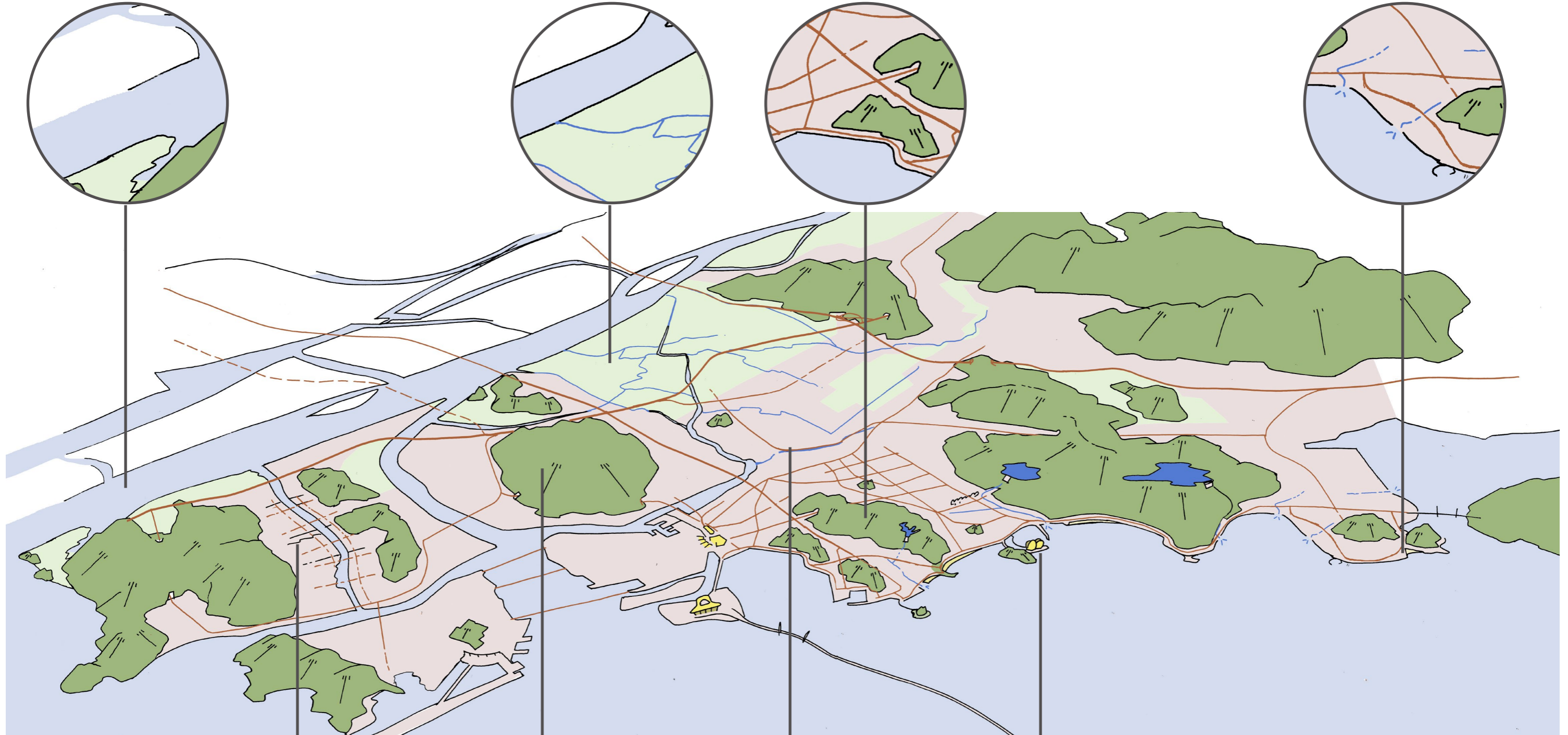
Possible opportunities in Zhuhai for integrating flood safety with improvements in urban development and landscape

Flood safe / preventing salt intrusion / agriculture

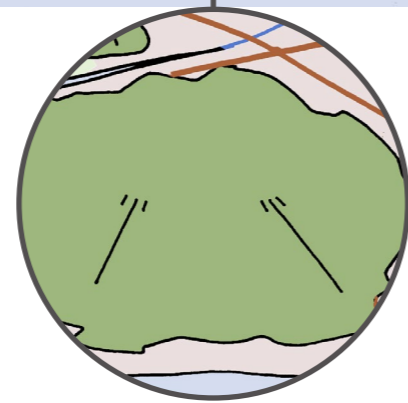
Flood safe / Ecologically sound / building with nature

Flood safe / renewable thriving communities / blue green building design

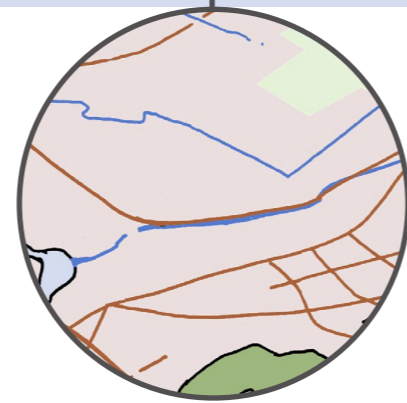
Flood safe / diverse coastline, Lovers Road / integrated flood protection



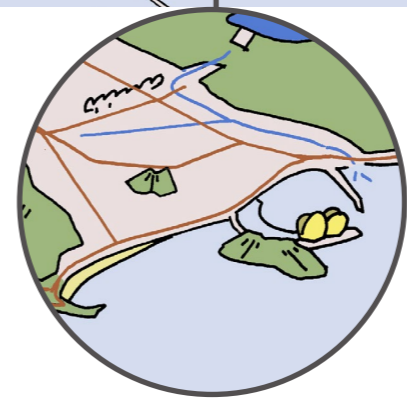
Flood safe development / integrated flood protection / integrating water, ecology



Strong green identity of Zhuhai / infiltration



Infrastructure / water retention / public space



Typhoon resistant / Multi levee design

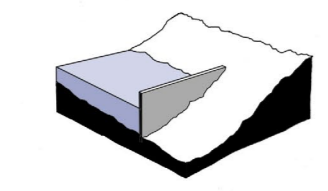
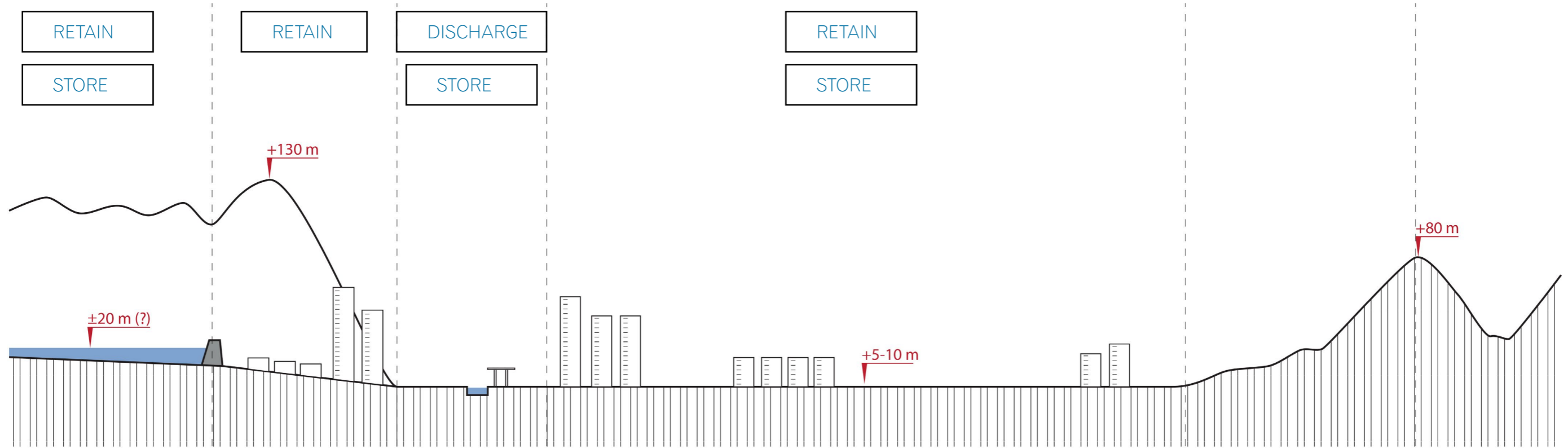
Appendix III, Toolbox

Location of the sections

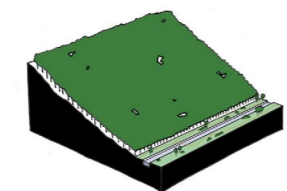


Appendix III, Toolbox

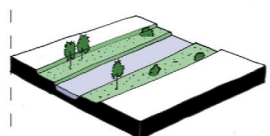
Section A: Interventions in the city



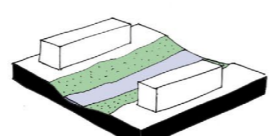
1. water reservoirs
 - flood prevention
 - fresh water supply



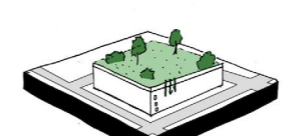
3. park
 - water storage/ discharge
 - park/recreation



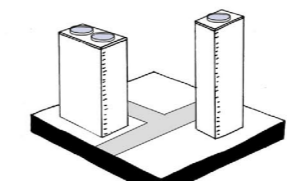
5. soft embankments
 - infiltration
 - recreation



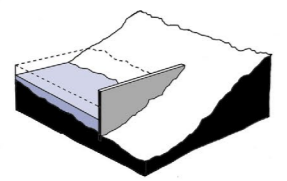
7. wadi/bioswale
 - infiltration
 - purification & recreation



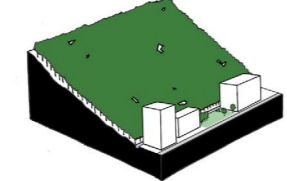
8. green roof
 - retain
 - (semi) public park



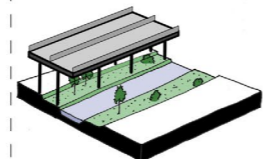
9. water basin on roof
 - storage
 - double use of space



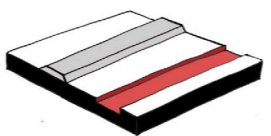
2. flexible water level
 - extra storage capacity



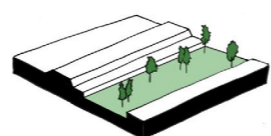
4. small park
 - water retention/ storage
 - park/recreation



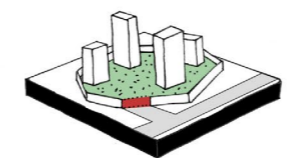
6. park under highway
 - infiltration/ discharge
 - park/ recreation



10. lowered infrastructure
 - storage
 - double use of space



11. raingarden
 - retention and storage
 - park/recreation



12. enclosed communities
 - local infiltration
 - (semi) public park
 - local flood protection

Appendix III, Toolbox

Section A: Interventions in the city

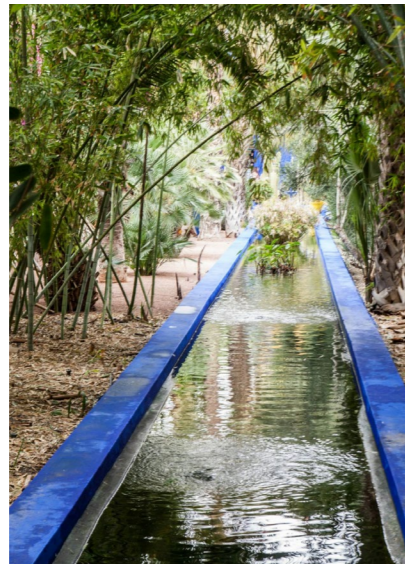
RETAIN
STORE

RETAIN

DISCHARGE
STORE

RETAIN
STORE

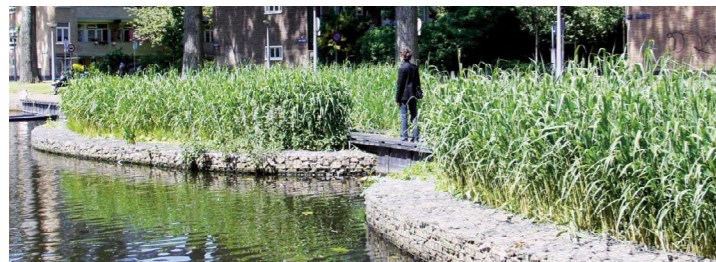
Existing lakes,
terraced landscape
Erosion prevention



Delay, water garden
Marrakesh



Water garden,
delay, purification,
Bordeaux



Floating garden, delay, purification,
Amsterdam



Discharge canal, park,
Seoul



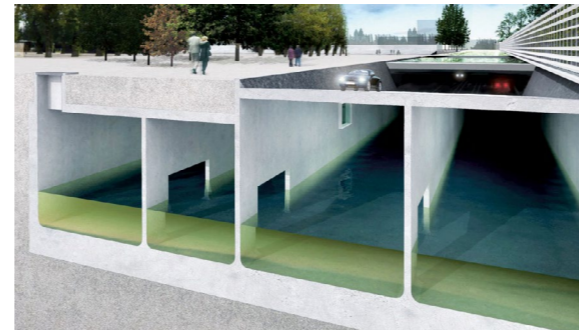
Watersquares, green in combination concrete basins /
underground storage with green, Rotterdam



Delay, water storage,
Roofpark, Rotterdam



Delay, water storage, roof garden,
agriculture, Rotterdam



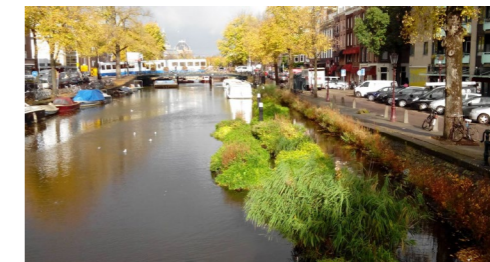
water storage under car
parking, Rotterdam



Delay, water storage, bikepath, The
Netherlands



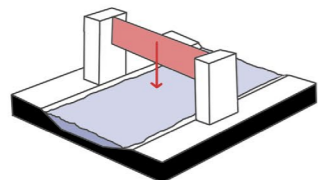
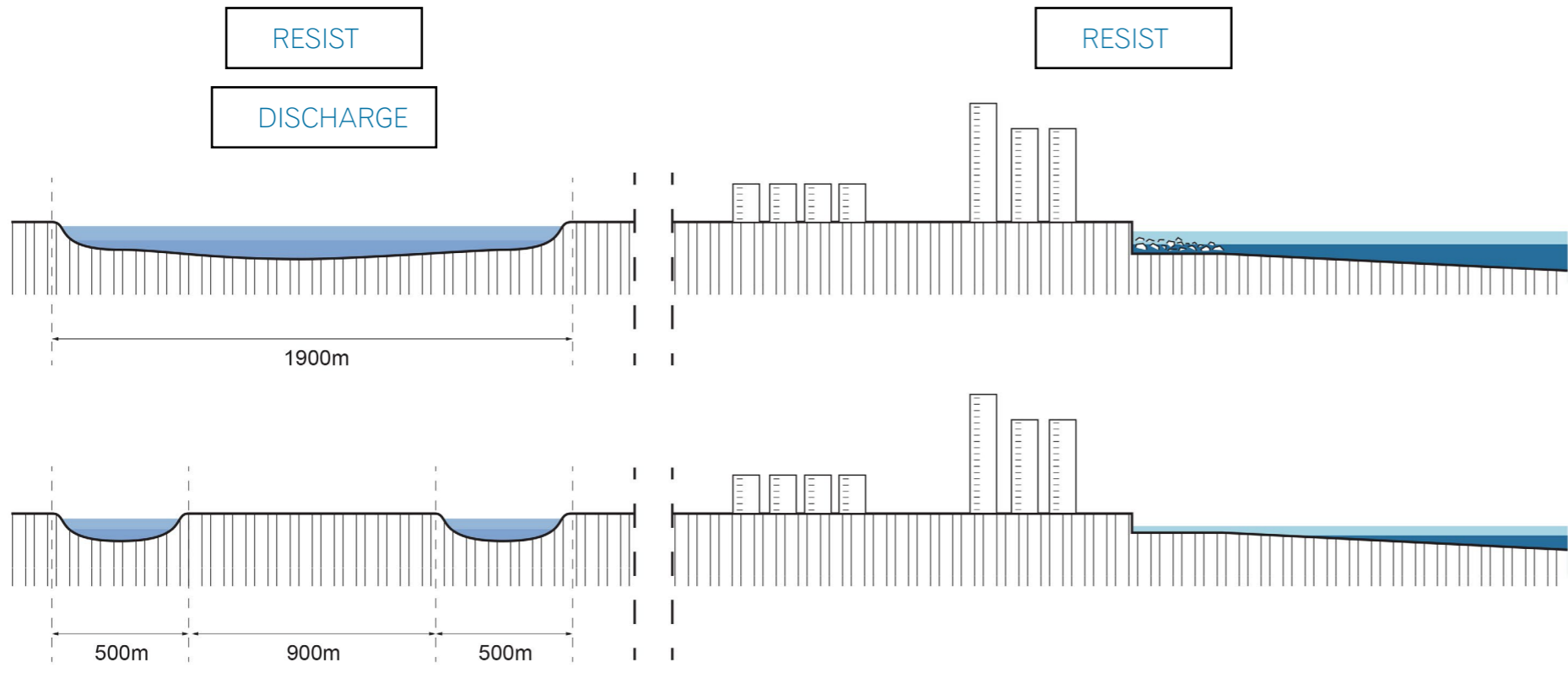
Bioswale, groundwater recharge, green street
profile, Amsterdam



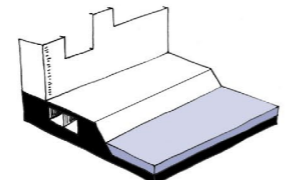
Water purification, Amsterdam

Appendix III, Toolbox

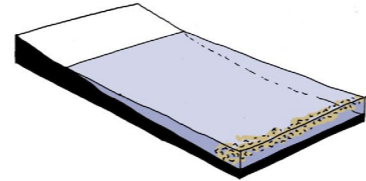
Section B: From river to the sea



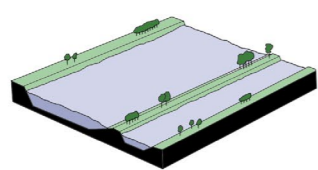
13. storm surge barrier
 - protection of hinterland
 - can be combined with a bridge



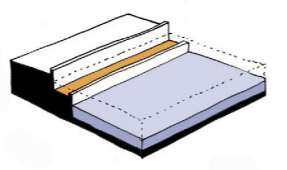
15. multifunctional levee
 • - flood protection
 • - double use of space



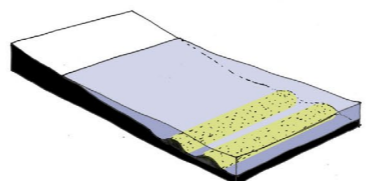
16. artificial reefs
 • wave reduction
 • biodiversity



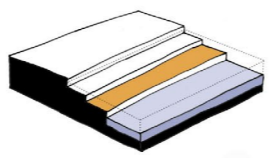
14. Room for the River
 • lowers water levels
 • recreation/development



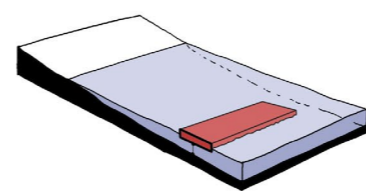
17. floodable quay
 • flood protection
 • recreation/awareness



18. sandbanks
 • wave reduction



19. multiple level flood defence
 • flood protection
 • recreation/awareness

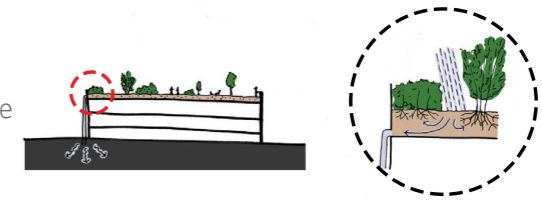


20. floating wave barrier
 • wave reduction
 • energy production

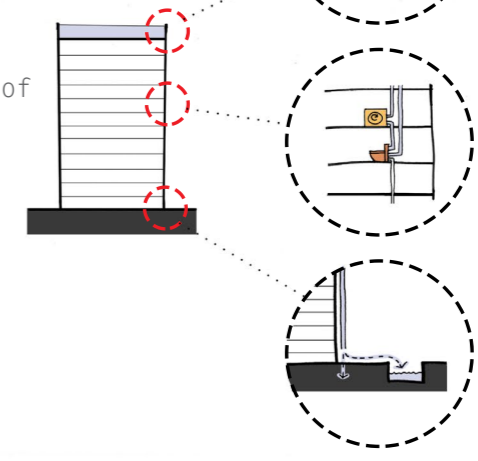
Blue-Green buildings

RETAIN

21. green roof
 • retention/storage
 • park/recreation



22. water storage on roof
 • retention/storage
 • re-use rain water

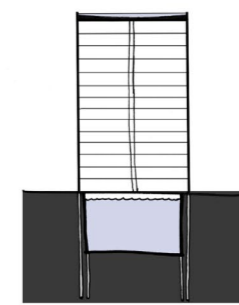


22a. Re-use of rain water
 • retention/storage
 • green facade

22b. Re-use of rain water
 • retention/storage
 • reduces water consumption

22c. delayed discharge
 • retention/storage
 • buffer for dry period

23. underground water storage
 • retention/storage
 • re-use of rain water



24. floodproof building
 • local resistance
 • no/little damage



Appendix III, Toolbox
Section B: From river to the sea

RESIST

DISCHARGE

RESIST

RETAIN



Flood gates, infrastructure, Europoort Rotterdam (NL)



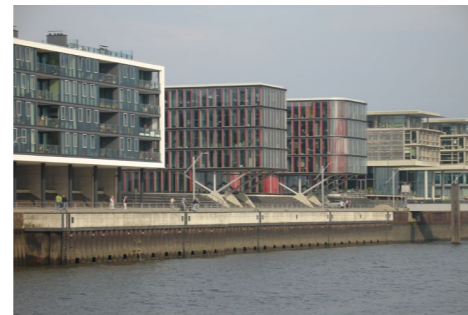
Room for the river, ecology, dynamic landscape, Nijmegen (NL)



Sand engine, provoke sedimentation, The Hague (NL)



Waterfront, tunnel (study), Rotterdam (NL)



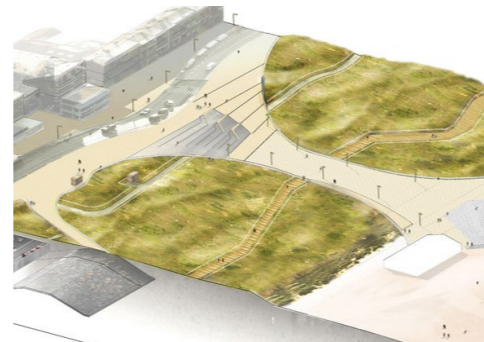
Waterfront, building, quay, Hamburg (D)



Layered, multi functional flood defense, The Hague (NL)



Flood defense, tidal park, Antwerp (BE)



Flood defense, dunes, beach, underground parking, Katwijk (NL)



Off-shore breaking waves, mitigation, natural reef
Tha Chin Delta



The George, Amsterdam (NL)



Zuiderspoor, Rotterdam (NL)



Consulting report for guidelines, principles and process for a resilient Zhuhai

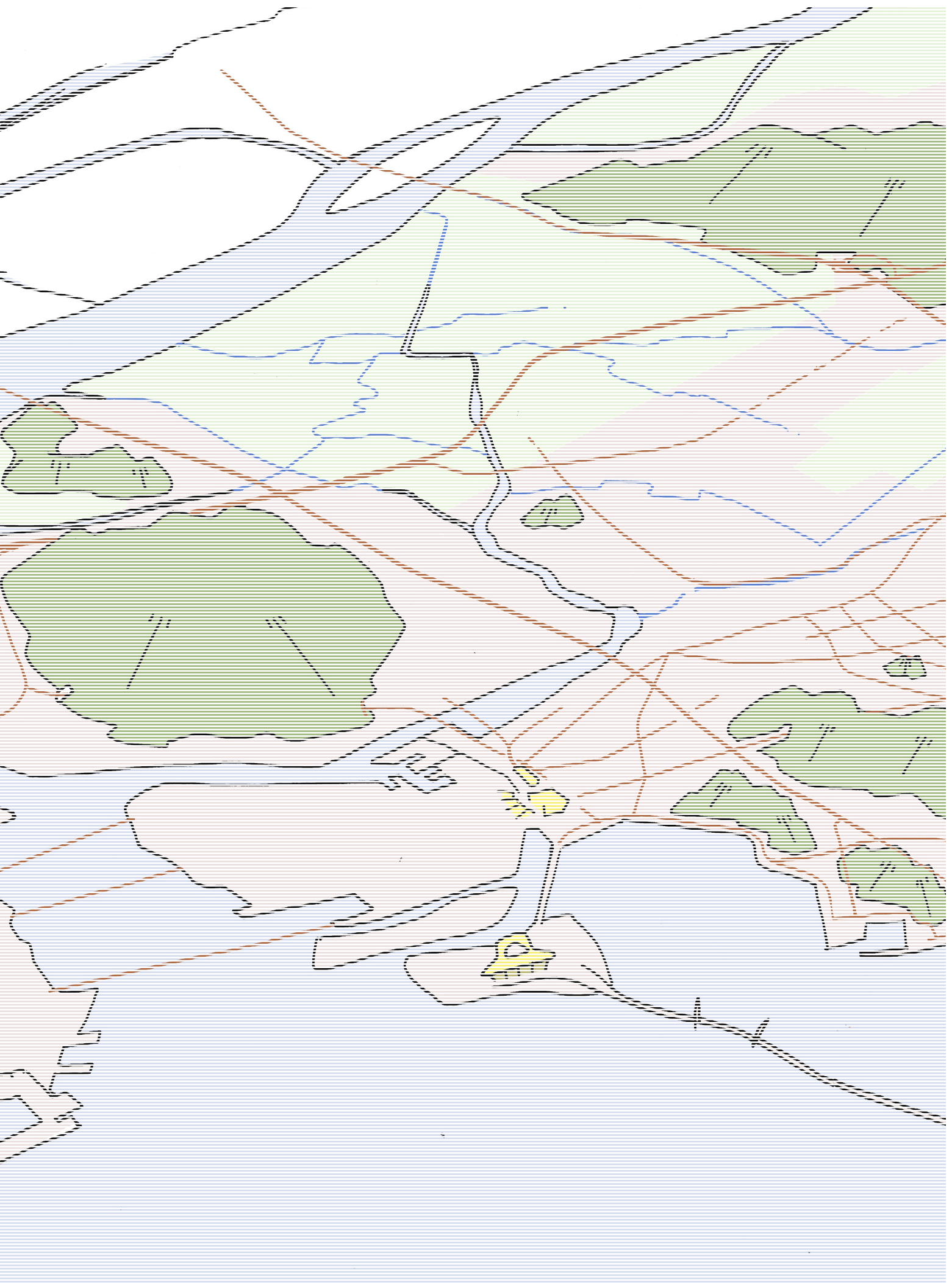
References

May 2019

Kasper Spaan, Marcel van der Meijs, Marieke van Nood

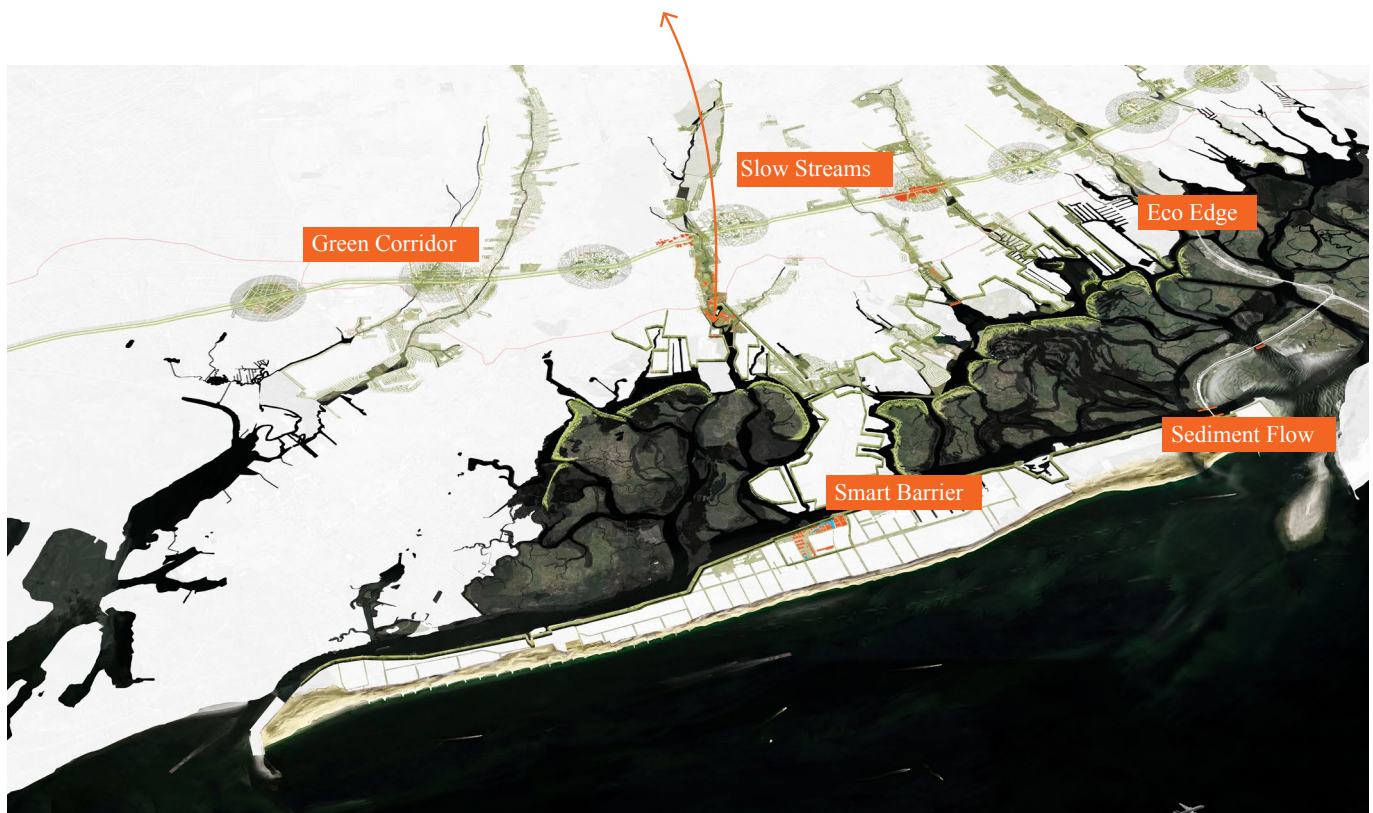


Europe-China Eco-Cities Link
中欧低碳生态城市合作项目



Living With The Bay, Long Island, USA

Five prototypical conditions Ocean shore, Barrier islands, Marshlands, Estuary and Highlands



At the scale of the sub-region, we zoomed in and focused on high-impact areas within Nassau County to develop prototypical resiliency strategies for ocean shores, barrier islands, saltwater marshes, creeks and river estuaries, and highlands, respectively. While the plan zeroes in on a particular ocean shore (Long Island's), barrier island (Long Beach Barrier Island), saltwater marsh (West, Middle and East Bays), river estuary (Mill River), and highland (Sunrise Highway corridor), each strategy is prototypical, and broadly applicable elsewhere in the Sandy-affected region.

General project information / Specifications:

Location: Long Island (New York)
Country: USA
Year: 2013-2017
Design: Waterland Design, EU-team: Palmbout Urban landscapes (NL), HNS Landscape Architects (NL), Bosch Slabbers Landscape Architects (NL)

Main characteristics:

- Combining flood safety and climate change with ecology, recreation and urban development
- Soft coastal engineering
- Water purification
- Education and creating awareness

Description

The Living with the Bay regional plan provides a comprehensive suite of resiliency interventions for Nassau County's South Shore. Because Nassau County faces multiple water-related threats, there needs to be a range of responses. Indeed, there are no "silver bullet" solutions here. The way forward is a robust resiliency program.

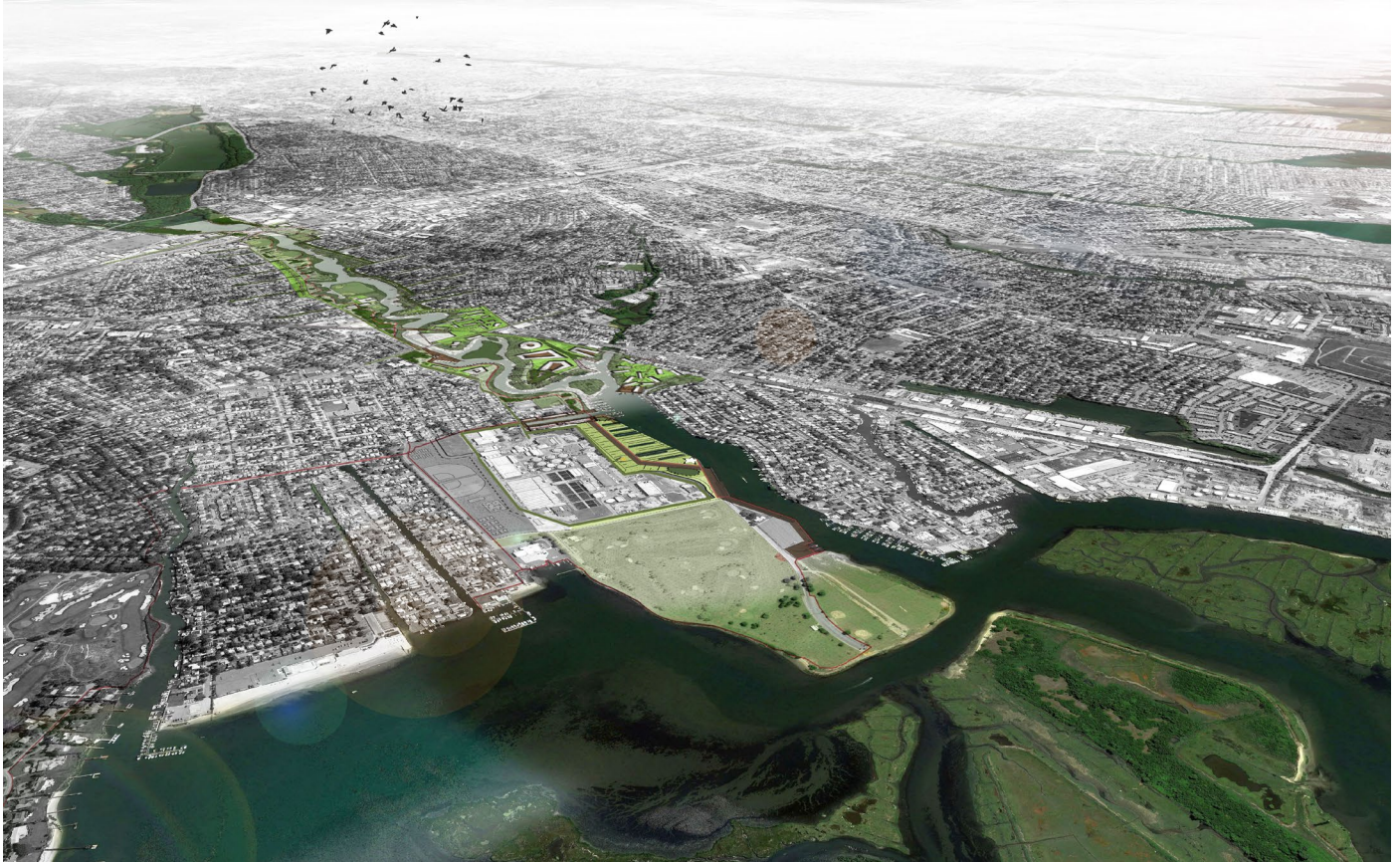
At the scale of the region, we have developed a draft, long-range, comprehensive, regional resiliency plan, the 'Buffered Bay'. The project contains strategies for flood defense (smart barrier, sediment flow and eco edge) and upstream strategies for creating space for water (slow streams: park areas, water purification, dams, routing).

LINKS AND REFERENCES

[HTTPS://WWW.PALMBOUT.NL](https://www.palmbout.nl)

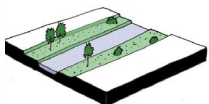
[HTTP://WWW.HNSLAND.NL/EN/](http://www.hnsland.nl/en/)

[HTTPS://WWW.BOSCHSLABBERS.NL](https://www.boschslabbers.nl)

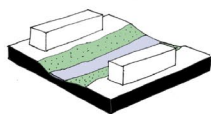


The living with the bay plan provides a comprehensive suite of resiliency measures for southern Nassau County. The 'slow streams' component was awarded \$125 in funding by HUD and further developed as part of the Mill River project.

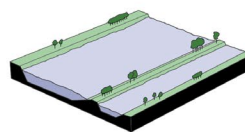
Link with the toolbox



5. soft embankments
- infiltration
 - recreation



7. wadi/bioswale
- infiltration
 - purification and recreation



14. Room for the River
- lowers water levels
 - recreation and development

The George, apartment building Amsterdam (NL)

Green living in the urban environment



Hanging gardens on balconies

General project information / Specifications:

Location: Amsterdam
Country: The Netherlands
Year: 2020
Design: Liesbeth van der Pol

Description

The gardens of Babylon
The building incorporates green inside and outside the façade with a hint to the hanging gardens of Babylon. A fully computer-controlled irrigation system is integrated into the green infrastructure to ensure exactly the right amount of irrigation for the more than 500 linear meters of green on the balconies. For this, the rainwater is collected in the special, cup-shaped roof that is lined with solar panels.

Main characteristics:

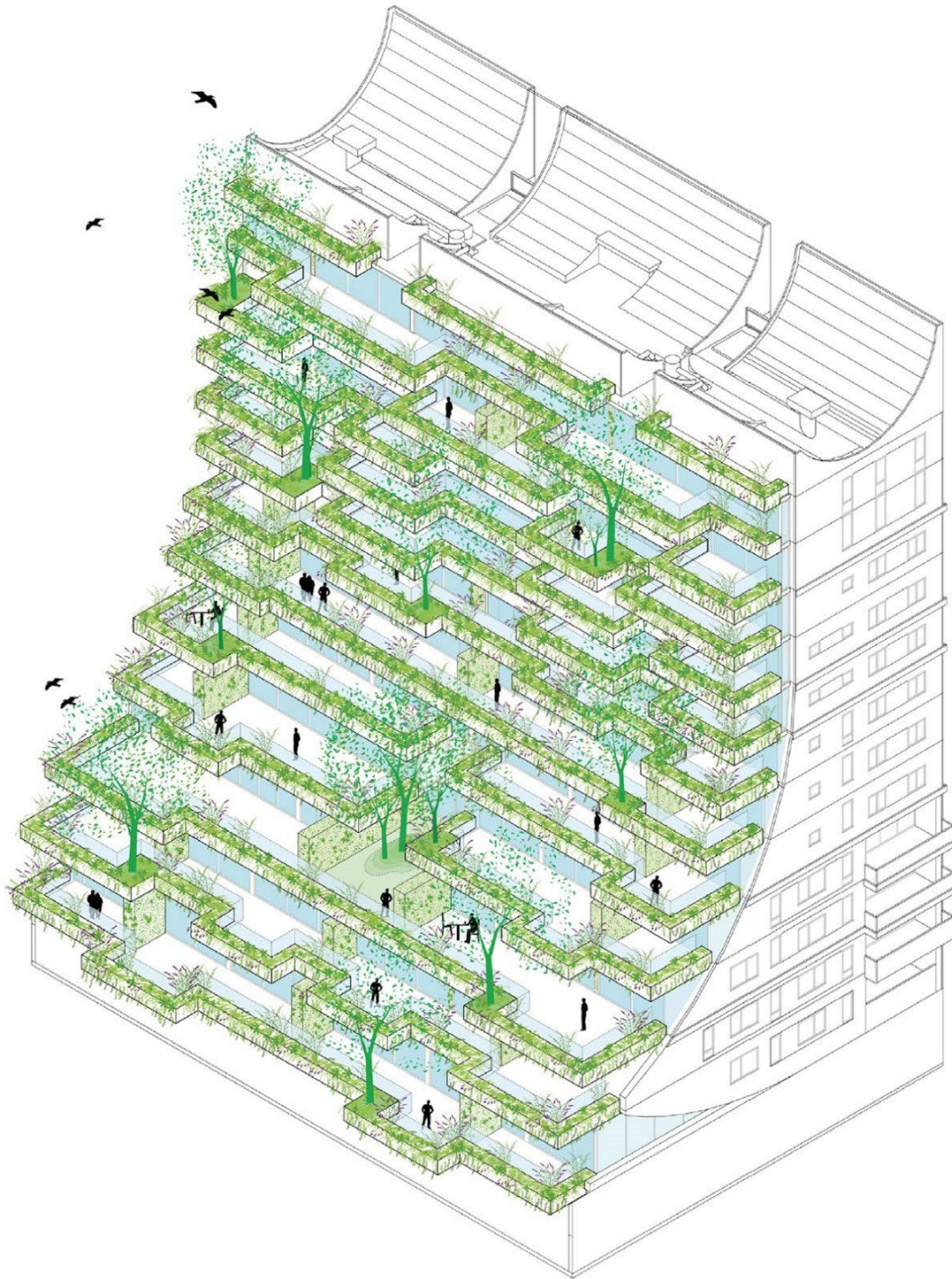
- Water catchment and storage
- Harvesting of rainwater
- Blue-green building

LINKS AND REFERENCES

[HTTPS://WWW.BPD.NL/ACTUEEL/BLOG/DUURZAAMHEID/PROJECT-THE-GEORGE](https://www.bpd.nl/actueel/blog/duurzaamheid/project-the-george)

[HTTPS://THEGEORGE.NL/EN/](https://thegeorge.nl/en/)

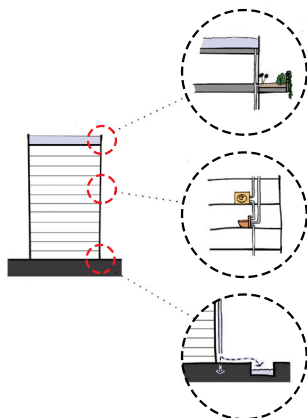
[HTTPS://BOOMLANDSCAPE.NL/EN/WORK/THE-GARDENS-OF-GEORGE/](https://boomlandscape.nl/en/work/the-gardens-of-george/)



Technical landscape

Link with the toolbox

22. water storage on roof
- retention/storage
 - re-use rain water



- 22a. Re-use of rain water
- retention/storage
 - green facade

- 22b. Re-use of rain water
- retention/storage
 - reduces water consumption

- 22c. delayed discharge
- retention/storage
 - buffer for dry period

Steigereiland, Amsterdam (NL)

Floating houses



Author: Luuk Kramer

General project information / Specifications:

Location: **Amsterdam**
Country: **The Netherlands**
Year: **Start 2001 - ...**
Design: **Marlies Rohmer, Waterstudio**

Main characteristics:

- flood risk reduction
- enhancing local identity

Description

Project description

The neighborhood of Steigereiland (Jetty-island) comprises a community of over 100 floating houses. In a relative high density with attention on the communal jetty system for amenities as sewage, drinking water and energy its is a diverse village. Floating real estate is a serious answer to rising water levels and flood threats. Other positive aspects are the highly valued direct relation with the water and the possibility of relocation of the homes.

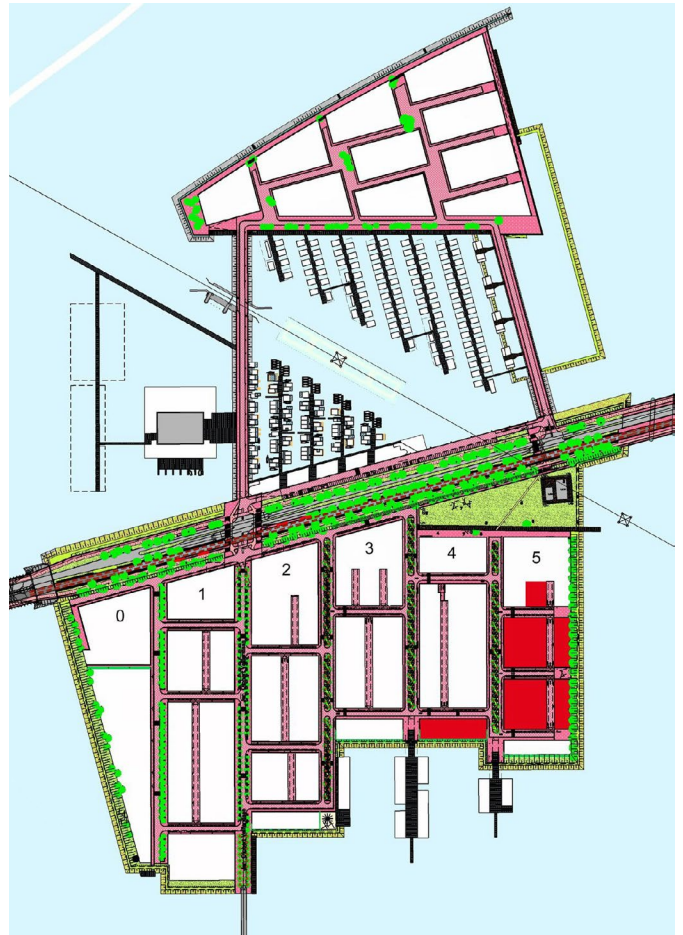
LINKS AND REFERENCES

[HTTP://WWW.ROHMER.NL/EN/PROJECT/WATERWONINGEN-IJBURG/](http://www.rohmer.nl/en/project/waterwoningen-ijburg/)

[HTTPS://WWW.WATERSTUDIO.NL/](https://www.waterstudio.nl/)



Living close to the water



Steigereiland

Coastal boulevard, Scheveningen (NL)

Flood defense integrated in public space



Overview of the new coastal defence which acts as a public space as well

General project information / Specifications:

Location: Scheveningen, The Hague
Country: The Netherlands
Year: 2012
Design: Manuel de Solà-Morales

Technical details

- A new levee is constructed and covered by public space
- Sand suppletion: 2,6 million m³ sand over 2 km of
- Highest point levee: 12 meters
- The boulevard is constructed in a way it cannot damage the levee during a severe storm.

Main characteristics:

- Combining flood safety and spatial quality in one project
- Separating the modalities by using elevations
- Creating more space for pedestrians and bikers, less space for cars
- Facilitating increasing numbers of visitors
- The new boulevard refers to the old wavy shape of the coastline

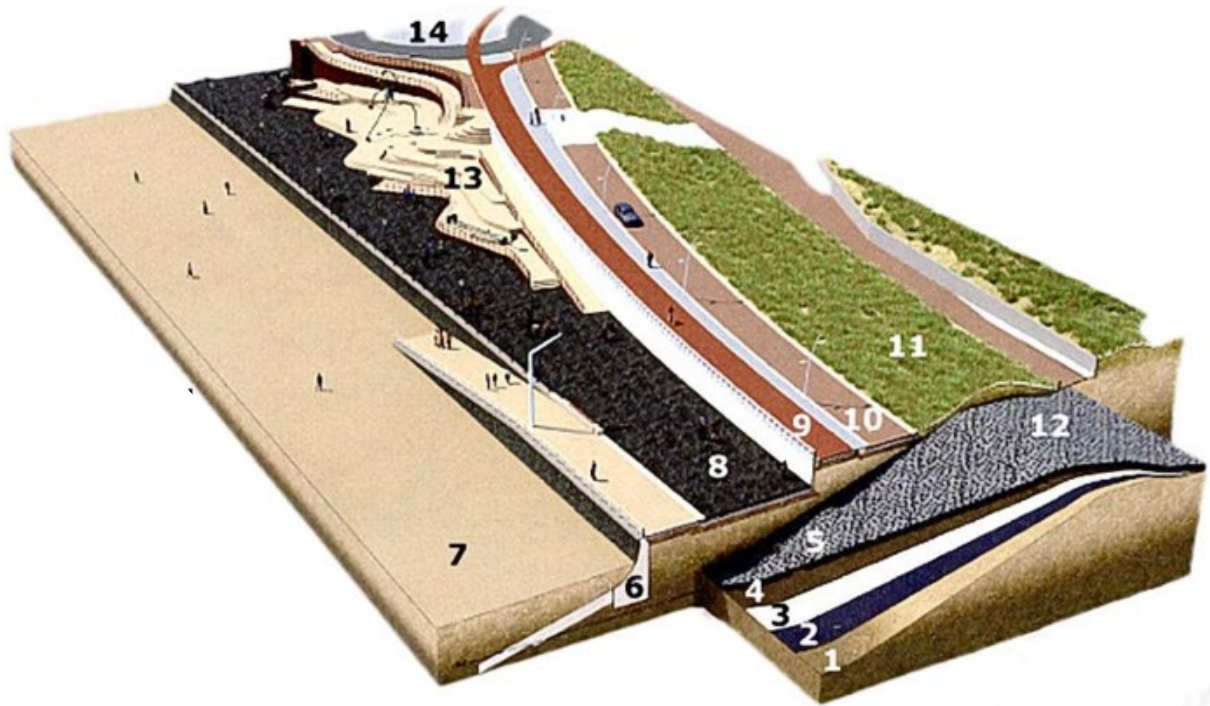
Description

The coast at Scheveningen was one of the weak spots in the Dutch coastal flood defence line and therefore it had to be enhanced. However, this part of the coast is popular for local, national and international visitors. The required improvement of the flood defence offered a great opportunity to give the public space an upgrade as well. This combined approach led to a design with a new levee which is covered by the boulevard.

LINKS AND REFERENCES

[HTTPS://WWW.EUROPAOMDEHOEK.NL/PROJECTEN/BOULEVARD-SCHEVENINGEN](https://www.europaomdehoek.nl/projecten/BOULEVARD-SCHEVENINGEN)

[HTTPS://WWW.DELTAXPERTS.NL/WIKI/INDEX.PHP/HWBP_BOULEVARD_SCHEVENINGEN_VN](https://www.deltaxperts.nl/wiki/index.php/HWBP_BOULEVARD_SCHEVENINGEN_VN)



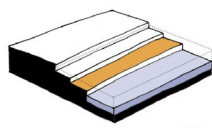
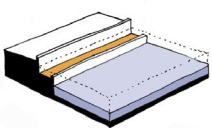
Section of the water defence, covered by the boulevard

1. Layer of sand
2. Layer of slag
3. Geotextile
4. Layer of slag
5. Basalt blocks
6. Wall at the beach
7. Beach
8. Boulevard
9. Bicycle lane
10. Road
11. Dune
12. Levee
13. Area with sculptures
14. Bus platforms



Detail of the new boulevard

Link with the toolbox



17. floodable quay
 - flood protection
 - recreation/awareness

19. multiple level flood defence
 - flood protection
 - recreation/awareness

Roof garden Zuiderspoor, Rotterdam (NL)

Retention garden for a densely built apartment block



General project information / Specifications:

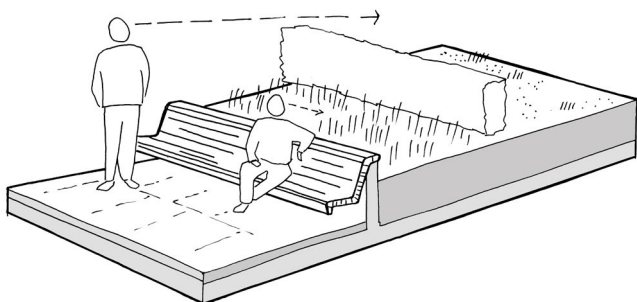
Location: Rotterdam
Country: The Netherlands
Year: 2013
Design: Palmbout Urban Landscapes

Description

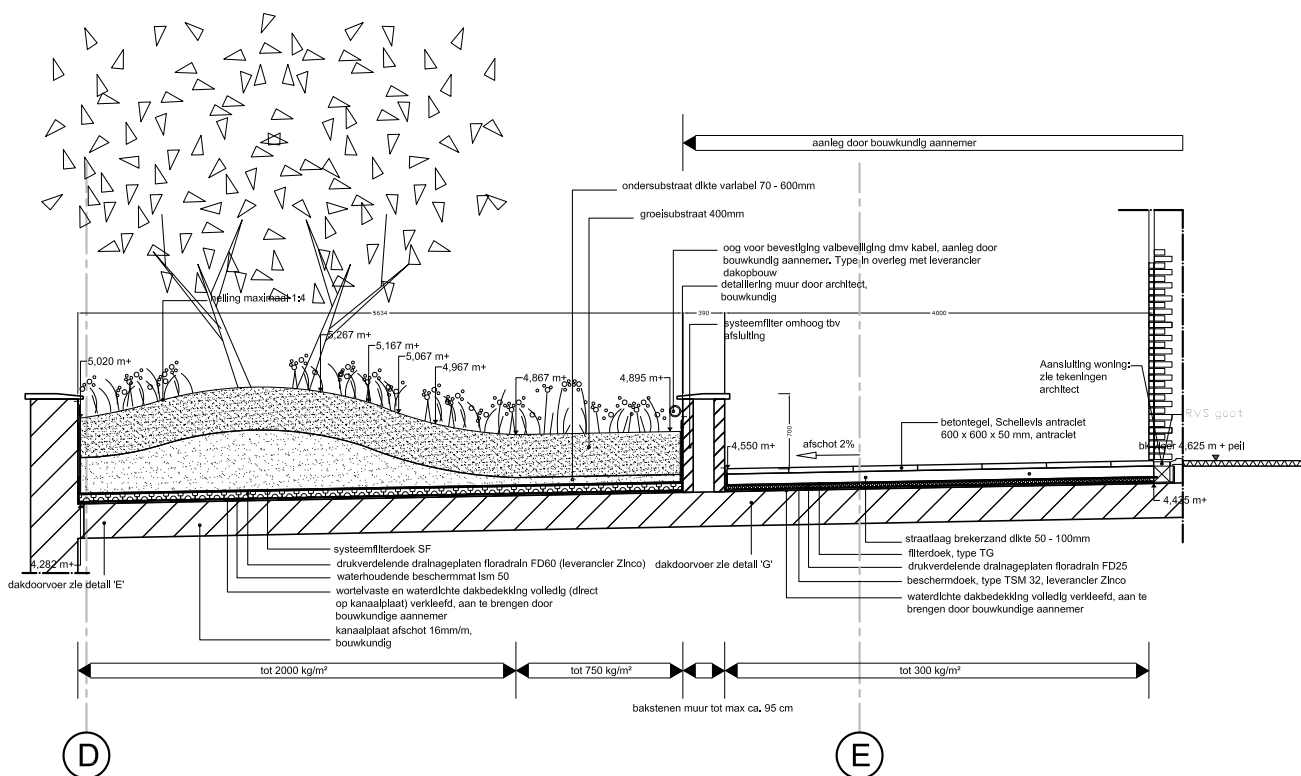
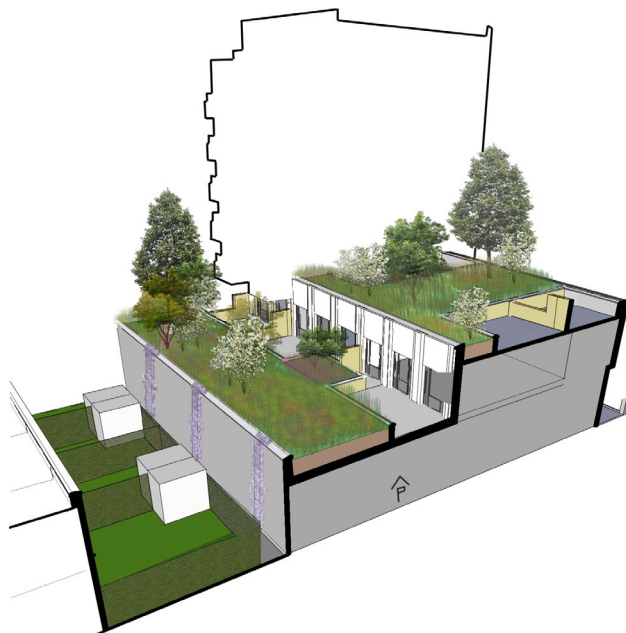
The roofgarden for the apartmentbuilding Zuiderspoor in Rotterdam combines a communal garden and private terraces with water storage. The 60 cm to 1 meter ground covering the roof of a parking garage provides a lush garden next to the terraces. The maximum weight the roof can hold is limited, but trees need sufficient ground and water to grow. Following the column structure of the parking the ground coverage is maximized on strategic spots to provide sufficient coverage to grow bigger trees and scrubage.

Main characteristics:

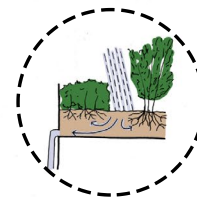
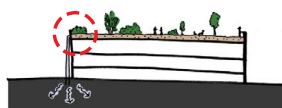
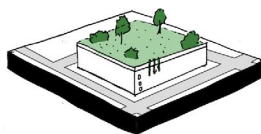
- Inner city waterstorage retains water in the city and limits a peak level for the sewage system during heavy rainfall.
- Garden for a densely built apartment block
- Cooling capacity for the inner courtyard



LINKS AND REFERENCES
 HTTPS://WWW.PALMBOUT.NL



Link with the toolbox



8. green roof
- retain
 - (semi) public park

21. green roof
- retention/storage
 - park/recreation

Houtan Park, Shanghai (CH)

Ecological flood control on former brownfield



General project information / Specifications:

Location:	Shanghai
Country:	China
Year:	2010
Design:	Turenscape

Main characteristics:

- Combining flood safety with recreation and ecological restoration
- Transformation of a brownfield
- Wetland park as public park
- Recreational harbour

Description

Built on a brownfield of a former industrial site, Houtan Park is a regenerative living landscape on Shanghai's Huangpu riverfront. The park's constructed wetland, ecological flood control, reclaimed industrial structures and materials, and urban agriculture are integral components of an overall restorative design strategy to treat polluted river water and recover the degraded waterfront in a aesthetically pleasing way.

The eminent site design challenge was to transform this degraded landscape into a safe and pleasant public space. The second challenge was to improve flood control.

Houtan Park demonstrates a living system where ecological infrastructure can provide multiple services for society and nature and new ecological water treatment and flood control methods. The post-industrial design demonstrates a unique productive landscape evoking the memories of past and the future of the ecological civilization, paying homage to a new aesthetics based low maintenance and high performance landscapes.

LINKS AND REFERENCES

[HTTP://WWW.TURENSCAPE.COM](http://www.turenscape.com)

[HTTP://HTTPS://K-LEARN.ADB.ORG/SYSTEM/FILES/MATERIALS/2015/05/201505-SHANGHAI-HOUTAN-PARK-LANDSCAPE-LIVING-SYSTEM.PDF](http://https://k-learn.adb.org/system/files/materials/2015/05/201505-shanghai-houtan-park-landscape-living-system.pdf).....

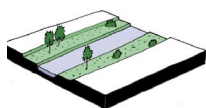


(Photo Arch Daily)

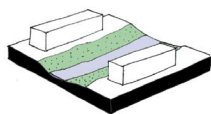


(Photo Arch Daily)

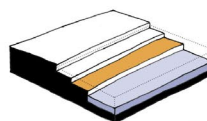
[Link with the toolbox](#)



5. soft embankments
- infiltration
 - recreation



7. wadi/bioswale
- infiltration
 - purification and recreation



19. multiple level flood defence
- flood protection
 - recreation/awareness

COLOFON

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3044 ED Rotterdam
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<http://palmhout.nl>

PALMBOUT
Urban Landscapes.

Client

EC-Link



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