CRC for
Water Sensitive Cities

Adaptation mainstreaming for achieving flood resilience in cities

Jeroen Rijke, Richard Ashley, Berry Gersonius and Robert Sakic

Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

Adaptation mainstreaming for achieving flood resilience in cities
Socio-technical flood resilience in Water Sensitive Cities: Adaptation across spatial and temporal scales (Project B4.2)
B4.2 – 2 - 2016

Authors
Jeroen Rijke[1,2], Richard Ashley[1,2], Berry Gersonius[1,2] and Robert Sakic[1,2]

[1] UNESCO-IHE Institute for Water Education
[2] CRC for Water Sensitive Cities

Publisher
Cooperative Research Centre for Water Sensitive Cities
Level 1, 8 Scenic Blvd, Clayton Campus
Monash University
Clayton, VIC 3800

p. +61 3 9902 4985
e. info@crcwsc.org.au
w. www.watersensitivecities.org.au

Date of publication: May 2016

Cover image: HSB Turning Torso, courtesy of Malmö Tourism (www.malmotown.com)

An appropriate citation for this document is:
Rijke et al. (2016) Adaptation mainstreaming for achieving flood resilience in cities. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

Table of contents

Summary **4**

1. Introduction **7**
1.1 Mainstreaming as a means to achieve flood resilience 7
1.2 Reading guide 7

2. Mainstreaming in theory **9**
2.1 Definitions of mainstreaming 9
2.2 A case for adaptation mainstreaming 10
2.3 Reported experience with mainstreaming 11
2.4 Conclusion 13

3. Mainstreaming in practice **14**
3.1 Introduction 14
3.2 Mainstreaming as a precondition for urban development in Hamburg 14
3.3 Mainstreaming as a by-product of urban regeneration in Rotterdam 16
3.4 Mainstreaming as a means to implement a vision for greening Hoboken 19
3.5 Reflection 22

4. Feasibility assessment of mainstreaming opportunities **24**
4.1 Introduction 24
4.1.1 Multi-layered safety against flooding 24
4.1.2 The role of mainstreaming for achieving multi-layered safety 25
4.2 Feasibility assessment framework 26
4.3 Case: Planned maintenance works on the Merwedestraat-Oranjelaan 27
4.3.1 Identification of the opportunity 27
4.3.2 Determination of added value 28
4.3.3 Conclusion 28
4.4 Case: Planned road reconstruction of the N3 28
4.4.1 Identification of the opportunity 28
4.4.2 Determination of added value 29
4.4.3 Assessment of practical feasibility 29
4.4.4 Financing and organisation 30
4.4.5 Conclusion 30
4.5 Case: Nature development of the Nieuwe Dordtse Biesbosch 30
4.6 Reflection 33
4.6.1 Reflection on the three mainstreaming opportunities in Dordrecht 33
4.6.2 Reflection on the feasibility assessment framework 35
4.7 Conclusion 36

5. A way forward for mainstreaming in the Australian context **37**
5.1 Introduction 37
5.2 Mainstreaming across strategic, tactical and operational levels 37
5.3 A way forward for mainstreaming in the Australian context 39

6. Conclusion **41**

7. References **42**

Summary

Many cities across the world have started to adopt resilience approaches for flood risk management. These approaches typically combine different types of interventions to protect against flooding, minimise damages caused by flooding, and recover efficiently after flooding. However, a common challenge for such cities is that the (public) budgets for enhancing urban water systems are under pressure. This has stimulated policy makers to adopt mainstreaming as an important means to implement resilience approaches to flood management.

The OECD defines adaptation mainstreaming as “the integration of adaptation into decision making across a range of policy areas, rather than through the implementation of standalone adaptation measures” (OECD, 2015). As such, it refers to bringing something into standard practice by linking multiple policy objectives within projects. By doing so, it aims for synergistic effects, such as more value for money or relative cost savings. A simple example is the simultaneous reconstruction of roads and sewerage to save costs and reduce hindrance to the community. Water sensitivity and Water Sensitive Urban Design (WSUD) already aim to bring together multiple objectives in relation to the effective delivery of multiple benefits from careful planning of how water is managed and utilised within public realms; mainstreaming broadens the perspective in that other infrastructure and services are also considered in the overall water sensitivity perspective.

This report, a product of research for the Cooperative Research Centre for Water Sensitive Cities’ (CRCWSC) project *Socio-Technical Flood Resilience in Water Sensitive Cities − Adaptation across spatial and temporal scales* (Project B4.2), provides guidance to policy makers, planners and project managers for implementing mainstreaming as a means to realise flood risk management strategies as part of a water sensitive approach. Using lessons from Hamburg, New York, Rotterdam and Dordrecht, and reflecting upon the Australian context, we suggest the following steps when considering mainstreaming as a means for achieving flood resilience.

Step 1: Develop a vision for flood resilience

A vision for flood resilience would ideally be based on the following principles:

1. Manage water to deal with both water scarcity and water excess concurrently and in an integrated way.

2. Manage and utilise the water cycle as locally as possible as all aspects/occurrences of water are potential opportunities.

3. Deal with water appropriately and synergistically within urban environments.

4. Take a systems based approach that deals with interdependencies between water management and the wider systems, services and utilities that provide human and ecological needs.

The CRCWSC report ‘*Flood Resilience in Water Sensitive Cities. Guidance for enhancing flood resilience in the context of an Australian water sensitive city’* sets out the principles for this and provides guidance for enhancing flood resilience in water sensitive cities (Gersonius et al., 2014).

Step 2: Develop a strategy for mainstreaming that fits with the characteristics of the area

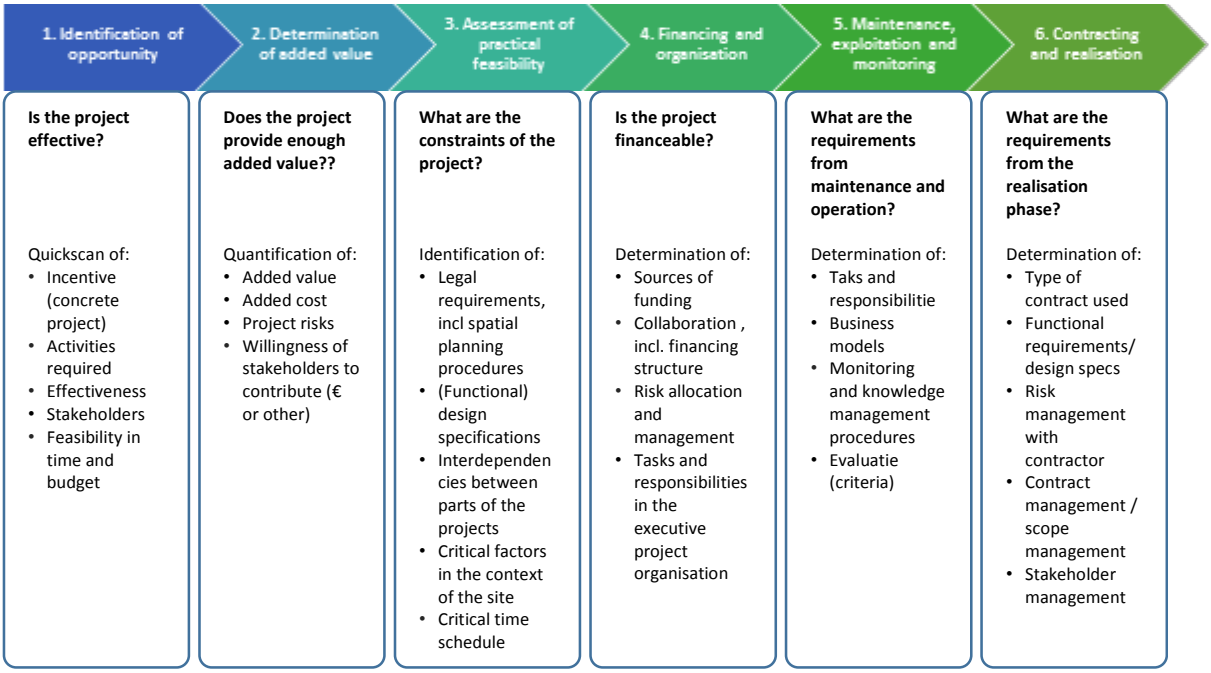
A strategy for mainstreaming is ideally based on an analysis of the potential opportunities and possible effectiveness of measures in a particular area. Mainstreaming opportunities for physical flood resilience measures typically emerge from physical interventions such as development, reconstruction and large maintenance works. As such, typical objects that may provide mainstreaming opportunities include e.g. roads, sewers, drinking water and utilities, public parks, sporting ovals, as well as private property such as buildings or golf courses. The potential for mainstreaming is determined by the configuration of assets and in an area, the projected end-of-life of the assets. In addition, asset ownership (public vs. private) is important, as different governance approaches are required: typically government agency collaboration vs. incentives and/or enforcement respectively.

Step 3: Identify possible mainstreaming opportunities

Possible opportunities for mainstreaming are most efficiently identified through regular exchange of information between the broadest range of asset operators on planned development, reconstruction and maintenance works. Although in practice there may be reluctance to exchange information about capital works programmes, it should be noted that sharing information does not compromise the flexibility of asset owners to accelerate or delay investments as long as interdependencies are avoided.

Step 4: Do a comprehensive, but quick-n-dirty, feasibility assessment of the identified mainstreaming opportunities

Consider the opportunity as a project in order to determine the feasibility of a mainstreaming opportunity. For this, it does not suffice to make a case for the added value of using the mainstreaming opportunity. Instead, a more comprehensive analysis is needed in which the practical constraints, financing, organisational aspects, requirements from maintenance and operation, contracting and legitimacy also need to be determined. To this end, an assessment framework has been developed and tested in the Netherlands (figure below). Its practical application has shown that this functions as a checklist that can be used to efficiently get a first insight into the feasibility of emerging mainstreaming opportunities associated with already planned developments.



Step 5: Further work out the mainstreaming opportunities that are promising

If a mainstreaming opportunity remains promising after initial assessment, all aforementioned aspects to the project need to be worked out further. This would require increasingly intensive stakeholder collaboration and, if appropriate, community involvement. Finally, this stage results in a 'go – no go' decision for the project.

Step 6: Share your successes *and* failures!

Except for greenfield developments, mainstreaming takes a relatively long time to implement flood resilience strategies on the scale of complete urban districts. This provides an opportunity for learning and iterative improvement of the measures that are being implemented. It is essential to share lessons about the effectiveness and implementation of measures within and between the involved organisations and departments in order to accommodate effective learning processes, before moving on to new projects. Departmental managers can enable this by creating an organisational context that provides time for reflection and positively values the sharing of lessons about success *and* failure.

1. Introduction

1.1 Mainstreaming as a means to achieve flood resilience

Many cities and service providers are adopting a resilience approach to cope with flooding. Such an approach is adaptive to acute shocks, gradual trends and climate variability and considers flood management objectives as an integral part of the liveability of public space and buildings (Ofwat, 2015). Examples include New York, Hamburg, Copenhagen and Rotterdam who have each started to adopt resilience approaches through a combination of measures for protecting against flooding, preventing or minimising damages caused by flooding, and recovering from flooding. However, many cities focus almost exclusively on disaster resilience (e.g. London;) not realising that resilience is a continuum that should not be addressed in 'silos'. In Australia, for example, Brisbane's Floodsmart Future Strategy (2014) and the draft Flood Management Strategy for Port Philip and Westernport (2015) take a broad view when aiming for resilience.

In many cities, urban water systems are performing sub optimally, whilst the (public) budgets for enhancing these systems are under pressure. This has stimulated many policy makers to adopt mainstreaming as an important means to implement resilience approaches to flood management. The mainstreaming approach provides an opportunistic complement to traditional predict-and-adapt approaches. It follows the principle "adapt where you can instead of where you have to" (Rijke et al 2010). As such, it stands for an opportunistic approach that uses planned and ongoing developments to couple flood management objectives with other objectives to achieve synergistic effects, such as cost savings or societal benefits (Veerbeek et al., 2012, Pedersen Zari, 2012, Serrao-Neumann et al., 2015) .

The mainstreaming approach is in line with the concepts of water sensitivity and WSUD, as they aim to bring together multiple objectives in relation to the effective delivery of multiple benefits from careful planning of how water is managed and utilised within public realms; mainstreaming broadens the perspective in that other infrastructure and services are also considered in the overall water sensitivity perspective.

Despite the recognition of the potential benefits of mainstreaming, the documentation of practical experience with the approach is limited. Moreover, practical guidance for achieving the benefits of mainstreaming has not yet been made readily available to planners and project managers who operate within the context of climate adaptation strategies and water plans. As such, there is a risk that mainstreaming remains an empty promise by policy makers. With this report, the authors aim to provide a way forward for mainstreaming in order to implement flood resilience approaches in the context of water sensitive cities.

1.2 Reading guide

This report is divided into the following chapters:

- **Chapter 2** provides a concise review of the definitions, interpretations and outcomes of mainstreaming.

- **Chapter 3** provides three examples of how the mainstreaming approach is being applied to enhance urban flood resilience in Germany, the Netherlands, and the United States. From these experiences, several lessons are drawn to enhance the application of the mainstreaming approach in practice.

- **Chapter 4** provides guidance for converting the ambition to mainstream into actionable projects, by introducing a tool (‘checklist’) for qualitatively assessing the feasibility of mainstreaming opportunities. In addition, Chapter 4presents the results of the application of this tool for the assessment of mainstreaming opportunities for realising a multi-layered flood risk management strategy on the Island of Dordrecht in the Netherlands.

- Based on the insights that are described in the previous Chapters, **Chapter 5** provides a way forward for the Australian context, focusing on enhancing flood resilience in the context enhancing the water sensitivity of Elwood, Victoria.

- To conclude, in **Chapter 6** suggestions are made for further research to strengthen the uptake of the mainstreaming approach for achieving water sensitivity in practice

2. Mainstreaming in theory

2.1 Definitions of mainstreaming

There are many definitions of mainstreaming within an urban development context (Uittenbroek et al., 2012). Mainstreaming commonly relates to bringing something into normal, everyday, prevailing use and it's most common application in relation to urban water is for adapting to climate change (ECONADPT, 2015). In addition, mainstreaming refers to linking policy objectives. In this light, adaptation mainstreaming can be defined as "the integration of adaptation into decision making across a range of policy areas, rather than through the implementation of standalone adaptation measures" (OECD, 2015). As such, it refers to bringing something into standard practice by linking multiple policy objectives within projects.

By doing so, it aims for synergistic effects, such as more value for money or relative cost savings (see also the next Section). For example, by taking advantage of an urban regeneration project that is enhancing existing buildings or neighbourhoods, to include blue-green infrastructure and to deliver additional benefits, beyond necessarily the primary reason for the regeneration. There are also ideas for urban environments to be 'regenerative'; i.e. contribute more than they take from systems such as ecosystem services (Pedersen Zari, 2012). This has happened in parts of Malmo in Sweden (Figure 1), where urban regeneration has utilised blue-green infrastructure for surface water, enhancing the overall quality of the neighbourhoods as illustrated in Figure 1 as part of a much broader sustainable city approach (City of Malmo, 2006).

Figure 1. Malmo green city district.

2.2 A case for adaptation mainstreaming

A common challenge for many cities is that the (public) budgets for enhancing urban water systems are under pressure ((World-Bank, 2013, World Bank, 2013). However, the case for mainstreaming is clearly demonstrated in several studies, as we describe below. Such insights have stimulated policy makers to adopt mainstreaming as an important means to implement resilience approaches to flood management ((Rotterdam-Climate-Initiative, 2012, Rotterdam Climate Initiative, 2012).

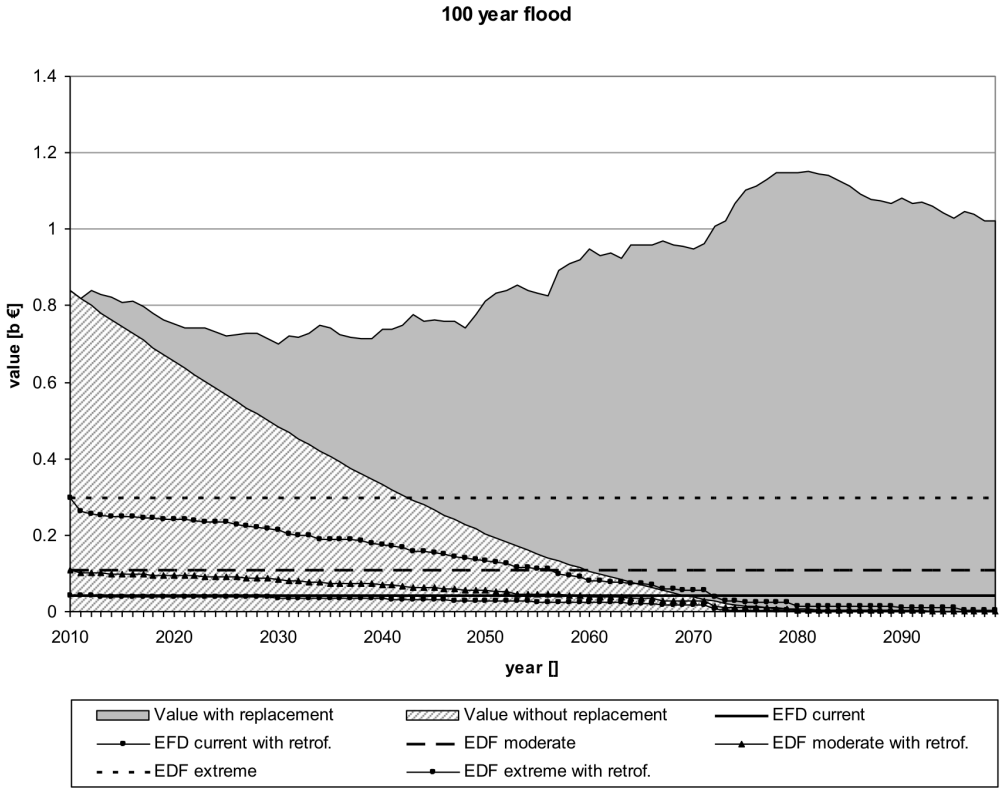
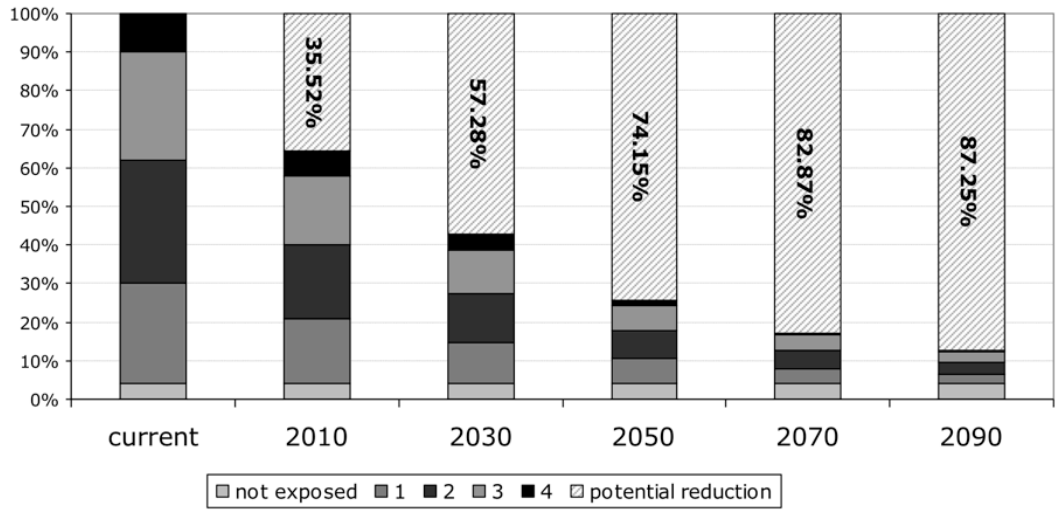


Figure 2. Development value and expected flood damage (EFD/EDF) for the 57,000 units of housing stock in the areas of the Rijnmond-Drechtsteden region outside the dikes.

Figure 2 is the result of a Dutch study (Veerbeek et al., 2010) in which the expected value of some 57,000 units of housing stock is compared for either with or without replacement after the estimated end-of-lifespan (EOL). Value has been estimated using a linear depreciation scheme based on cadastral data for the year 2009. What can be clearly seen is the approximate linear decay of value for the housing stock to almost zero by the year 2070. Replacement, however, increases the value in a non-linear fashion into the future. The question then is how the renewal cycle might benefit the need for climate adaptation of this stock of properties? The expected flood damage is modest when compared with the value of the housing stock. However, application of climate change scenario planning changes this. While the expected damages in 2009 are about 5% of the estimated value, this may rise to 13% in 2050 and 36% in 2100. If redevelopment (i.e. no replacement) is postponed, value depreciation causes expected damages to increase in a relative way; since as the expected value gradually declines, the significance of expected flood damage gradually increases.



Key: 1-coastal and river flooding; 2-pluvial flooding; 3-drought; 4- heat stress 'current' is 2009.

Figure 3. Components of the total combined exposure (100%) to drought, heat stress and flooding (pluvial and fluvial) in combination with the potential reduction in exposure for all Dutch urban areas.

In a similar approach, the 2010 study 'Building the Netherlands Climate Proof' (Ven et al., 2011), the exposure of buildings to flooding (pluvial and fluvial), drought and heat stress of Dutch urban areas was examined. Some 4% of the Dutch building stock was found to be safeguarded against all of the four climate hazards, while some 10% was potentially susceptible to impacts from all four hazards. The effects of proactive retrofitting during redevelopment (mainstreaming) were assessed by applying a replacement scheme in which the building cycle was assumed to be some 80 years. By assuming that the applied retrofitting measures would reduce the sensitivity to climate hazards to zero; a reduction of about 35% in exposure to the identified climate hazards could be achieved if all buildings reaching the end-of-life were to be replaced by retrofitted buildings. In the future, this reduction would increase to about 57%, 74%, 82% and 87% in the years 2030, 2050, 2070 and 2090 respectively (Figure 3).

Moreover, the most productive opportunities are likely to be as a result of reconstruction programmes following a catastrophe, such as after Hurricane Katrina in New Orleans. Simply providing enhanced flood management, or greater levels of protection will not necessarily deliver maximum benefits to society and plans for reconstruction should consider adding value compared with what was there before the catastrophe and at the very least pre-preparing by taking advantage of the synergies between disaster risk reduction and climate change (and other) adaptation in land use and property planning processes to reduce community vulnerabilities (Serrao-Neumann et al., 2015).

2.3 Reported experience with mainstreaming

So far there is limited reported experience with mainstreaming. It is probable that high ideals regarding the need to mainstream wherever possible, even in policy, are often abandoned during the process of trying to make it come about in a real project (Rijke et al., 2012, Rijke,

2014),. Even aspirations to use for example, green infrastructure options rather than grey, set out at the start of a design or planning process are often abandoned due to it being 'too difficult' or 'it does not fit with the road layout' and/or because of the problems of reconciling the disparate aims of the project stakeholders, resulting in a 'business-as-usual' silo approach (Bauer and Steurer, 2014). Much of the ongoing literature and development work relates to efforts to mainstream ecosystem services into urban areas (Hansen and Pauleit, 2014). The complexities of bringing together often disparate ambitions such as a new road in a neighbourhood to increase accessibility, together with climate proofing for flooding and droughts, with different time schedules, funding streams and asset management perspectives are frequently too confounding to expect synergies in saving on costs and bringing added value. Although certain services have a tendency to 'occur together in hotspots' even without being planned for, as found by Holt and colleagues (Holt et al., 2015), where in certain (500m) grid squares in the City of Sheffield between three and six ecosystem services were found. Despite the difficulties in delivery, mainstreaming ambitions should not be ignored even if these will result in only rather modest synergistic outcomes from an urban redevelopment or development project.

Table 1. Mainstreaming Framework (Wamsler, 2015).

Dimensions	**Mainstreaming Strategies**
Horizontal mainstreaming	
Add-on mainstreaming	The establishment of specific on-the-ground projects or programmes that are not an integral part of the department's core work but directly target adaptation or related aspects.
Programmatic mainstreaming	The modification of a department's core work by integrating aspects related to adaptation into on-the-ground operations, projects or programmes.
Inter- and intra-organisational mainstreaming	Promotes collaboration between individual sections or departments and other stakeholders, e.g., other departments, committees, organisations, governmental bodies and civil society, to generate shared knowledge, develop competence and take joint actions to advance adaptation.
Vertical mainstreaming	
Managerial mainstreaming	The modification of managerial and working structures, including internal formal and informal norms and job descriptions as well as the configuration of sections or departments to better address and institutionalise aspects related to adaptation.
Regulatory mainstreaming	The modification of planning procedures and related activities, including formal and informal plans, policies, regulations, and legislation that lead to the integration of adaptation.
Directed mainstreaming	Supports or redirects the focus onto aspects related to integrating adaptation by e.g., providing topic-specific funding, promoting new projects, supporting the education of staff, or directing responsibilities.

Moreover, the available documentation of mainstreaming approaches suggests that mainstreaming is predominantly implemented through single actions rather than in a comprehensive way (Wamsler et al., 2013). To overcome this challenge, the development of

a typology, or rating system is suggested to provide a reference to keep track of the resilience of existing urban areas and property performance; this would help to identify where upgrading was required over time (Bernier et al., 2010) and also to what extent mainstreaming has been included in policy and development (Gersonius et al., 2012) (i.e. joined up). In addition, potential ways of mainstreaming adaptation into urban planning have been identified in a so-called Mainstreaming Framework (Table 1.). In this framework, a distinction is made between vertical and horizontal mainstreaming in which there is respectively sufficient and insufficient authority of a single actor to exercise top-down control.

2.4 Conclusion

The literature on mainstreaming is mostly policy oriented: mainstreaming should become the norm and policies should adapt is a key principle to implement visions or strategies. However, there is limited reported experience with mainstreaming and systematic analysis of how opportunities from planned and ongoing projects can be used is not yet available. Evidence suggests it is challenging and although aspired to, is readily abandoned in the design and planning process even if it is in policy.

It should be noted that several studies have focused on the implementation of adaptation from a policy perspective, through analysis of the enabling and disabling factors for the implementation of, for example, sustainable water systems (Brown and Farrelly, 2009) and adaptation to climate change (Biesbroek et al., 2013). However, systematic analysis of how opportunities from planned and ongoing projects can be used and guidance for how to do this efficiently is missing.

In the following chapters, a review is presented as to how mainstreaming can lead to concrete projects in practice.

3. Mainstreaming in practice

3.1 Introduction

Using examples from Germany, the Netherlands and the United States, this Chapter describes how mainstreaming evolves in practice. The examples illustrate that mainstreaming can evolve in various different ways, as: 1) a precondition for urban development (Hamburg HafenCity); 2) a by-product of urban regeneration (ZoHo Rotterdam); and 3) a means to implement a vision (Hoboken, New Jersey).

In the following Sections, the examples are described and lessons are drawn from each of these cases. Subsequently, some general observations are made.

3.2 Mainstreaming as a precondition for urban development in Hamburg

Figure 4. Masterplan Hamburg HafenCity (www.hafencity.com, accessed 25-9-2015).

Hamburg Hafencity is Europe's largest inner-city development project (Figure 4.). With the redevelopment of a 157 ha former port and industrial site, the city centre of Hamburg will be enlarged by some 40%. The development is located in the River Elbe, on a relatively low-lying island that is prone to flooding at 4 to 5.5m above sea level. Protection against flooding was therefore a prerequisite for urban use of the area.

Figure 5 provides a schematisation of the measures that are realised for flood protection in HafenCity. HafenCity is built on elevated foundations consisting of low-lying promenades (4.5m above mean sea level) and higher 'warfts' (8-9m above mean sea level). In many places, the historic quay structure is conserved and/or restored and in sections where the old quay walls were absent or too damaged, new walls were built. The boundary between water and land is flexible: promenades are low lying and flood prone, whilst building plinths and entrances to parking garages are equipped with moveable flood gates (building/asset owners are responsible for the functioning of these gates). This accommodates partial flooding of HafenCity's public space during storm surges, whilst avoiding damage to buildings or cars. As a result, the historic character could be conserved at relatively low cost (compared with raising the whole area to 8-9m above mean sea level).

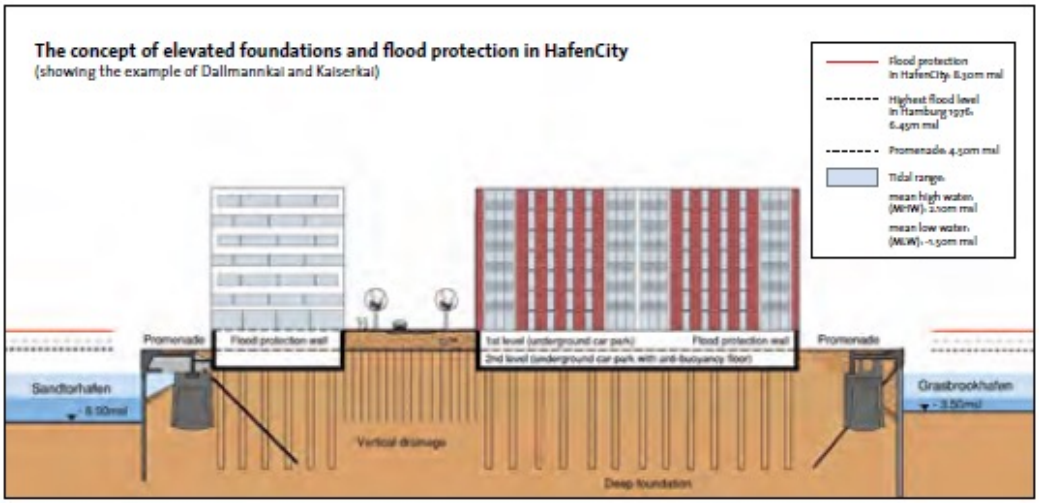


Figure 5. Flood protection in HafenCity (HafenCity Hamburg GmbH, 2015).

The development of HafenCity is managed by HafenCity Hamburg GmbH, a 100 percent subsidiary of the City of Hamburg. This development company is responsible for a dedicated development fund, which controls land owned by the City of Hamburg located in the HafenCity area. This fund is being filled through the sale of development sites to private developers and it is used to finance the development of the majority of infrastructure and public areas in HafenCity, such as roads, bridges, squares, parks, quays and promenades. As such, it provides the financial resources that are needed for the realisation of the flood risk mitigation measures in the public areas.

In addition, HafenCity Hamburg GmbH is responsible for the clearance and preparation of the building sites for the private developers and the development of public spaces. Moreover, HafenCity Hamburg GmbH can influence the approval for land sales and zoning plans, as it is represented in juries for urban planning, open space and buildings, which are ultimately decided upon by the Land Commission and the Commission of Urban Development. Because of this, the development company is able to enforce the realisation of flood protection measures on both public and private land.

The development process for Hamburg HafenCity includes an exclusive option period before the actual selling of the land in which developers and the development company collaborate to prepare the plans for the development. With this, it is aimed to encourage cooperative behaviour between the HafenCity Hamburg GmbH and the developers to minimise risk, cost and delays whilst maintaining quality. If the developer fails to meet the terms of the exclusive

option contract, the land can be retrieved without administrative expense. In this way the development company is able to build relationships with the developers and enhance the quality of the plans.

The case of Hamburg HafenCity illustrates that the approach of mainstreaming as a precondition for urban development requires a certain context for it to be implemented successfully:

- Availability of technology for flood proofing of buildings.
- Positive business case and available funds for incorporating flood protection measures in the development plans of public space and private buildings, and the maintenance thereof.
- Presence of an authority (i.e. HafenCity Hamburg GmbH) that is able to enforce the adoption of flood protection measures.
- Incentives in the design of the development process for cooperative behaviour between the development authority and the private developers to enhance the quality of the plans (and thus adequate adoption of flood risk mitigation measures).

3.3 Mainstreaming as a by-product of urban regeneration in Rotterdam

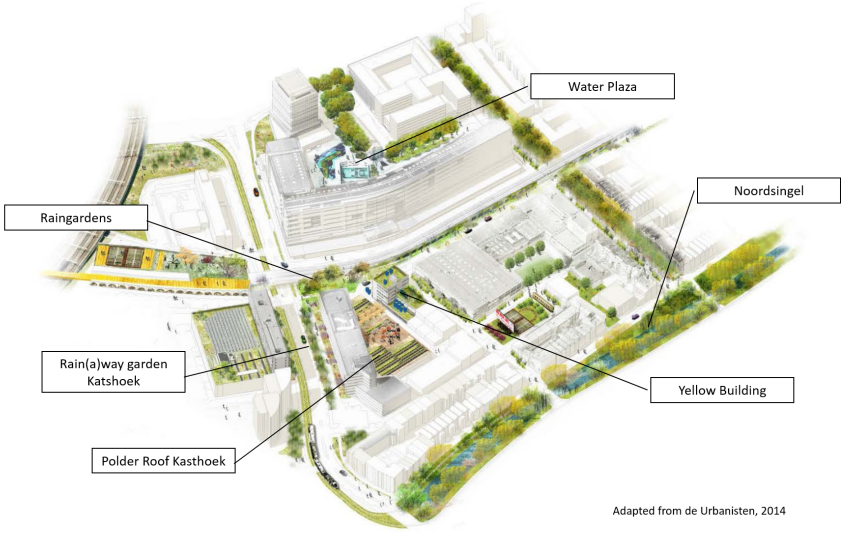


Figure 6. Overview of the Zomerhofkwartier, Rotterdam.

The Zomerhofkwartier in Rotterdam, the Netherlands, is a business park with an industrial character that is subject to regeneration. Although the quarter is located only 10 minutes walking distance from Rotterdam's Central Station, it has been mostly overlooked by urban planners and investors over the last decades and many users moved away, leaving empty office buildings behind. The Housing Association Havensteder owns most of the social housing units in the adjacent area. Recognising the potential of the Zomerhofkwartier,

Havensteder acquired several office buildings around 2005/2006. It intended to demolish the office buildings and replace them by social housing units and new amenities such as a market hall, a swimming pool, a theatre, and a soccer pitch. However, these plans came to a halt when it appeared not possible for Havensteder to make large investments in the area as a result of the financial crisis.

In order to protect the value of its housing stock in the area, Havensteder started in 2013 to collaborate with Stipo, an urban planning firm, to introduce an approach of “slow urbanism” for the regeneration of the area, which would later also be re-branded as ZoHo. The approach of “slow urbanism” evolves through an incremental small scale development process with no predefined end-goal that is driven by local stakeholders and engaged entrepreneurs. The overall goal is that ZoHo becomes an attractive urban district without the use of a predefined plan for how this should be achieved. As such, the development of the area is driven by opportunities that arise over time. All developments in the area should add value to the local stakeholders and/or community. This is, for example, reflected in the procedure for office rental in Havensteder’s office buildings in the area, such as the Yellow Building (Figure 6.). These office buildings are organised as business complexes, in which prospective companies are required to pitch their added value to the residing companies in the building who have a say in the decision to accept new renters. With this approach approximately 10.000 m^2 vacant office space was filled in the period of one year, whilst other office buildings in Rotterdam have not been so well taken up following the effects of the financial crisis.

Making the public space more attractive fits with the ambition of the local stakeholders to make ZoHo an attractive location for working and living. The area contains few public and green spaces and it has to cope with flooding of streets, back gardens and cellars caused by heavy rainfall. Hence the implementation of climate adaptation measures that involve greening of the area is considered a possible catalyst for making the area more attractive. In line with the “slow urbanism” approach, climate adaptation measures are implemented incrementally in the area (Urbanisten, 2015). This process started with the realisation of the ‘Water Plaza’ (2011-2013), a public square that functions as a temporary stormwater storage facility during periods of heavy rainfall. This project located just outside ZoHo, functions as a showcase for climate adaptation, but required additional measures for optimal functioning. De Urbanisten, the company that made the design for the Water Plaza, subsequently organised a series of workshops together with the City of Rotterdam and Stipo to gather local entrepreneurs in ZoHo to identify local opportunities for related climate adaptation (greening) measures that could also contribute to making the area more attractive. This generated, for example, ideas for streetscape greening (“depaving ZoHo”), green roofs and raingardens.

Figure 7. Raingardens in ZoHo.

Shortly after these workshops, two abandoned parking places were replaced by raingardens (Figure 7) in a collective effort of the municipality, a local contractor, de Urbanisten and several members of the community. Also, streetscape greening took place in front of the 'Katshoek' office building to make the building entrance attractive to new renters. In turn, the building owner agreed to take responsibility for the maintenance of the new strip of vegetation. These projects were considered 'low hanging fruit' that could be achieved through effective collaboration between stakeholders in the area and against negligible costs. These projects connected stakeholders and enhanced the positive dynamics in the neighbourhood by achieving quick results and providing opportunities for branding.

As a result of these initiatives, the City of Rotterdam decided to adopt ZoHo as a showcase for climate adaptation. In the Rotterdam Adaptation Strategy that was published in 2014, it identified ZoHo as the district to experiment with physical climate adaptation measures that enhance the quality of the public space. Accordingly, financial resources were allocated for greening the area and a municipal project leader was installed for the coordination of various new climate adaptation initiatives in the area, such as the 'Polderroof' (a green roof combined with a stormwater retention basin) on the parking garage of the Katshoek office building, a linear (rooftop) park on the former railway viaduct Hofbogen and the Rain(a)way garden for retention and infiltration of stormwater in front of the Katshoek office building, and the connection of the Water Plaza with surface water of the Noordsingel (Figure 6.). The City of Rotterdam received a Life+ subsidy from the EU for the realisation of these initiatives and further development of ZoHo.

The case of ZoHo, Rotterdam, illustrates how mainstreaming can evolve as a by-product of urban development. The process initially started with small-scale ad hoc projects and transformed into a more coordinated approach. Factors that contributed to this outcome:

- Climate adaptation is not seen as a goal in itself. Instead it is considered as a means

to make the area more attractive. As such, it contributes to an overarching goal that is shared by all key stakeholders.
- There is a driving force for both urban development (Stipo/Havensteder) and climate adaptation (de Urbanisten/City of Rotterdam). Both recognise that they are complementary and that their efforts are reinforced through good collaboration.
- The costs for the initial projects that catalysed larger investments were negligible. However, they provided a potential for connecting a diversity of stakeholders and a platform for branding for the actors that invested their time and energy in the projects.

3.4 Mainstreaming as a means to implement a vision for greening Hoboken

Hoboken is a densely populated city with a high percentage of impervious area in the New York metropolitan area. Currently, its drainage system is experiencing severe problems, which manifests itself around two times per year in flash flooding on the streets of low-lying areas in the city (Figure 8) and approximately one hundred combined sewer overflows per year. Although there is a long record of flooding problems in the area, political momentum for a different urban drainage approach was catalysed by the Rebuild Design competition that was held in the aftermath of Hurricane Sandy that hit the East Coast of the US in 2012.

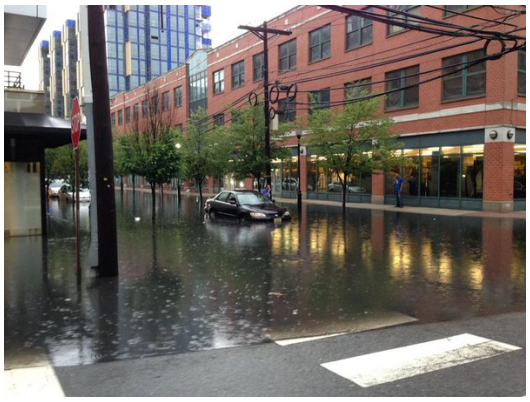


Photo by Michael Gearge

Figure 8. Flooded street in Hoboken after a heavy rainstorm on June 1, 2015.

Causing at least 186 casualties and approximately US$ 65 billion damage, Hurricane Sandy was a wake-up call to the vulnerability of the highly populated urban communities for extreme weather (Figure 8). Its impact was attributed to a combination of the magnitude of the wind and storm surge *and* to a maladjusted socio- economic system, long history of poor urban planning and inadequate urbanisation (Wagner et al., 2014). Therefore Hurricane Sandy unveiled multiple vulnerabilities in the region (environment, infrastructure, social, economy and governance) (Gendall, 2015) and acted like a ‘’tipping point’’ demanding a new approach to disaster risk management (Rosenzweig and Solecki, 2014).

During the Rebuild by Design competition, a team[1] of architects, urban designers, engineers and economists embarked on a collaborative design process with the local stakeholders to

[1] TeamOMA, which consisted of OMA, Royal HaskoningDHV, Balmori Associates and HR&A Advisors.

develop a strategy for flood resilience at the scale of the city district. The name of the strategy is ‘’Resist, Delay, Store, Discharge: A Comprehensive Urban Water Strategy for Hoboken’’ (hereafter RDSD strategy). The terms ‘’Resist, Delay, Store, Discharge’’ indicate (respectively): (1) hard infrastructure for protection against storm surges; (2) series of green infrastructure for the delay in runoff; (3) storage areas for excessive rainfall across the city district; and (4) discharge pumps (Figure 9.).

The activities in Rebuild by Design accelerated the adoption of the concept of resilience in the planning agendas of local decision makers. Moreover, it stimulated the uptake of green infrastructure as a means of providing multi-functional solutions to a series of challenges, including liveability, flood risk management and urban heat island mitigation. The value of green infrastructure was already acknowledged in Hoboken’s Master Plan that was published in 2004 and subsequently in the Master Plan Re-examination Report (2010). In the aftermath of Hurricane Sandy, the narratives for green infrastructure of both planning documents were further specified in the Green Infrastructure Strategic Plan (2013) through the identification of three zones (detention, retention, infiltration) that were based on the geological characteristics of the area. In parallel, green infrastructure was integrated with other aspects of flood risk management and increased political support for green infrastructure was created through the process of Rebuild by Design.

Figure 9.The Resist, Delay, Store, Discharge strategy for flood resilience in Hoboken (Source: OMA).

The federal government awarded US$ 230 million to the State of New Jersey to implement the RDSD strategy. These funds are allocated for an upgrade of the coastal defence to protect against a once per 500 year storm surge event and create a more attractive coastline for the local residents. As part of this, the current focus is on implementing the Resist part of the RDSD strategy. The funding for the other parts (Delay, Store, Discharge, and thus green infrastructure) needs to be covered by other financial resources. Moreover, the largest opportunities for large scale implementation of green infrastructure are located in areas that are identified as redevelopment zones for city transformation from industrial areas to business districts. Previous analysis has revealed that these areas are particularly prone to flooding and that relatively large scale green infrastructure projects would be effective in this area. Therefore there may be an opportunity for effective flood risk measures at a relatively low cost by incorporating the implementation of green infrastructure in these redevelopments.

In a recent study, several ongoing activities were identified for effectively making use of these opportunities (Sakic et al., Submitted):

- Development of partnerships to identify “low hanging fruit” and synchronise capital works investments between the key stakeholders, primarily between the City of Hoboken and the North Hudson Sewerage Authority (NHSA), but also involving for example the water retailer United Water, local schools, hospitals, religious institutions and the social housing organisation.
- A detailed analysis as to what extent green infrastructure can be employed in the redevelopment zones and in which areas its performance would be optimal. Ideally, this analysis would be conducted within the next three years, so that the findings can be incorporated into the NHSA’s long term plan for control of combined sewer overflows[2].
- Acquisition of privately owned land that is suitable for the adoption of green infrastructure. For this, the City of Hoboken is currently using the possibility for low interest loans from the New Jersey Environmental Infrastructure Trust.

The implementation of green infrastructure by making use of the mainstreaming opportunities in the redevelopment zones follows a process in which green infrastructure is first demonstrated in several pilot projects, before it will be laid out at a larger scale. Green infrastructure is incorporated in renewal projects on Washington Street and near the City Hall. Two raingardens will be included in a curb extension project, and the designs for the Southwest Resiliency Park (green infrastructure incorporated) are complete. Such projects are considered to “educate the community about the particular green infrastructure practice while garnering support for future projects” (USEPA, 2015). In addition, the Stormwater Best Management Practices Manual, which is developed by New Jersey Department of Environmental Protection and needs to be followed by developers according to the Stormwater Rules, is being updated to provide better guidance on the implementation of green infrastructure measures, such as vegetated filters strips and grass swales. Furthermore, a wide range of stakeholders in the area have identified a need for new incentive mechanisms and/or regulation to stimulate the adoption of green infrastructure on privately owned land and buildings (e.g. green roofs) (Sakic, 2015).

The case of Hoboken illustrates how mainstreaming can be applied to implement an innovative urban water vision, when the availability of large funding sources is uncertain., The following lessons can be identified for achieving a transformation of the urban water system:

- Mainstreaming is a gradual process that depends on the speed of redevelopment and asset management cycles. It can be particularly suitable for the implementation of innovative technologies, such as green infrastructure in the case of Hoboken, because it enables iteration that is needed for demonstration and continuously improved upscaling (from small scale or limited uptake to larger and more widespread).

- Preparation is required for effectively making use of mainstreaming opportunities. In the case of Hoboken, this involved: 1) development of partnerships to identify “low hanging fruit” and synchronise capital works investments between the key stakeholders; 2) a detailed analysis of the potential opportunities and possible

[2] Long Term Control Plan

effectiveness of measures; 3) acquisition of privately owned land that is suitable for the adoption of green infrastructure; and 4) guidelines for design and implementation.
- Mainstreaming on privately owned land requires a different approach, including incentive mechanisms and/or enforcement through regulation (e.g. planning provisions) to stimulate property owners and developers to adopt green infrastructure.

3.5 Reflection

Mainstreaming in many recent policy documents is being considered as a means to implement innovative urban water systems to achieve climate adaptation. However, it should be noted that the people who are involved in the cases that are described in this chapter are not using the term ‘mainstreaming’.

The examples of Hamburg, Rotterdam and Hoboken show that there are various ways of how mainstreaming is being put into practice. The examples from Hamburg and New York illustrate an implementation process that starts with a vision for urban water management, whereas the example from Rotterdam illustrates that urban regeneration can also be a driving force for mainstreaming. In addition, the three examples illustrate that there are several different reasons to opt for a mainstreaming approach: cost savings (Hamburg); limited access to funding (Hoboken); experimentation and learning (Hoboken); achieving multiple policy objectives, including those outside the water domain (Rotterdam); and achieving a means for stakeholder collaboration (all).

Several factors that are needed for effectively making use of mainstreaming opportunities can be identified from the three cases. Firstly, effective partnerships between different organisations and departments are needed to identify opportunities for mainstreaming, determine the added value of mainstreaming opportunities, synchronise capital works investments and secure funding. Although the importance of such partnerships is widely acknowledged (van Herk et al., 2011), it should be noted that the availability of decision support tools can significantly stimulate the effectiveness of such partnerships (van Herk et al., 2015). For example, in the case of Killingworth and Long Benton in the UK it was shown how the use of a new software tool (BeST) (CIRIA, 2015) for the valuation of the financial benefits provided confidence to a group of major stakeholders to move beyond the traditional approach to managing flood risks from rainfall and rivers to one that maximises the potential added value benefits to the local community by using green infrastructure.

Secondly, the need for leadership is clearly illustrated in all three cases to drive innovative approaches and their implementation though mainstreaming. The three cases show three different manifestations of leadership: coordination by an agency that is capable of enforcing and influencing projects of private developers in a large scale urban redevelopment project (Hamburg); shared leadership of individuals from different organisations based on a common ambition for development (Rotterdam); a collaboration between the responsible government agencies and a group of international experts in a high profile design competition (Hoboken).

These forms of leadership are shaped by the context in which they are implemented. For example, it was possible to encourage an innovative urban water approach by enforcing mainstreaming in the context of the Hamburg HafenCity redevelopment project, because it included several crucial enabling conditions, such as a positive business case, fair risk allocation amongst shareholders, feasibility to finance and the availability of the competencies

required to realise and maintain this new approach. Furthermore, leadership may evolve over time, such as in the Rotterdam example in which the character of shared leadership evolved from a purely action oriented one towards an increased focus (of the municipality) on learning to transfer lessons to other urban districts.

4. Feasibility assessment of mainstreaming opportunities

4.1 Introduction

In this chapter, a framework for assessing the feasibility of mainstreaming opportunities is introduced and applied to three separate cases on the Island of Dordrecht in the Netherlands. Each of these cases relates to the implementation of the multi-layered safety strategy for flood risk management on the Island. As a result of a comparative analysis of the three cases, implications for practice and key knowledge gaps that require further research are identified.

4.1.1 Multi-layered safety against flooding

Multi-layered safety against flooding is a relatively new approach for flood risk management that has been developed over the last 5-10 years in the Netherlands (Gersonius, 2014). In addition to protection against flooding, which was the traditional approach in the Netherlands, multi-layered safety encompasses prevention of damage and casualties in case of flooding (layer 2) and preparedness for future flooding (layer 3; see Figure 10). See also (VenW, 2009) and (Gersonius et al., 2015).

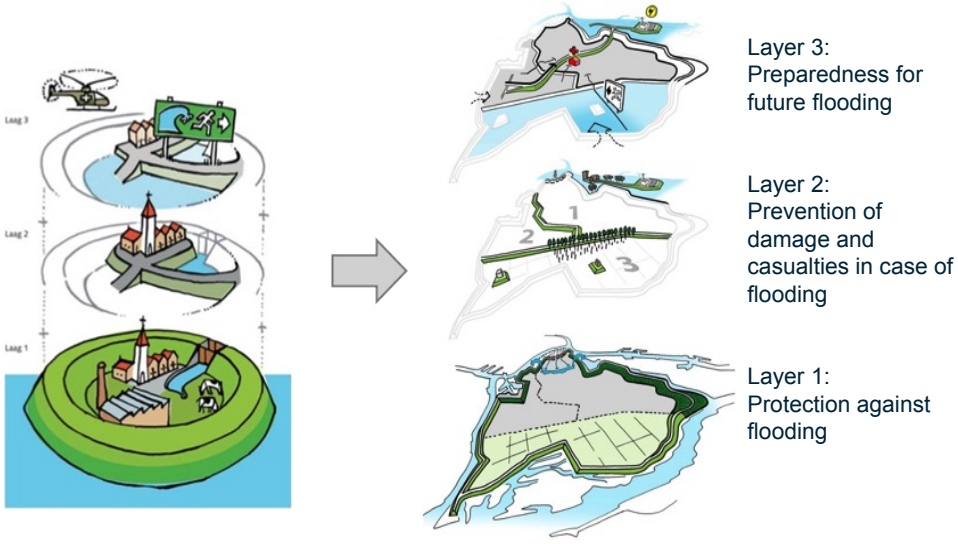


Figure 10. The concept of multi-layered safety and its initial application in the city of Dordrecht.

The management of flooding for the Island of Dordrecht played an important role in the development of the concept of multi-layered safety (Gersonius et al., 2015). Moreover, the concept was adopted as a promising strategy for flood risk management on the Island (Delta-Commisioner, 2014). The key motivations for doing so are outlined below.

1. The traditional approach of flood protection through dike strengthening is very expensive in the built areas and requires structural measures to the historic buildings in the city centre affecting its cultural heritage.

2. The Netherlands have adopted a flood risk management approach that takes into account both the probability and the (potential) effects of flooding. Flood protection standards are replaced by flood risk standards. As a result, flood risks can also be reduced by spatial measures, such as elevation of buildings or controlled flooding in less vulnerable (rural) parts of the Island of Dordrecht.

3. The capacity for horizontal evacuation (e.g. by car or boat) is inadequate for timely evacuation of the population. Hence, the city needs to become self-sufficient in order to be able to cope with the consequences of a dike breach on the Island, This requires emergency management plans and vertical evacuation possibilities (e.g. to flood shelters within the flooded area).

4. When a dike breach occurs and the Island is flooded, it is expected that the recovery will take several months. Minimising economic damage requires reducing the recovery time as much as possible, which in turn requires e.g. spatial measures or protection of (some) critical infrastructure to enhance the accessibility of the most vital parts of the island.

4.1.2 The role of mainstreaming for achieving multi-layered safety

In Chapter 3, it was described how mainstreaming approaches can unfold in various ways: 1) mainstreaming as a precondition for spatial (re)development; 2) mainstreaming as a by-product of spatial (re)development; and 3) mainstreaming as one or more means to implement a vision. This third interpretation of mainstreaming applies to multi-layered safety on the Island of Dordrecht, as the regional stakeholders consider it a necessity to use planned and ongoing developments to couple objectives to achieve multi-layered safety in a cost-effective manner (DPRD, 2014).

Currently, the key stakeholders in the region are jointly studying the effectiveness and feasibility of the multi-layered safety strategy on the Island of Dordrecht in a so-called ‘MIRT’ study (MIRT-Projectteam, 2015). They make a distinction between so-called ‘complementary combinations’ and ‘mainstreaming opportunities’, where a ‘complementary combination’ refers to the possibility, in specific cases, to replace flood protection measures with spatial or non-structural measures; and a ‘mainstreaming opportunity’ refers to the possibility to link measures to reduce flood risk with spatial (re)developments and investments in infrastructure and buildings .

The city of Dordrecht, who are leading the MIRT Study, have identified multiple mainstreaming opportunities that could potentially contribute to the implementation of multi-layered safety on the Island of Dordrecht. In this chapter, the feasibility of three of these opportunities has been assessed:

1. an opportunity for cost-effective realisation of a ‘life-line’ for an unembanked area in times of flood, provided by planned maintenance works on the Merwedestraat-Oranjelaan;
2. an opportunity for cost-effective realisation of an evacuation/recovery route during/after flooding, provided by planned reconstruction works on the regional road N3; and
3. an opportunity for the cost-effective realisation of a flood diversion scheme as a cheaper alternative to strengthening flood defences in the historic city centre, provided by the ecological restoration project Nieuwe Dordtse Biesbosch.

These opportunities were selected because the city considered them to be those most feasible relative to the other opportunities that were identified.

In the following section, the framework that was used to assess the feasibility of these mainstreaming opportunities is described.

4.2 Feasibility assessment framework

The framework that is used to assess the feasibility of the mainstreaming opportunities in Dordrecht has originated from another case in which advantage was taken from a mainstreaming opportunity: the realisation of the world's first fish migration river through the Afsluitdijk in the Netherlands (theafsluitdijk, NA).

The fish migration river is a fish passage through the 32 km long Afsluitdijk that connects the marine environment of the Wadden Sea with the fresh water environment of the IJsselmeer (Figure 11.). It will contribute to ecological restoration by enabling several fish species to reach their breeding grounds that are located in the fresh water systems of the IJsselmeer, the river IJssel and, further upstream, the river Rhine. It is currently being realised as the result of the opportunity that was provided by the reinforcement works that were required to comply with the flood protection standards for the Afsluitdijk. This case is a successful example of using a mainstreaming opportunity. The final decision to realise this work was taken in November 2014 and its final design is currently being prepared.

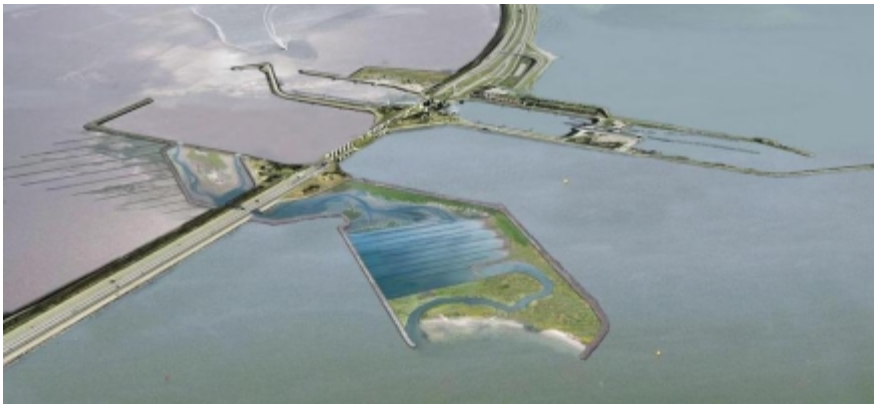


Figure 11. An artist impression of the fish migration river through the Afsluitdijk.

One of the authors of this report was involved in a study of the steps that were required to turn the aspiration for a fish migration river into reality. 13 interviews with a total of 16 representatives of all key stakeholder groups involved (National government, regional government, and NGOs for environmental protection and fishery) were conducted to identify the interests at stake; including the expected added value and the practical, legal, organisational and political preconditions, sources of funding and their requirements, and critical moments in the time schedule. Analysis revealed that there were six main factors that were required for the decision to go ahead with the realisation of the fish migration river. These factors are combined into the framework that is presented in Figure 12.

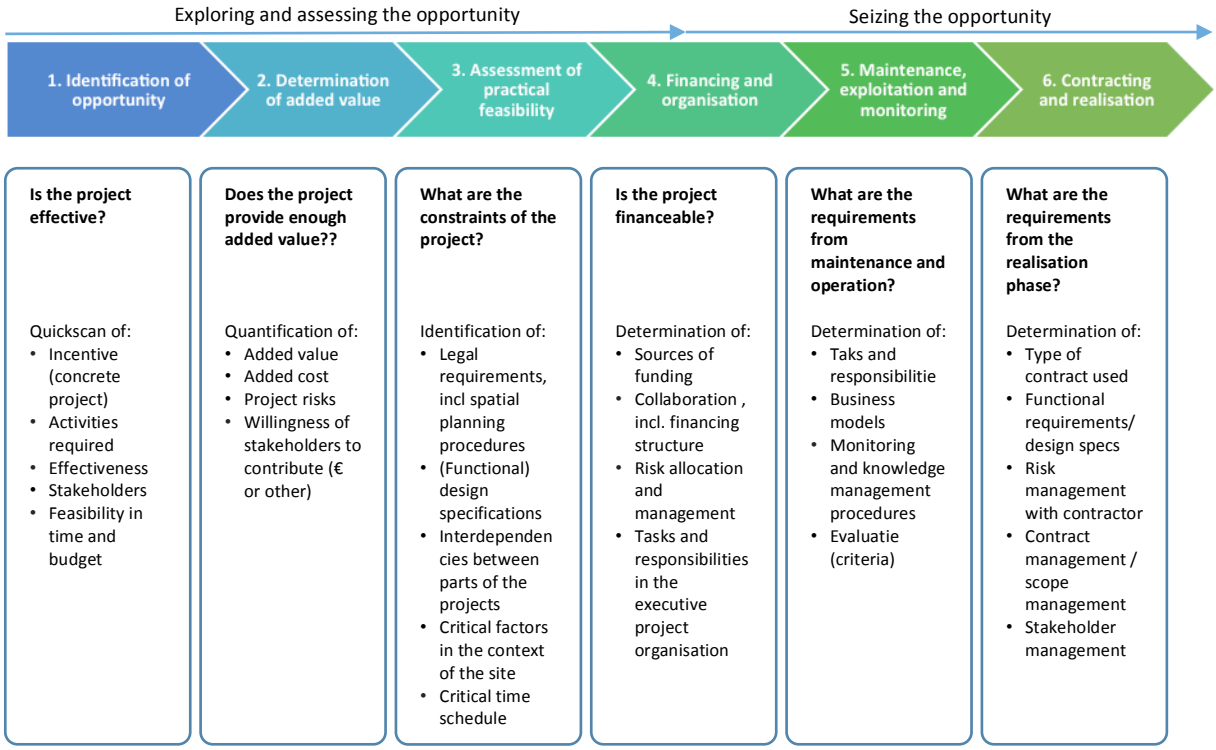


Figure 12. Framework for assessing the feasibility of mainstreaming opportunities.

The factors are structured as a serial process that sets out the steps that need to be fulfilled before the decision can be made to utilise a mainstreaming opportunity. However, the order is only indicative and the assessment itself is more an iterative process in which the elements are gradually analysed in more detail during the course of the assessment. The order is used in the following sections to describe the findings of the selected mainstreaming opportunities that were identified for realising multi-layered flood safety on the Island of Dordrecht.

4.3 Case: Planned maintenance works on the Merwedestraat-Oranjelaan

4.3.1 Identification of the opportunity

The Merwedestraat-Oranjelaan connects Dordrecht's city centre and the unembanked 'Stadswerven' area with the N3 highway (Figure 13.). If the connection were to be elevated in certain places, it could potentially function as a 'life-line' for evacuation of the population in the unembanked 'Stadswerven' area. Major maintenance works for both roads are scheduled for 2015-2016. As the design phase for this is still ongoing, these works were identified by the city of Dordrecht as an opportunity for realising this 'life-line' at relatively low cost and with minimum hindrance during the construction works for the community living and working in the area.

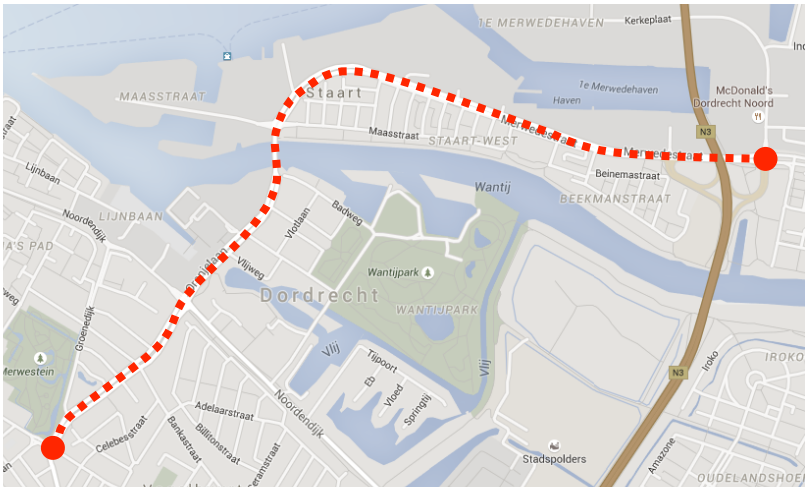


Figure 13. Location of the Merwedestraat and Oranjelaan in Dordrecht.

4.3.2 Determination of added value

The realisation of a ‘life-line’ in the Stadswerven would lead to increased accessibility of flood shelters in the area for the distribution of goods and the evacuation of people. These benefits have not been quantified because a first dialogue between the departments of City Development and Public Works at the municipality immediately revealed that the costs for elevating the road would be not acceptable for them. The discussions about this mainstreaming opportunity revealed that for safeguarding the stability of the road, the groundwater table should be at least 1m below the road foundation. As a result, it appeared that the whole road should be elevated, which is considered overly expensive (costs not yet quantified). In addition, the discussion about the requirements for an evacuation route has also revealed that the existing part of the road in the unembanked area is not water robust under current circumstances.

4.3.3 Conclusion

Because the costs are considered too high by the city of Dordrecht, it is not considered feasible to create a ‘life-line’ on the Merwedestraat-Oranjelaan at the time of major maintenance works. It is therefore not necessary to focus on the other factors within the feasibility assessment framework.

4.4 Case: Planned road reconstruction of the N3

4.4.1 Identification of the opportunity

The N3 is a regional road that connects the Island of Dordrecht with two other dike rings: the Hoeksche Waard in the West and the Alblasserwaard in the North. Because of these connections, the N3 could potentially be used for evacuating/accessing the area during/after flooding. As shown by Figure 14., the elevation of the road varies, with particularly low lying parts in the south and north. In 2015, a road reconstruction project was initiated by Rijkswaterstaat (the National organisation responsible for major infrastructure), which is being considered as an opportunity to provide a cost effective realisation of an evacuation road. In

fact, the N3 is considered as the only opportunity available now to implement horizontal evacuation strategies on the Island of Dordrecht. The planned reconstruction works are providing a window of opportunity to realise this aspect of multi-layered safety on the Island of Dordrecht.

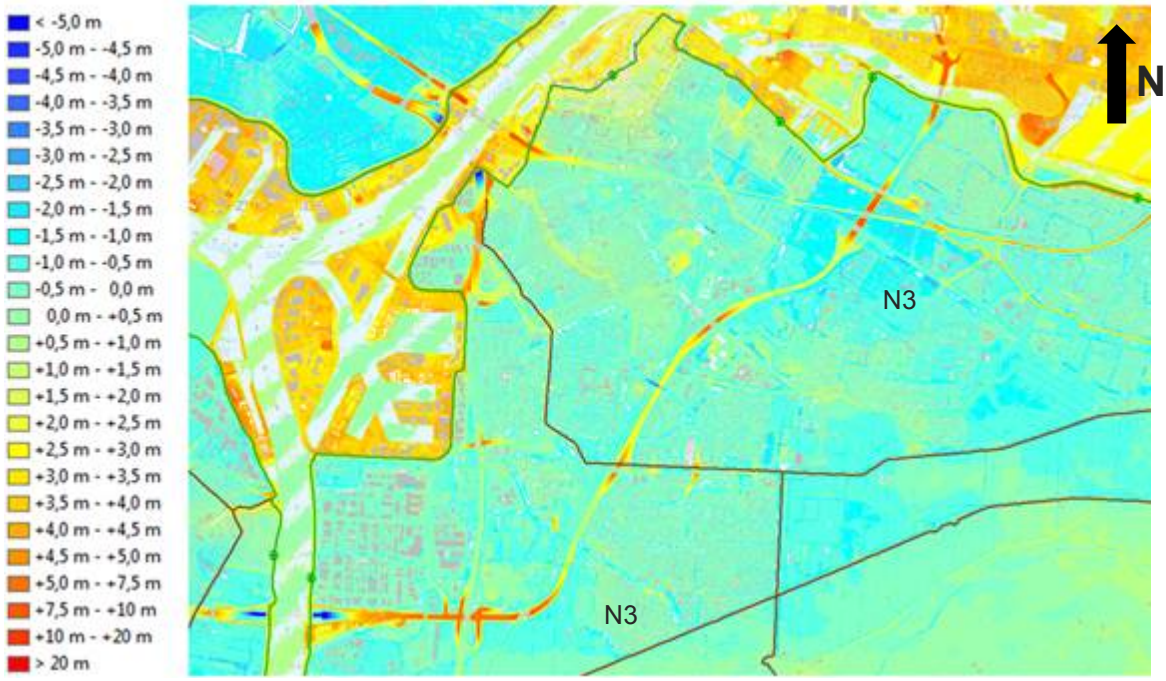


Figure 14. Altitude map for the N3 on the Island of Dordrecht.

4.4.2 Determination of added value

At the time of this study (summer 2015), it is not yet possible to quantify the added value of converting the N3 into an evacuation/access route.

An upgrade of the N3 into an evacuation/access route would be beneficial for the evacuation and recovery capacity of the Island. Although a quantified cost-benefit estimate is not yet available for both aspects, it is assumed by several stakeholders that the increased recovery capacity is valuable, because this would enable the regional economy to recover faster after flooding has occurred.

Precise cost estimates are not yet available, because the activities that are required to realise an evacuation route (e.g. road elevation, road signs, moveable road barriers for one way traffic on all lanes) have not yet been specified. However, because the required road elevation would be at least hundreds of meters for several meters height, it is roughly estimated that the additional costs for converting the N3 into an evacuation/access route would be in the order of millions of euros.

4.4.3 Assessment of practical feasibility

Rijkswaterstaat started the project in 2015 and realisation is scheduled for 2018-2019, therefore any additions to the original scope should be included in the specifications in the concept contract for the tender (planned early 2017). The city of Dordrecht has recognised the opportunity for mainstreaming in the earliest stage (first meeting of project team) of the road reconstruction project for the N3.

4.4.4 Financing and organisation

At present, Rijkswaterstaat is responsible for the planning and execution of the reconstruction works for the N3. The costs of the reconstruction works are covered from Rijkswaterstaat's dedicated budget for maintenance of the road network. The additional costs for converting the N3 into an evacuation/access route need to be covered from additional funding sources. The stakeholders have considered several funding options, following from different perspectives of what an evacuation/access route exactly is and to what policy objectives it contributes:

- when the route is considered a flood risk management measure, the most logical funding source is the Delta Fund. However, it is not likely that this can cover the costs for upgrading the N3 into an evacuation/access route, because this measure will not reduce the flood risks on the Island of Dordrecht itself; and

- when the route is considered a measure for mobility (during and after floods), funding logically comes from the national budget for mobility. As a consequence funding for the upgrade of the N3 competes with funding for measures addressing traffic congestion. It is therefore not likely that the upgrade of the N3 is a priority for the Ministry of Infrastructure and Environment.

Although the stakeholders involved have currently not completely ruled out any of these funding options, none of the stakeholders believes that the case for an upgrade of the N3 is convincing enough to attract funding from either option. The standard procedure for achieving this is through the MIRT planning procedures (MIRT Onderzoek en MIRT Verkenning), which started in 2015 and is expected to be completed by the end of 2017. Hence, it is not likely that funding will be secured before the specification needs to be incorporated into the concept contract for the tender.

4.4.5 Conclusion

Whilst the opportunity for mainstreaming has been identified in the earliest stage (first meeting of project team) of the road reconstruction project for the N3, there seems to be insufficient time available to attract the requisite funding for the additional costs for establishing an evacuation route. As a result, the current window of opportunity for realising a means for horizontal evacuation from the Island of Dordrecht will remain inaccessible. The next window of opportunity is expected in 45-50 years, when the next round of large reconstruction works will be undertaken.

4.5 Case: Nature development of the Nieuwe Dordtse Biesbosch

4.5.1 Identification of opportunity

A dike breach at the location of the Kop van‘t Land is the worst possible flood scenario for the Island of Dordrecht, because it would lead to flooding of the urbanised part of the Island in the northern dike ring. If the flood water could be diverted towards the southern part of the Island (mostly agricultural land), the flood risk for the urbanised parts in the northern dike ring would be reduced. Diversion of this flood water requires an opening through the Zeedijk, a secondary dike that separates the northern and southern parts of the Island. South of the Zeedijk, the Noorderdiepzone will be redeveloped from agricultural land into wet marshlands as part of the ecological restoration project Nieuwe Dordtse Biesbosch that aims to connect the Dordtse and Sliedrechtse Biesbosch (Figure 15.).

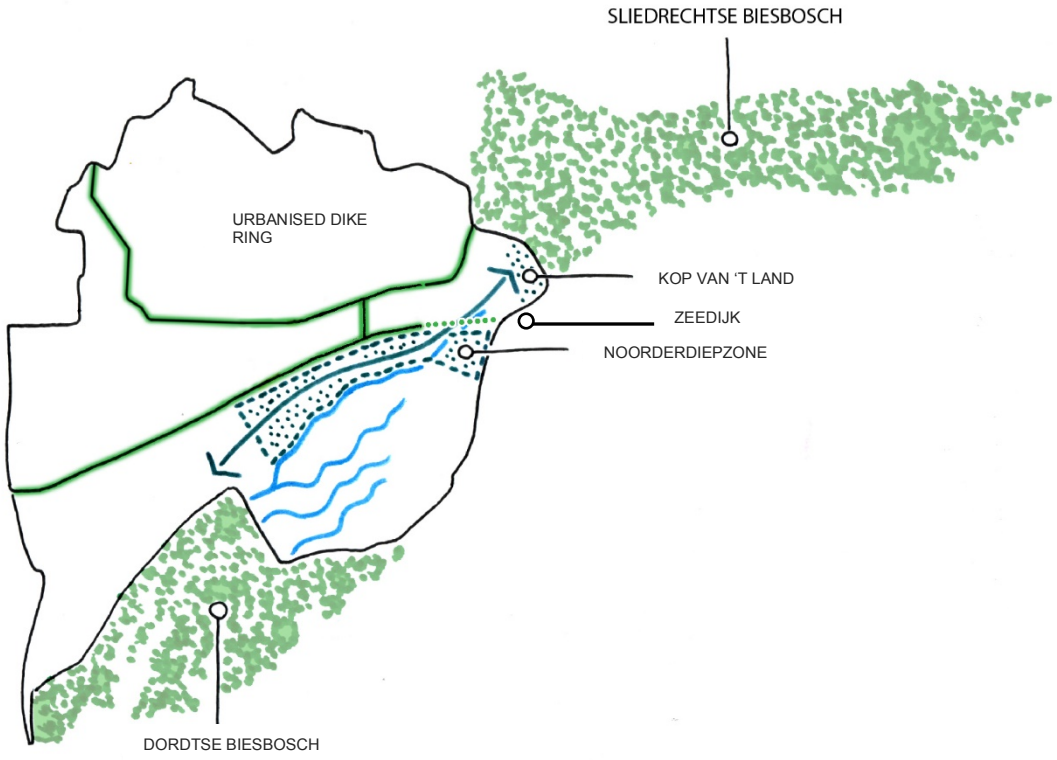


Figure 15. Project area of the Nieuwe Dordtse Biesbosch (De Urbanisten, 2015).

The construction of a 150 m eco-passage through the Zeedijk could be beneficial to the objectives for flood risk management and also to the ecological restoration of the Nieuwe Dordtse Biesbosch. In view of this, the development of the Nieuwe Dordtse Biesbosch potentially provides a window of opportunity to realise this eco-passage cost-effectively.

4.5.2 Determination of added value

Cost benefit analyses for utilising the opportunity that is described above have not yet been conducted. It is, however, possible to give a qualitative indication of the benefits and costs of the opportunity. The potential benefits include:

- Considerable cost savings and preservation of cultural heritage for dike reinforcement in the historic city centre can be expected. Due to a reduction of flood risk in the northern dike ring, reduced flood risk standards apply to the northern part of the Island caused by the reduction in expected damage and casualties.

- Strengthening ecological values of Nieuwe Dordtse Biesbosch by providing a link with the Sliedrechtse Bieschbosch;.

- Sustaining the landscape value of trees on the Zeedijk, because the secondary flood defence will partially be redundant after construction of the new eco-passage. At present, the trees are creating a risk for the functionality of the Zeedijk as a flood defence.

If the strength and stability of the existing secondary dikes is sufficient to be able to function as a flood defence (their performance is not maintained for this at the moment), it is expected by all stakeholders that the benefits will outweigh the costs for the realisation and maintenance of the150 m wide eco-passage and any additional measures to mitigate the new flood risk in the southern dike ring. However, the structural condition of the secondary dikes is currently uncertain.

4.5.3 Assessment of practical feasibility

There are several significant uncertainties that need to be resolved before a well informed decision can be made about the measure to divert flood water if there is a dike breach at Kop van‘t Land, such as the cost effectiveness and state of the secondary dikes. Furthermore, the Water Board has emphasised the importance of assessing the legal feasibility of this measure, as it redistributes the flood risks on the Island. During the next phase of the MIRT procedure (‘MIRT Verkenning’; early 2016 - end 2017) analyses will be performed to gain better insights into these aspects. However, the development of the Nieuwe Dordtse Biesbosch cannot be delayed due to the short window of eligibility for EU subsidies and an obligation for the Water Board to timely achieve EU Water Framework Directive requirements.

4.5.4 Maintenance, exploitation and monitoring

For the Water Board who are responsible for flood risk management, it is a precondition that the flood risks are adequately managed and safeguarded after realisation of the eco-passage. For example, urban development in the southern part of the Island could lead to an increased flood risk, unless additional measures are taken to protect the new development. Hence, instruments, such as a ‘Maintenance and Management Covenant’, that could be used to overcome this barrier for the Water Board need to be explored.

4.5.5 Financing and organisation

The measure of diverting flood water requires the coordination of tasks and responsibilities of multiple actors, as it involves spatial planning and adjustments to secondary flood defences. Therefore the city, Water Board and Province need to agree on their involvement in terms of roles, responsibilities and funding. Usually in the Netherlands, these aspects are described in a collaboration agreement that is co-signed by all public stakeholders involved.

Creating an opening through the Zeedijk as an eco-passage is primarily driven by a policy objective for flood risk management. The largest (monetary) benefits, however, are expected to accrue as a result of avoiding the need for strengthening of flood defences in the historic city centre. This means that the Delta Fund is the most logical funding source. However, it is currently unclear if projects other than dike strengthening are eligible for funding from the Delta Fund.

4.5.6 Contracting and realisation

The Zeedijk is currently outside the project scope of the development of the Nieuwe Dordtse Biesbosch. Hence, the project scope needs to be broadened to encompass the eco-passage as part of the Nieuwe Dordtse Biesbosch. This would require political decisions by the Water Board and the local government, as it involves a change of the functionality of a part of the Zeedijk (no longer a defence) and a change of the zoning plan for the Nieuwe Dordtse Biesbosch. This would introduce a risk for the planning and progress of the realisation of the Nieuwe Dordtse Biesbosch.

Alternatively, the eco-passage can be considered as a separate project. The eco-passage can be realised later than currently planned, when better information to motivate the decision for the realisation of the flood diversion measures, funding, a legal basis and contractual agreement amongst the public agencies involved has become available. However, in order to ensure the effectiveness of the measure, the design for the Nieuwe Dordtse Biesbosch should take the possible realisation of the eco-passage into account. This requires preparation and collaboration between the project teams of the Nieuwe Dordtse Biesbosch and the MIRT study for multi-layered safety, and the Water Board Hollandse Delta.

4.5.7 Conclusion

It is not necessary to coordinate construction of the Zeedijk eco-passage as part of the Nieuwe Dordtse Biesbosch project because the Zeedijk is not formally a part of the scope of the project. The eco-passage can be realised later, when the decision for the measure can be motivated better and legal, contractual and financial issues are resolved. However, coordination (and hence planning) with the Nieuwe Dordtse Biesbosch project is necessary to ensure the effectiveness of the eco-passage. Although policy objectives are in this case not being linked within the scope of one project, this supports the importance of identifying mainstreaming, or synergistic opportunities at the earliest possible stage.

4.6 Reflection

4.6.1 Reflection on the three mainstreaming opportunities in Dordrecht

Mainstreaming is considered a means for implementing the multi-layered safety strategy for flood risk management for the people on the Island of Dordrecht. However, it is not likely that any of the opportunities identified so far and outlined above will be utilised to combine flood risk management objectives within the original projects. The most important reasons for this are:

- Mainstreaming is not free of cost. Particularly the elevation of the roads which even without quantification, was considered overly expensive (Merwedestraat-Oranjelaan, N3).

- Mainstreaming can only work when there are dedicated funding sources for the objectives that are to be included in the original project scope and can provide the means for linking objectives. At present, additional and dedicated funding sources for the potential spatial measures for evacuation are uncertain as such resources are usually allocated for dike strengthening.
- The timeframes lack synchronicity: the windows of opportunity provided by the ongoing projects is shorter than the time required for political decision making on the allocation of funding for flood risk management objectives (N3, Nieuwe Dordtse Biesbosch).
- There is no or limited added value in using the opportunities apparently available and it would be easier from a project management point of view to separate the projects rather than trying to synchronise them (e.g. eco-passage as a separate project in the Nieuwe Dordtse Biesbosch).

The process of assessing the feasibility of the three mainstreaming opportunities has resulted in a number of outcomes in each of the three cases investigated:

- Awareness has been raised in public works agencies about the limited water robustness of roads (Merwedestraat-Oranjelaan) and the use of roads as evacuation/recovery routes (N3).
- Project alignment is important where feasible to prepare for possible future measures (Nieuwe Dordtse Biesbosch and N3).
- It was demonstrated that current planning provisions (i.e. MIRT) do not adequately enable mainstreaming opportunities at the level of ongoing projects. Particularly, the time needed for the decision making process is too long for revision of goals and objectives setting and in attracting funding for specific projects.

There seems to be no more options for improving the horizontal evacuation during floods for the Island of Dordrecht, if the mainstreaming opportunities are not being used. This means that vertical evacuation is the only remaining alternative to make a complete multi-layered safety strategy work on the Island of Dordrecht. Hence, it can be concluded that the decision to make use of mainstreaming opportunities is, amongst other factors, influencing the way in which multi-layered safety is taking shape on the Island of Dordrecht (Figure 16.).

In Section 2.1, it was described how, in literature, mainstreaming often relates to making a process or objectives ‘business-as-usual’ (BAU). However, the cases on the Island of Dordrecht illustrate that the BAU of multi-layered safety itself includes a limited number of measures (i.e. one option for flood diversion and one option for horizontal evacuation). In this context, mainstreaming relates to bringing flood risk management objectives into the everyday course of planned or ongoing spatial development projects. The combinations (synergies, co-incident opportunities) only become BAU when similar opportunities or propitious juxtapositions are commonly being utilised at a large spatial scale, e.g. on the scale of a region or for the Netherlands as a whole. Hence, it could be concluded that mainstreaming in projects relates to bringing an additional objective into the BAU of planned or ongoing projects in other policy/infrastructure domains, whilst mainstreaming of policies relates to such combinations themselves becoming BAU.

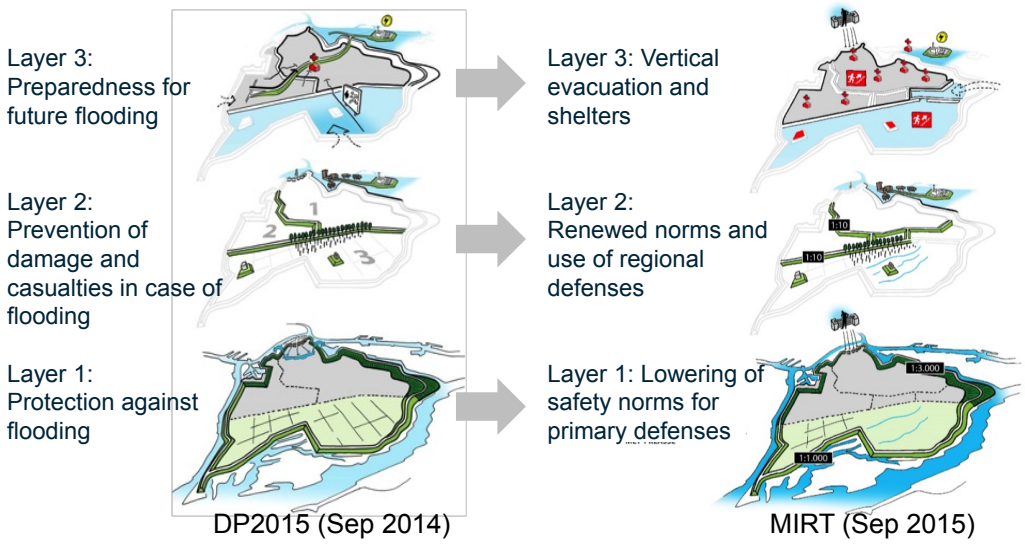


Figure 16. Changing application of the multi-layered safety concept since September 2014.

4.6.2 Reflection on the feasibility assessment framework

Application of the mainstreaming feasibility assessment framework (Figure 12) is – and should be – an iterative and cyclical process in which the level of detail considered increases throughout the process. The order of the six steps is the result of the properties of the case studies considered in this research, and is at best an indication of how decisions about the feasibility of mainstreaming can be structured effectively. In the cases presented here this is because of the characteristics of the respective mainstreaming opportunities. The order in which the six elements were addressed differed between the cases of the N3 and the Nieuwe Dordtse Biesbosch (‘maintenance, exploitation and monitoring’ comes before ‘financing and prganisation’ in case of Nieuwe Dordtse Biesbosch). Furthermore, the element of ‘contracting and realisation management’ receives typically less attention than the other elements of the framework. However, in order to realise a project efficiently, it is recommended that a strategic analysis of the project’s procurement and management approaches is included in the process.

The analysis of the feasibility of the mainstreaming opportunities outlined here was not a complete feasibility analysis. This was because a qualitative analysis quickly revealed reasons why these opportunities were not feasible, and hence the process was aborted, as it was not necessary to conduct further in-depth analysis, such as quantitative cost-benefit analysis. This indicates that a decision to let a mainstreaming opportunity pass typically may require less analysis than would a decision to use a mainstreaming opportunity. Nevertheless this review has shown that applying the framework is relatively time-efficient, and that the framework could be helpful to policy makers and planners in ensuring the systematic assessment of potential mainstreaming opportunities. Finally, it should be noted that the evaluation of the mainstreaming opportunities has been done here without consultation of the public.

4.7 Conclusion

A framework has been introduced (Figure 12) for assessing the feasibility of mainstreaming opportunities in relation to flood risk management. The three examined mainstreaming opportunities in Dordrecht illustrate that the framework can be used to assist in testing the feasibility of emerging mainstreaming opportunities associated with already planned developments. Because the application of the framework requires relatively limited resources, it can help policy makers and planners in adopting a systematic approach to assessing mainstreaming opportunities as a means to implement innovative urban water strategies, such as multi-layered safety.

Using the framework to assess the feasibility of the mainstreaming opportunities helped to show that it is not likely under the current conditions that the scope of any of three ongoing projects in Dordrecht will be widened to include flood risk management objectives. One impediment is that mainstreaming is in practice often a costly addition to the original project, contrary to what has previously been shown (Veerbeek et al., 2012); although the separate delivery of the various objectives may in itself be overall more costly for the same multiple outcomes. Mainstreaming should be seen as potentially providing added societal value against relatively limited additional cost. Another problem in the application outlined here is that present planning provisions in the Netherlands are not set up to enable mainstreaming. This is because the time between signalling an opportunity and project realisation, as shown in the case studies, is shorter than that needed for allocating (the additional) government funding to cover the added costs of delivering the additional mainstreamed objectives.

5. A way forward for mainstreaming in the Australian context

5.1 Introduction

In this Chapter, the insights about the mainstreaming approach from the examples from flood proofing Hamburg HafenCity, climate adaptation in ZoHo Rotterdam, city greening in Hoboken and multi-layered safety in Dordrecht will be considered in the context of water sensitive urban design in Australia.

For example, within the scope of the CRC for Water Sensitive Cities a strategy for flood resilience is currently being developed for Elwood in the City of Port Philip, Victoria. Mainstreaming could possibly be used to implement this strategy cost-effectively, as in Hoboken (Section 3.4) and Dordrecht (Section 3.5) respectively for city greening and multi-layered flood safety.

In the following section, conclusions are drawn from the findings that are described in the previous chapters. How the findings may apply to the Australian context is then considered.

5.2 Mainstreaming across strategic, tactical and operational levels

In Chapter 4, it was identified that there is a difference between mainstreaming at the level of policy and at the level of actual projects. Moreover, it was concluded that there is typically a mismatch between the time required for preparing the implementation of a mainstreaming opportunity added on to a project that has already been conceived and is well developed in planning and the time for accessing the additional funding required for the added opportunities. In a context similar to the Netherlands, mainstreaming ideally refers to an area-oriented approach in which there is harmonisation of policies (strategic level), alignment of investment agendas (tactical level), and practicability for project management (operational level; Table 2). Other contexts may favour top down approaches that enforce mainstreaming or agile approaches that are fully focused on embracing opportunities.

Table 2. Mainstreaming across strategic, tactical and operational levels

Level of engagement	Key objective
STRATEGIC Harmonisation of policies	• *Physical*: Identification of policy domains that could provide opportunities for flood resilience? (e.g. urban development, spatial planning, mobility, environment) • *Relational*: Building professional networks across relevant institutional actors to exchange ambitions, trends, opportunities and needs.
TACTICAL Alignment of investment agendas	• *Physical*: Identification of objects (e.g. roads, parks, various building types, waterways, agricultural land, nature areas) that may provide opportunities for mainstreaming in the future. • *Relational*: Periodic exchange of long term investment plans amongst the key stakeholders. (And advocacy for the development of these plans, in case they are not yet developed).
OPERATIONAL Practicability for project management	• *Physical*: Scope widening of projects to achieve synergetic effects in terms of relative cost savings or added societal values by combining objectives from various policy domains. • *Relational*: Negotiation of plans, roles, responsibilities, instruments (e.g. realisation contracts, covenants etc.) and funding.

Based on several exploratory interviews with professionals working for local government, the water authority and water retailer in Elwood, the context for mainstreaming across the three levels in Elwood has been assessed. From this, many similar challenges between the cases in this report and the Elwood context can be identified.

As described in Chapter 2, most of the literature about mainstreaming refers to the strategic level of harmonising policies. Accordingly, policy makers and planners consider mainstreaming a key principle to achieve climate adaptation policies. However, more attention to the tactical and operational aspects of mainstreaming is required. This also applies in the context of Elwood.

At a strategic level, the interviewees indicated that they are aware about the policy domains and organisations that are needed to enhance flood resilience. Moreover, they unanimously agreed that flood resilience requires a systems approach on a catchment scale. Whilst the water authority (Melbourne Water) is responsible at a catchment scale, coordination is suboptimal because coordination of decentralised measures between the four local governments in the catchment is currently lacking.

Moreover, there is limited information sharing between asset owners about planned investments at a tactical level. According to the interviewees, reconstruction of sewers, drainage pipes, roads and parks occurs reactively depending on the performance of the assets and the need for replacement. This makes it difficult to plan for alignment with other capital works investments. However, there have been attempts in the past to coordinate capital works programmes across organisations. These attempts failed due to several reasons, such as the desire to maintain flexibility to cope with changing corporate priorities and inflexible timing after capital works have been planned.

At the operational level, the interviewees suggested that the most promising measures for mainstreaming would be relatively small scale raingardens. For such small scale projects, it was noted that these projects will only go ahead if their impact projected by flood models is such that they result in a lower risk category of the area in which they are located[3]. However, as the range of these risk categories is relatively large, the projected impact of small scale measures is often insufficient to achieve this. The only large scale development that possibly provides a mainstreaming opportunity in the catchment is the redevelopment of the Elsternwick Park, but its expected impact in terms of flood risk mitigation is limited because this park is located at the downstream end of the catchment.

As well as the UK case quoted[49], the example of the Rotterdam ZoHo (Section 3.3), where there is no strategic plan for redevelopment, but rather a vision; only taking action where there have been detailed models or analyses to demonstrate that each and every small action has a beneficial effect, misses the opportunity to utilise the uptake of incremental changes to land use, that together will lead to beneficial outcomes. Small changes, where minor areas are changed from paved to green or other WSUD measures are often not amenable to modelling that will demonstrate their effectiveness on flood risk management or water pollution control. This is not because they are not effective at doing this, but because of the limitations of the models and the resource costs of setting up computational models for small areas.

5.3 A way forward for mainstreaming in the Australian context

In the previous section it was described how the implementation of flood risk mitigation or adaptation measures through mainstreaming is not likely to be straightforward in the context of Elwood. Reflecting upon the case studies in Chapters 3 and 4, several recommendations to help with mainstreaming can be identified:

- Greater and better exchange of information between infrastructure asset owners across all levels (strategic, tactical and operational) is needed in order to be able to capture the benefits of mainstreaming. This could be used to inform decisions to accelerate or postpone reconstruction, renovation or maintenance works in order to achieve e.g. increased societal value of public infrastructure, cost-effectiveness and reduced

[3] This contrasts with recent UK applications where the multiple benefits of surface water GI systems are promoted via a ‘get nibbling’ banner – meaning literally to nibble away at every paved surface with GI irrespective of whether or not an analysis of the urban hydrology effects has been undertaken: http://www.engineeringnaturesway.co.uk/resource/prevent-flooding-landscape-institute-lets-get-nibbling/.

hindrance to communities caused by construction work in progress. The 'checklist' that was introduced in Chapter 4 could be used as a tool to structure stakeholder dialogues.

- More proactive asset management approaches are required in order to anticipate upcoming capital works investments and notify other asset owners about possible mainstreaming opportunities. This would also reduce impacts on the community caused by malfunctioning infrastructure.
- Improved catchment management is needed through better coordination amongst local governments regarding urban drainage projects. Also, a systems approach for demonstrating risk reduction that considers groups of projects rather than individual projects in order to ensure that individual projects are not abandoned due to insufficient impact in terms of flood risk reduction.
- Small scale 'nibbling' projects, retrofitting GI stormwater measures should be recognised as importantly contributing to a cumulative overall greater benefit through gradual implementation, and not being dismissed due to lack of analytical demonstration of their individual effectiveness[4].
- When assessing the cost-effectiveness of mainstreaming opportunities, not only should the added value in terms of risk reduction be incorporated, but also other benefits related to spatial quality and durability. For example, the BeST tool (CIRIA, 2015) or other equivalents, including the WSC Modelling Toolkit, are available for assessing the financial value of the multiple benefits of water sensitive features.

[4] This should be seen in the same way as Melbourne Water's 10,000 raingardens project: http://www.melbournewater.com.au/aboutus/news/Pages/10000+-Raingardens-contribute-to-healthy-waterways.aspx

6. Conclusion

Whilst mainstreaming is a promising approach for realising adaptation strategies, the literature on adaptation mainstreaming as yet provides only limited reported experience with mainstreaming in practice and does not yet provide guidance for the implementation of mainstreaming at the level of projects (Chapter 2).

In this report, a description is provided as to how mainstreaming can lead to the delivery of projects in practice. It was identified that there are various different ways to implement mainstreaming, including mainstreaming as a precondition for urban development, mainstreaming as a by-product of urban development, and mainstreaming as a means to implement an innovative urban water vision (Chapter 3). In addition, several enabling factors were identified, including leadership, effective partnerships, and the use of decision support tools. Further research and development is needed to better understand how the different approaches to mainstreaming can be enabled most effectively. This would contribute to a fit-for-purpose mainstreaming approach that is tailored to the context in which it is being applied.

This report has not focussed on timescales in the sense of using scenario planning as described in the CRCWSC report '*Flood Resilience in Water Sensitive Cities. Guidance for enhancing flood resilience in the context of an Australian water sensitive city'* (Gersonius et al., 2014). A better understanding of scenario planning in the context of mainstreaming could potentially contribute to an improvement in the synchronicity of capital works programmes, and, thus, to enhancing both the amount and feasibility of actually realising mainstreaming opportunities.

Mainstreaming is about linking multiple policy objectives and thus about generating multiple benefits. Therefore, the valuation of WSUD schemes is key to determining the added value of mainstreaming opportunities and capturing the multiple benefits those could provide. Several tools are available to this end, such as the WSC Modelling toolkit, the BeST tool developed for CIRIA in the UK (CIRIA, 2015) and the TEEB-stad tool developed for the Ministry of Economic Affairs in the Netherlands (EZ, 2015). However, careful adjustment is needed to ensure fit to the context and the location for which they are being used in order for these to provide appropriate outcomes. Further research and development is therefore needed to ensure these tools fit to the Australian WSC context.

Moreover, despite the introduction of tools, it remains a key challenge to capture (in practice and in principle) the multiple benefits of WSUD. It is therefore worthwhile to explore to which extent new business cases and financing models could be applied. At first glance, a promising start would be to attempt to draw lessons from the equivalent practices in the renewable energy sector, which is rapidly transitioning at the moment by using innovative models that enhance private sector investments (Rijke et al., 2014).

7. References

Bauer, A. and Steurer, R. (2014) 'National Adaptation Strategies, what else? Comparing adaptation mainstreaming in German and Dutch water management', *Regional Environmental Change,* 15(2), pp. 341-352.

Bernier, P., Fenner, R. and Ainger, C. (2010) 'Assessing the sustainability merits of retrofitting existing homes', *Proceedings of the Institution of Civil Engineers - Engineering Sustainability,* 163(4), pp. 197-207.

Biesbroek, G. R., Klostermann, J. E. M., Termeer, C. J. A. M. and Kabat, P. (2013) 'On the nature of barriers to climate change adaptation', *Regional Environmental Change,* 13(5), pp. 1119-1129.

Brown, R. R. and Farrelly, M. A. (2009) 'Delivering sustainable urban water management: a review of the hurdles we face', *Water Sci Technol,* 59(5), pp. 839-46.

CIRIA (2015) *New tool assesses the benefits of SuDS* 2015).

Delta-Commisioner (2014) *Delta Prgramme 2015. Working on the delta - The decisions to keep the Netherlands safe and liveable*.

DPRD (2014) *Advies Deltaprogramma Rijnmond-Drechtsteden. Stuurgroep Rijnmond-Drechtsteden*.

ECONADPT (2015) *The Costs and Benefits of Adaptation: Results from the ECONADAPT Project*: ECONADAPT consortium.

EZ (2015) *teeb.stad*.

Gersonius, B., Ashley, R., Salinas Rodriguez, C. N. A., Rijke, J., Radhakrishnan, M., Zevenbergen, C. and Pauwels, V. (2014) *Flood Resilience in Water Sensitive Cities. Guidance for enhancing flood resilience in the context of an Australian water sensitive city*, Victoria, Asutralia: Cooperative Research Centre for Water Sensitive Cities.

Gersonius, B., Nasruddin, F., Ashley, R., Jeuken, A., Pathirana, A. and Zevenbergen, C. (2012) 'Developing the evidence base for mainstreaming adaptation of stormwater systems to climate change', *Water Research,* 46(20), pp. 6824-6835.

Gersonius, B., Rijke, J., Ashley, R., Bloemen, P., Kelder, E. and Zevenbergen, C. (2015) 'Adaptive Delta Management for flood risk and resilience in Dordrecht, The Netherlands', *Natural Hazards*, pp. 1-16.

Hansen, R. and Pauleit, S. (2014) 'From Multifunctionality to Multiple Ecosystem Services? A Conceptual Framework for Multifunctionality in Green Infrastructure Planning for Urban Areas', *AMBIO,* 43(4), pp. 516-529.

Holt, A. R., Mears, M., Maltby, L. and Warren, P. (2015) 'Understanding spatial patterns in the production of multiple urban ecosystem services', *Ecosystem Services,* 16, pp. 33-46.

MIRT-Projectteam (2015) *Rapportage MIRT-Onderzoek Meerlaagsveiligheid Eiland van Dordrecht: Zelfredzaam Eiland*.

OECD (2015) *Tools to mainstream adaptation into decision-making processes in OECD, Climate Change Risks and Adaptation: Linking Policy and Economics.* OECD Publishing.

Ofwat (2015) *Resilience Task and Finish Group final report*, London: The Water Services Regulation Authority.

Pedersen Zari, M. (2012) 'Ecosystem services analysis for the design of regenerative built environments', *Building Research & Information,* 40(1), pp. 54-64.

Rijke, J. (2014) *Adaptief deltamanagement - Ontstaansgeschiedenis en toepassing in het Deltaprogramma*, Utrecht - Netherlands: Triple Bridge.

Rijke, J., Hertogh, M. and Zevenbergen, C. 'A comparison of financial arrangements for realising adaptation projects'. *2nd International Conference on Delta times of Climate Change*, Rotterdam-Netherlands.

Rijke, J., van Herk, S., Zevenbergen, C. and Ashley, R. (2012) 'Room for the River: delivering integrated river basin management in the Netherlands', *International Journal of River Basin Management,* 10(4), pp. 369-382.

Rosenzweig, C. and Solecki, W. (2014) 'Hurricane Sandy and adaptation pathways in New York: Lessons from a first-responder city', *Global Environmental Change,* 28, pp. 395-408.

Rotterdam Climate Initiative (2012) *Rotterdam Climate Change Adaptation Strategy*, Rotterdam.

Rotterdam-Climate-Initiative (2012) *Rotterdam Climate Change Adaptation Strategy*, Rotterdam.

Sakic, R. (2015) *From vision to reality: making cities flood resilient by implementing green infrastructure strategies; the case of the city of Hoboken, New Jersey.* Master of Science, UNESCO-IHE, INsititute for Water Education.

Sakic, R., Rijke, J., Dloman, N. and Zevenbergen, C. (Submitted) 'Rebuild by Design in Hoboken: A design competition as a means for achieving flood resilience of urban areas by implementing green infrastructure', *Ecology & Society*.

Serrao-Neumann, S., Crick, F., Harman, B., Schuch, G. and Choy, D. L. (2015) 'Maximising synergies between disaster risk reduction and climate change adaptation: Potential enablers for improved planning outcomes', *Environmental Science & Policy,* 50, pp. 46-61.

theafsluitdijk (NA) *Fish Migration River*.

Uittenbroek, C. J., Janssen-Jansen, L. B. and Runhaar, H. A. C. (2012) 'Mainstreaming climate adaptation into urban planning: overcoming barriers, seizing opportunities and evaluating the results in two Dutch case studies', *Regional Environmental Change,* 13(2), pp. 399-411.

Urbanisten (2015) *Climate Proof Zomerhofkwartier* (Accessed: 12-01-2016.

USEPA (2015) *Green infrastructure opportunities that arise during municipal operations*: United States Envornmental Protection Agency.

van Herk, S., Rijke, J., Zevenbergen, C., Ashley, R. and Besseling, B. (2015) 'Adaptive co-management and network learning in the Room for the River programme', *Journal of Environmental Planning and Management,* 58(3), pp. 554-575.

van Herk, S., Zevenbergen, C., Ashley, R. and Rijke, J. (2011) 'Learning and Action Alliances for the integration of flood risk management into urban planning: a new framework from empirical evidence from The Netherlands', *Environmental Science & Policy,* 14(5), pp. 543-554.

Veerbeek, W., Ashley, R. M., Zevenbergen, C., Rijke, J. and Gersonius, B. 'Building Adaptive Capacity For Flood Proofing In Urban Areas Through Synergistic Interventions'. *7th Int. Conf. on Water Sensitive Urban Design*, Melbourne, 21-23 February.

Veerbeek, W., Zevenbergen, C. and Gersonius, B. (2010) 'Flood risk in unembanked areas part C: vulnerability assessment based on direct flood damages', *Knowledge for Climate. National research programme, KfC report,* (022C).

Ven, F., Nieuwkerk, E. v., Stone, K., Veerbeek, W., Rijke, J., Herk, S. v. and Zevenbergen, C. (2011) *Building the Netherlands climate proof: urban areas.* Utrecht: Programme office Knowledge for Climate.

VenW (2009) *National Water Plan*, The Hague - the Netherlands: Ministry of Transport, Public Works and Water Management.

Wagner, M., Chhetri, N. and Sturm, M. (2014) 'Adaptive capacity in light of Hurricane Sandy: The need for policy engagement', *Applied Geography,* 50, pp. 15-23.

Wamsler, C. (2015) 'Mainstreaming ecosystem-based adaptation: transformation toward sustainability in urban governance and planning', *Ecology and Society,* 20(2), pp. 30.

Wamsler, C., Brink, E. and Rivera, C. (2013) 'Planning for climate change in urban areas: from theory to practice', *Journal of Cleaner Production,* 50, pp. 68-81.

World Bank (2013) *Planning, Connecting, and Financing Cities—Now: Priorities for City Leaders*, Washington DC, USA: The World Bank.

World-Bank (2013) *Planning, Connecting, and Financing Cities—Now: Priorities for City Leaders*, Washington DC, USA: The World Bank.