2 Flood Risk and Spatial Quality: A Paradigm Shift in Dutch Flood Risk Reduction Strategies

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This book chapter describes the current practice with regard to combined approaches for flood risk management and spatial quality enhancement in the Netherlands. Currently, there is a requirement to extend the current flood risk system because of increased flood risk (caused by climate change and increased investments in the protected area) and new insights with regard to acceptable risks. Flood risk measures nowadays need to be implemented in a context in which local stakeholders emphasise aspects such as spatial quality and ecology.

In this contemporary context, we see interesting developments with regard to combined approaches for flood risk protection, such as, for instance, the experimental flood proof building programme, the 'building with nature' concept (in which natural principles are employed for flood risk protection), the atelier for coastal quality (that as part of the Delta Programme developed integrated designs for coastal protection and quality) and the 'Room for the River' project (in which, as an alternative to dike reinforcement, the water load is reduced by creating extra space for the river to expand).

For this research, the 'Room for the River' project is an important reference. Within the project, which aims to address more extreme river discharges, spatial quality is an important secondary objective. Next to the availability of extra budgets, a 'Quality Team' was established to supervise the inclusion of spatial quality objectives. The project addressed the growing resistance against the elevation of traditionally-built levees, by offering an alternative option of lowering the water levels by improving the flow capacity of the river (for example, by creating a bypass to widen the river).

Within the development of the combined method for flood risk and spatial quality, different aspects have been inspired or based on the 'Room for the River' approach. Among such aspects are the dual flood risk and spatial quality objective, the principle of providing alternative options for flood risk management interventions, and the inclusion of a spatial quality assessment.

Key aspects: Current practice, Urgency integrated approach, future flood risk task.

§ 2.1 Introduction

Existing Dutch flood risk reduction policies are under debate as a result of two important trends:

- New insights with regard to the expected effects of climate change and a debate regarding the recalibration of protection levels in relation to increases in economic value drive a review and improvement of the current flood risk reduction system. At the same time, there is a better conceptual and technical understanding of flood risk, for instance, with regard to the failure mechanism of piping and the flood patterns caused by dike breaches, as well as regarding the conceptual understanding of (the impact of) infrastructural interventions within a Delta system.
- The context in which new flood risk reduction strategies are being developed and changed Nowadays, there is greater emphasis on spatial quality and ecology (Ministry of Housing, Spatial Planning and the environment 2008; World Wildlife Fund 2010). The political environment changed, moving from a national, top-down approach towards a process in which local stakeholders and ownership are essential..

These factors have contributed to a paradigm shift and led to new approaches to flood risk reduction. The emphasis is now on integrated design, stakeholder participation, regional holistic long-term visions, and the use of natural processes and the so-called 'risk-based' approaches in flood risk reduction strategies. The following sections describe recent developments in flood risk approaches in the Netherlands in the light of distinctive projects such as 'Room for the River' and the 'experimental adaptive building' programme, the 'Delta Programme', and 'Building with Nature'.

§ 2.2 Room for the River

Climate change is expected to lead to larger peak river discharges (Delta Programme 2008) and with that higher water levels. This increases the loads exerted on dikes and as a result, the probability of failure. With flood risk defined as the probability of a flood multiplied by its consequences (Jonkman, Kok & Vrijling 2008), climate change thus leads to an increased flood risk. If applying the traditional Dutch flood risk approach, this would mean that dikes have to be reinforced in order to maintain the same safety levels.

There are however two important arguments against dike reinforcements. From a flood risk perspective, the consequences of flooding grow proportionally in relation to the severity of the inundation; polders are subsiding while water levels in rivers are increasing (Delta Commissie 2008). From a spatial perspective, the increasing value placed on nature and cultural heritage has led to resistance against dike reinforcements, as these usually have a large impact on spatial quality (Klijn et al. 2013).

This led to a new policy and approach in which the reduction of the load by creating extra space for the river was favoured over dike reinforcements (Alberts 2009). This paradigm shift ends a long history of narrowing riverbeds. The key aspect here is an increased discharge capacity; this can be achieved in several ways, such as: through the removal of obstacles; lowering of the floodplains, riverbed, or groins; increasing the riverbed by moving a dike or creating a river bypass or; through the creation of retention areas in polders adjacent to the river (Rijke et al. 2012).

This new policy resulted in the 'Room for the River' programme, in which the improvement of spatial quality is a prominent second objective (Ministerie van Verkeer en Waterstaat 2007). In order to achieve and supervise goals with respect to spatial quality, a 'Quality Team' was established (Klijn et al. 2013).

Currently, several 'Room for the River' projects are under construction. One example is a dike relocation in Lent, near Nijmegen (Fig. 2.1), where a new stream channel is combined with urban development on the northern river bank of the city. Another example is the Biesbosch 'de-poldering' where the existing 'Noordwaard' polder has been changed into a flood plain and recreational area (Fig. 2.2).

FIGURE 2.1 River bypass in Lent, near Nijmegen (https://beeldbank.rws.nl, Rijkswaterstaat , Ruimte voor de Rivier / PDR)

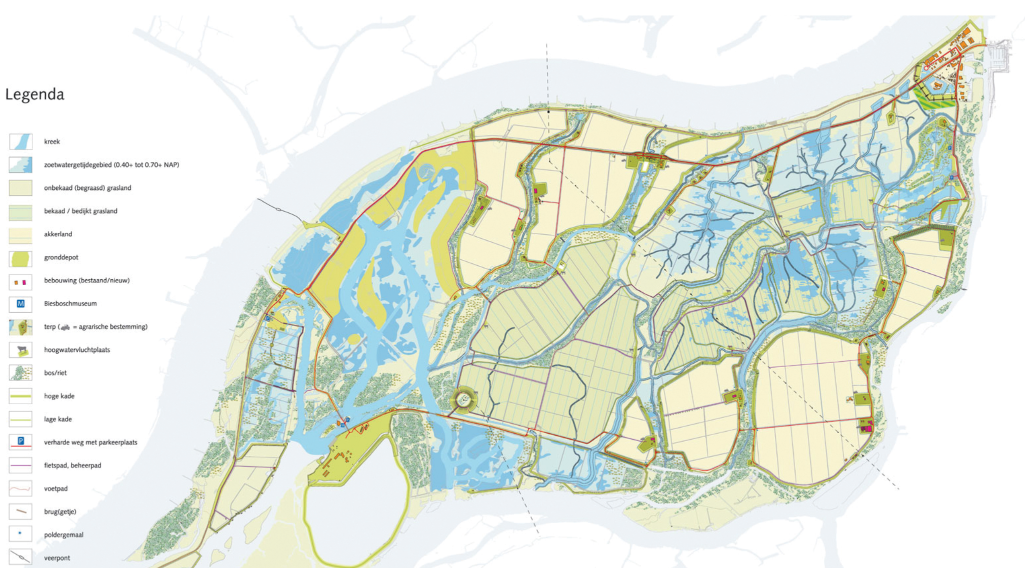

FIGURE 2.2 De-poldering of the Noordwaard (Biesbosch) (http://combinatie-noordwaard.nl/)

§ 2.3 Flood-Proof Houses

The Netherlands has a long tradition in flood-proof housing. As a result of the gradual extension of the regional and national flood risk reduction system, consisting of dams and dikes, small-scale flood risk management interventions have become obsolete. The 'Room for the River' programme required land reservations for riverbed extensions, thereby reducing availability of land for housing development. This resulted in a demand for the multifunctional use of riverbeds.

This demand was addressed through a Dutch government programme, 'EMAB', short for Experimenteren Met Aangepast Bouwen (Experimenting with Adapted Building). The programme defined 15 riverbed locations where it would be allowed to construct houses provided that certain conditions were met: the houses should be safe in the event of high water levels, contribute to the spatial quality of the area, and increase the space for the river. Several different types of flood-proof houses were developed, among which were pole houses, floating houses, and a new innovative housing type: amphibious houses.

An amphibious house is a house that is normally situated on dry land but will float in the event of high water levels. In order to accommodate floods, the houses are built upon a floating base, have flexible service connections to the main land, and are attached to mooring poles to ensure the houses stay at their location. The houses are positioned within the riverbed; a well-known example is the group of amphibious houses in Maasbommel where the water fluctuation can be up to 7 metres (Fig. 2.3). These houses can also be used in water retention areas, or in situations where a second layer of safety is desirable, such as in deep polders that inundate quickly in case of a dike breach (Fig. 2.4).

FIGURE 2.3 Amphibious houses of Maasbommel, developed by Dura Vermeer

FIGURE 2.4 Design for a lightweight composite amphibious house for retention areas.

§ 2.4 Dutch Delta Programme

Following the 1953 North Sea flood, in which large parts of the Netherlands were flooded, Dutch authorities established the so-called Delta Committee. This commission created a plan to minimise the chance of a similarly catastrophic flood event occurring in the future. Construction of the Delta Works was initiated, a system of closed and open-but-closable flood barriers that closes off the Rhine-Meuse-Scheldt estuary and protects against storm surges from the sea. Safety standards for existing dike-rings were improved and enshrined in law (Brinke & Jonkman 2009).

The present-day Dutch Delta Programme was established in order to define suitable long-term strategies and interventions to answer future flood risk challenges brought about by erosion, sea level rise, and subsidence; at the same time, the programme needs to ensure that the Dutch delta remains an attractive place in which to live, work, recreate, and invest (Delta Programme, 2008). In the Delta Programme, a variety of activities is performed, such as problem analysis, development of integrated long-term strategies, scenario development, assessment of alternative strategies, and the formation of regional strategies through extensive stakeholder consultation processes.

The Delta Programme will report to the Dutch government on a preferable flood risk reduction strategy for the country. This section presents some interesting studies that have been conducted over the course of the development of this strategy.

§ 2.4.1 Cornerstones

In an early phase of the Delta Programme, a sub-programme for Rijnmond-Drechtsteden, an interesting 'out of the box' design research was undertaken. Four extreme flood risk reduction strategies, so-called ‘cornerstones’, were defined; these were not considered realistic strategies but extremes that could widen the scope and allow for reflection on the effects and opportunities of certain high-level choices regarding flood risk protection. In addition to the current (‘as is’) situation, the cornerstones included a variation on a completely open delta (with no dams, but rather an emphasis on reinforcing dikes), a completely closed delta (with an emphasis on dams), and an open-but-closable delta (with an emphasis on closable barriers).

Interdisciplinary teams worked together on exploring the opportunities and consequences of the cornerstones. This resulted in a research-by-design study in which the relationship between flood risk management interventions and other essential aspects of the complex system of a delta such as shipping, ecology, economics, fresh water supply, and spatial development, were explored.

One of the strategies was the continuation of the current flood risk reduction system. Six urban and landscape design offices were invited to investigate and visualise the spatial consequences and opportunities of the current system, if extended to address the future flood risk reduction task up to 2100. This led to a wide range of projects varying from grand regional visions to small-scale investigations of the effects of dike elevations (Delta Programme 2011). Fig. 2.5 shows a vision for the reinforcement of old sea-dikes along the Haringvliet into a recreational dune landscape (by the urban and landscape design office Bosch and Slabbers). Fig. 2.6 shows the results of a research-by-design study by urban design office, Defacto, into the spatial effect of dike reinforcements along the historical dike ribbon of the Albasserwaard polder. Local stakeholders and governments were involved in the spatial assessment of the necessary interventions.

FIGURE 2.5 Design for a recreational dune landscape by Bosch Slabbers Landscape + Urban Design

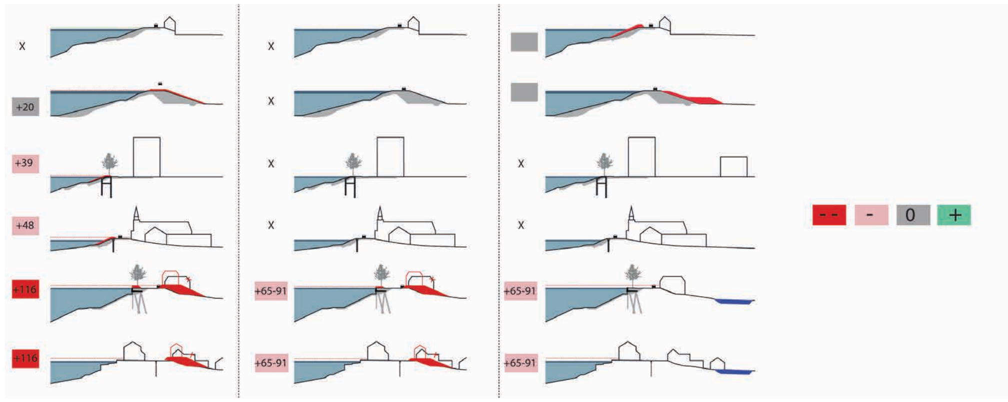

FIGURE 2.6 Assessment of the spatial impact of dike elevations for the Alblasserwaard area, in relation to different regional strategies.

§ 2.5 The Hague - City by the Sea

One of the studies that stands out for its interdisciplinary approach to flood risk and spatial design, is a research-by-design study for the development of the beach resort of Scheveningen (City of The Hague). The study was performed within the creative setting of the 'Atelier for Coastal Quality'. Sketches were made of holistic, long-term perspectives based on three different flood risk reduction strategies: a flexible dune extension, a hard quay extension, and a perpendicular dam. The goal of this study was to address long-term flood risk reduction (2100) while also improving the identity, accessibility, vitality, spatial quality, and identity of the area.

The working method of the Atelier for Coastal Quality consisted of interdisciplinary studio and workshop sessions in which civil engineers, spatial designers, and local stakeholders cooperated. These experts worked together in integrated sessions to explore and evaluate different options. The designers deemed it essential to understand the essence of the flood risk reduction task and interventions, in order to properly embed these in an integrated design. In the end, three strategies were developed, each of which had a different guiding design theme in relation to the type of flood risk intervention (Fig. 2.7). In the design for a seaward extension, the focus was on the flexibility of the solution and possibility for it to be developed in phases.

In the design featuring the hard quay, the focus was on creating proximity of the city to the water. The design for the perpendicular dam concentrated on a research-by-design approach in order to optimally position the dam. Here, the interdisciplinary way of working was essential to the research-by-design process, performed to explore the hydraulic, as well as the spatial, suitability of different possible locations for the dam.

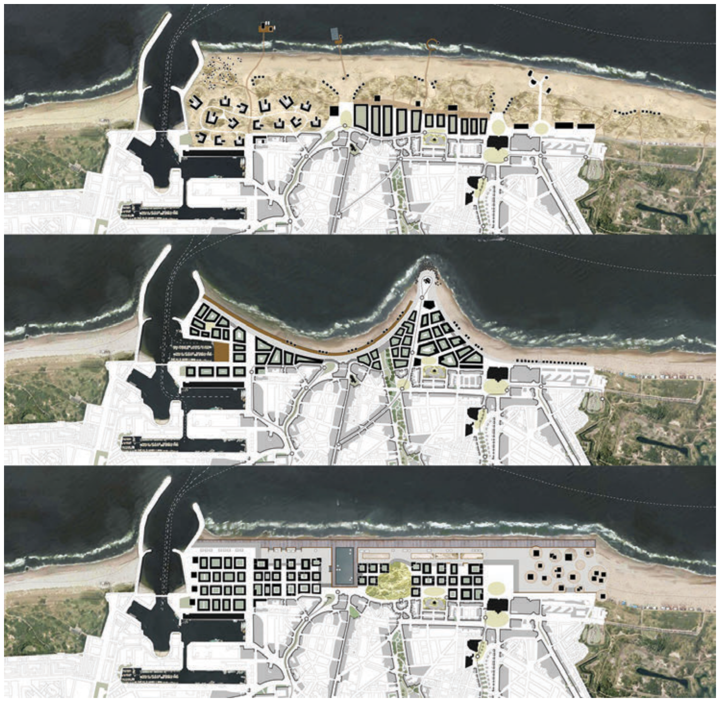

FIGURE 2.7 Three alternatives for the future development of The Hague.

§ 2.5.1 Risk-based Approach & Multi-layered Safety

A more recent development is the so-called risk-based approach. Potential failure mechanisms of dikes and the associated consequences, such as flood patterns, are studied with the use of new insights and models. This provides valuable information with respect to the contribution of specific dike segments to the potential amount of fatalities and economic damage. Dike segments that contribute significantly to risk can be held against stricter safety standards. In the Netherlands, some dike segments are being considered for construction as so-called 'delta dikes', which have a very small probability of failure, thus increasing the level of safety of an area. Generally, this results in a bigger footprint, which serves as an incentive for multifunctional use and design of such dikes.

In addition to reducing flood risk by reducing the probability of flooding, there is also renewed attention to impact (consequence) reduction. The so-called 'multi layered safety approach' aims to provide flood risk reduction, not just from a first layer of probability reduction (such as dikes and dams), but also from a second layer of spatial interventions that reduces the consequences (such as mound, compartmentations of areas, flood proof houses) and a third layer of evacuation and recovery (Ministry of Infrastructure and Environment, 2009). In particular, the interventions in the second layer appeal to designers and many imaginative design studies are made; however, it appears to be difficult to make a feasible business case for investment in flood risk reduction by means of consequence reduction in the protected areas. Nevertheless, more awareness of the flood risk in certain areas could contribute to a reduction of the risk by applying modest measures such as placing vital functions (power generation, healthcare) in higher areas, providing roofs with a rooflight to serve as an emergency escape route, or placing power sockets in houses at a height sufficient to prevent damage.

§ 2.6 Building with Nature

The 'Building with Nature' programme aims to facilitate 'a paradigm shift from building in nature to building with nature, to ensure a sustainable future' (Ecoshape 2014). New concepts and trials are developed in which the natural system is put to optimal use to provide, or contribute to, flood risk protection. Interdisciplinary cooperation is essential to developing new eco-dynamic spatial approaches that anticipate the dynamics of the natural system (Ministry of Infrastructure and Environment 2008). In the programme, engineering companies, universities, governments, and natural advocacy organisations cooperate to develop sustainable, effective, and affordable flood risk management interventions.

§ 2.6.1 Sand Engine

One of the pilots is the 'Sand Engine': an imaginative alternative to conventional sand replenishments along the Dutch coast (Fig. 2.8). Whenever, due to erosion or climate change, there is a severe inland deviation from a so-called base coastline, as defined in 1990 by Dutch authorities, Rijkswaterstaat will interfere with sand replenishments (Ministry of Public Housing, Spatial Planning and Environment 2006). Usually, this is done every 5 years, thereby temporarily disturbing ecology and recreation. The Sand Engine breaks with this strategy by providing a large-scale concentrated replenishment of 21.5 million cubic metres of sand along the coast of the Delfland region (Province of Zuid-Holland and Rijkswaterstaat, 2015). From this location, the replenishment is continued by the natural forces of wind and currents that distribute the sand gradually along the Dutch coast, thus limiting the disturbance of ecosystems and tourism. While it exists, the Sand Engine itself serves as a temporal location for nature and recreation.

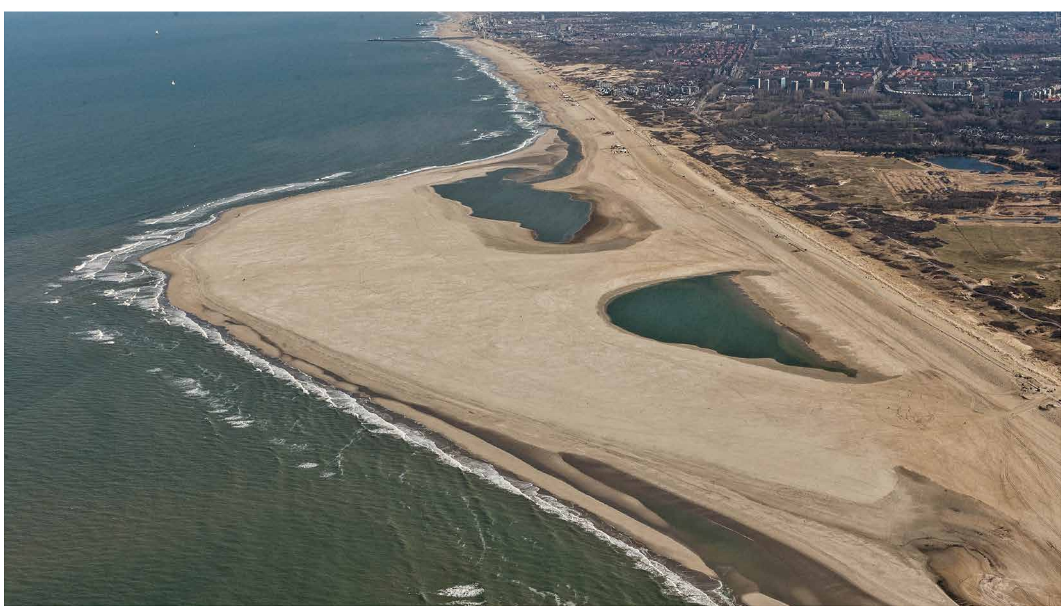

FIGURE 2.8 The Sand Engine along the Dutch Delfland coast (https://beeldbank.rws.nl, Rijkswaterstaat / Joop van Houdt)

§ 2.6.2 Vegetation as Wave Reduction

Another concept is the use of vegetation to break waves in the flood plain and thus reduce the loads exerted on dikes behind the vegetation. The necessary height and strength of a dike is linked to the expected water levels under extreme circumstances; the height of waves is included in calculations and may be severe due to strong winds combined with large fetches. In areas where vegetation within the flood bed does not compromise the discharge capacity of the river, vegetation such as willows can successfully lower the wave energy and height. In Dordrecht, a study was performed to combine the development of a landscape design for a recreational and ecological park with a flood risk reduction function (Fig. 2.9). Engineers and spatial designers worked together on the design of a park with willow vegetation that, in case of high water levels, is part of the flood risk reduction system.

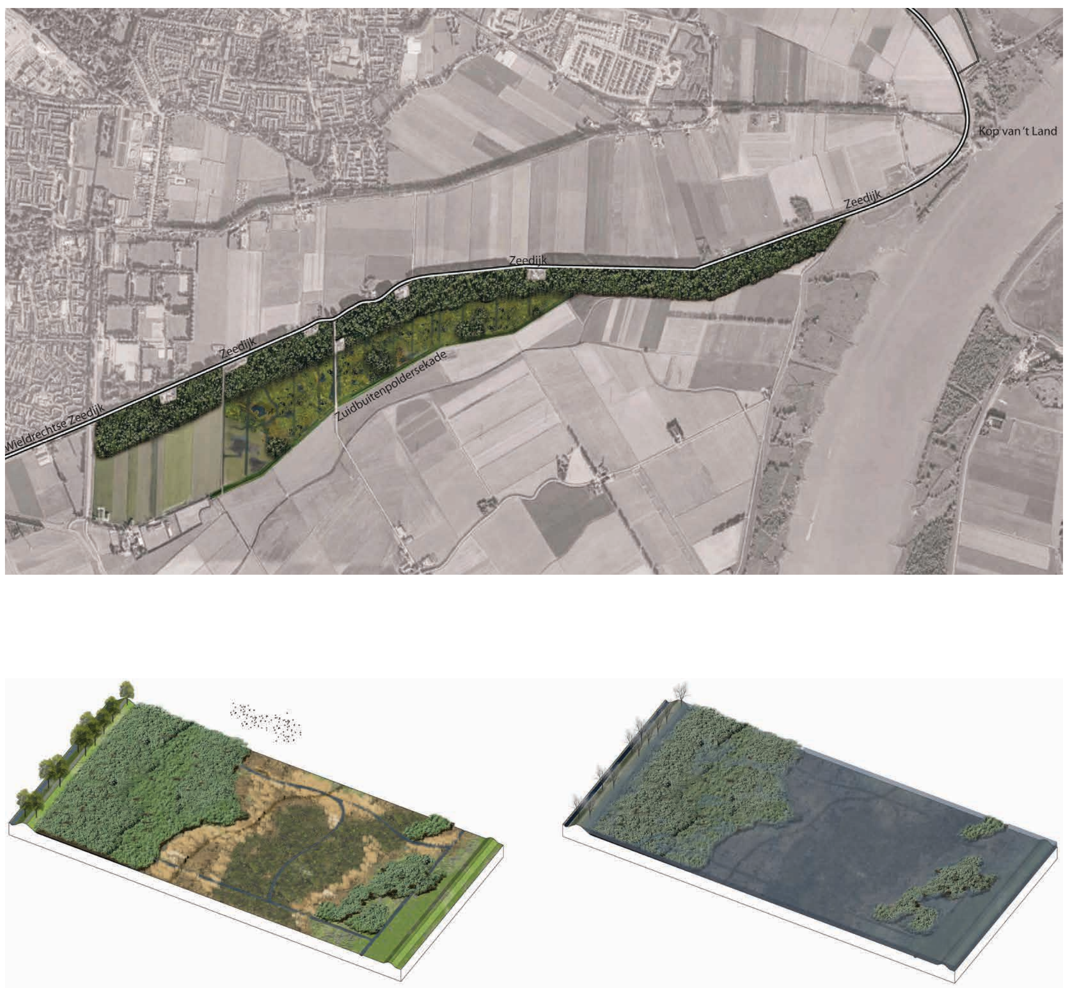

FIGURE 2.9 Dordrecht, willows as flood risk protection.

§ 2.7 Conclusion

A new emphasis on spatial quality in relation to flood risk reduction provides promising opportunities. Designers are gradually becoming more involved in flood risk reduction projects: initially, to embed interventions in a qualitative way, but, gradually, also to develop innovative and outside-the-box approaches to flood risk protection. This development is very interesting from both an urban and landscape perspective as well as from a flood risk perspective. New approaches are developed by breaking paradigms and consensus, and viewing flood risk from new angles. The 'Room for the River' and 'Experimenting with Adapted Buildings' programmes have already changed the approach to, and perception of, flood risk reduction in a permanent way. Projects such as 'Building with Nature' and the 'multi-layered safety approach' are still in the early stages but are expected to further change and develop the consensus about flood risk protection.

The outcomes of the Delta Programme and the final strategy will probably not deviate much from the current flood risk reduction strategies; changes and optimisations have been made to the current system. However, the undertaken studies that resulted in those strategies embody the new paradigm of flood risk in direct relation to spatial design, on local as well as regional scales.

Local stakeholder participation and local ownership have become important elements in the formulation, development, and implementation of flood risk reduction programmes. This leads to an important role for the designer and the design atelier approach, in order to communicate the challenges and opportunities and facilitate the stakeholder process. The role and relevance of the designer as a facilitator in the formulation of complex long-term holistic visions appears to be recognised and furthered. More and more international projects dealing with major infrastructural interventions invite spatial designers to be part of the development team, based on their skills in connecting different scale levels, work in an interdisciplinary manner, and thinking in terms of opportunities.

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Intermezzo 2: Rotterdam Rijnmond Photographs

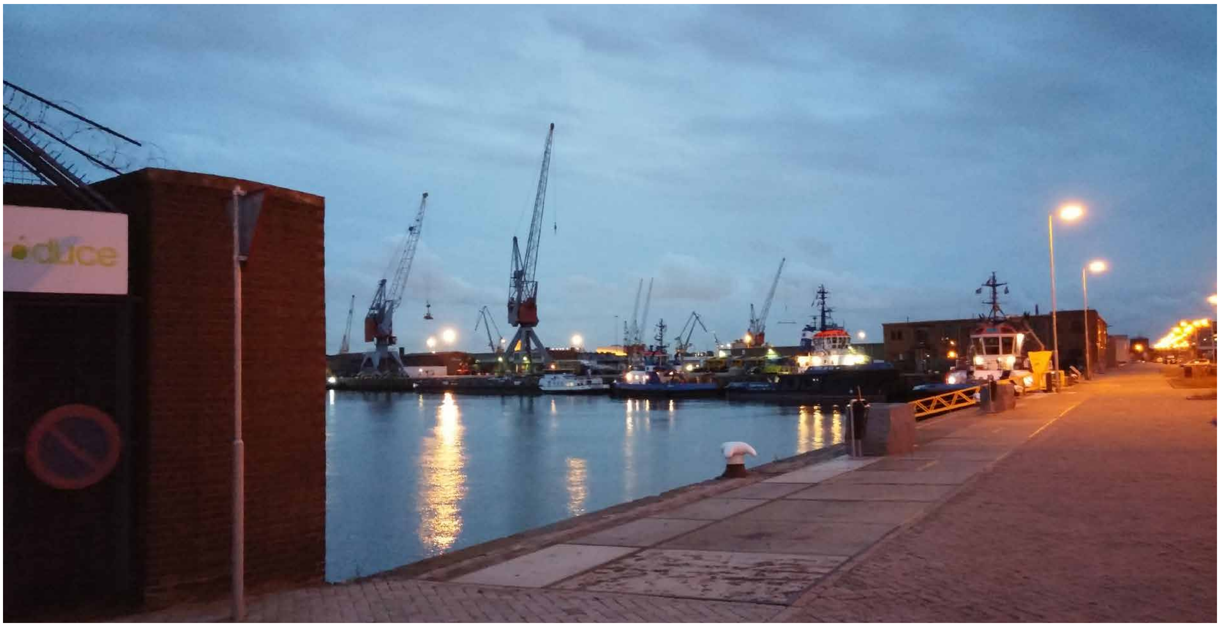

FIGURE 2.10 Photograph of the 'city-harbours' that are positioned close to the urban centre of Rotterdam and are currently transformed into mixed use areas

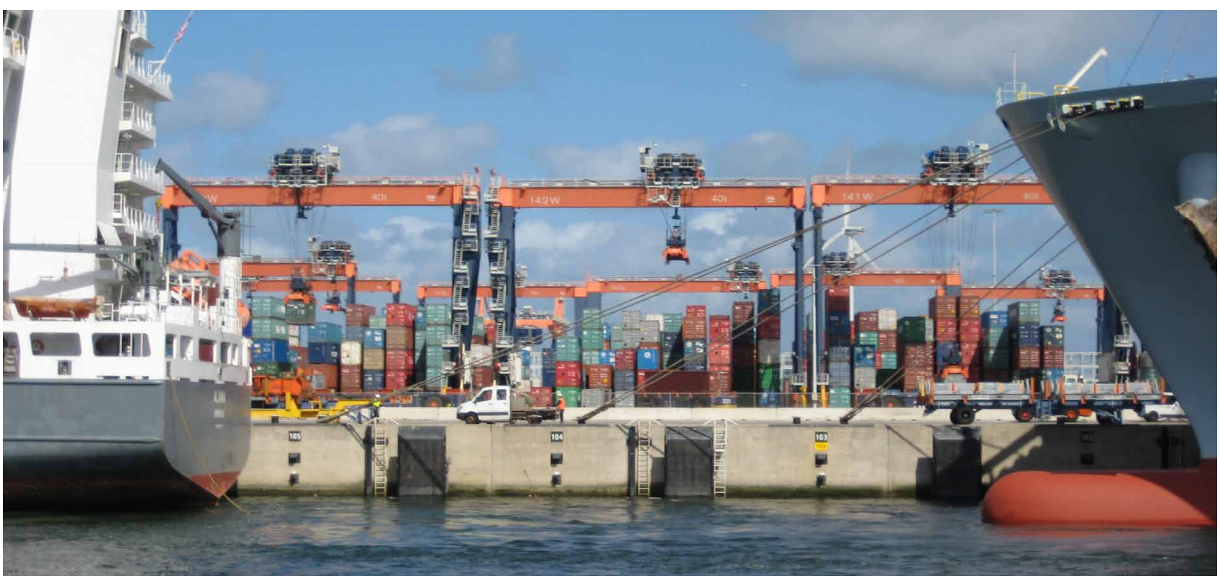

FIGURE 2.11 Photograph of the second Maasvlakte, a recent harbour extension that allows for large sea vessels to enter the harbour and unload

FIGURE 2.12 Part of the unembanked residential area 'Noordereiland' in the city centre of Rotterdam, during high water levels

FIGURE 2.13 Photograph of the Rotterdam riverfront, including the Erasmus bridge, the 'Boompjes' city quays, and the unembanked 'Noordereiland'