10 Discussion & Recommendations

Value of the Developed Method for Practice

The proposed methodology creates opportunities for designers to actively participate in debates concerning the location, layer, and scale of flood risk management interventions, resulting in a more integrated design approach. The systematic approach and the strong connection to variables and data sets provides a framework that makes it easier to communicate designers' propositions from a spatial point of view to engineers and facilitates interdisciplinary cooperation.

The developed sub-method for evaluating interventions at different flood risk levels, to shift flood risk management interventions to the most suitable locations, offers a framework for developing a combined probability and consequence reduction strategy. This method can become a valuable tool for strategy development and decision making in so-called multi-layered flood risk management approaches, in which interventions regarding the probability and the consequential damage of a flood are combined. Multi-layered safety approaches have often been referred to in flood risk management debates in the Netherlands, but so far, consistent methods for achieving a balanced probability and consequence reduction strategy have not been put in place.

Ian McHarg's Layer Model as a Conceptual Framework

The layer model is documented by the Dutch Ministry of Infrastructure and Environment (VROM 2001) and based on the triple layer model by Ian McHarg (1969). The layer model contains three conceptual layers: the natural layer of the subsoil (in which changes take place over the course of centuries), the layer of the infrastructure networks (changing over the course of 50-100 years) and the occupation layer (changing over the course of 25-50 years) (Meyer & Nijhuis 2013). The model stacks those layers with the natural layer as a solid base on which the infrastructure networks intervene, and on top of that the more flexible occupation layer.

It is striking to notice the gap between the theoretical time periods assigned to changes in the different layers and the frequency of change observable. We see for instance that the river as part of the natural layer (indicated by the theoretical model to change over the course of centuries) due to climate change and canalisation shows relevant differences in the peak river discharges that require action over periods of decades. Additionally, the altitude of the soil (also part of the natural layer) is subsiding a rapid rate due to drainage. Both of these conditions result in the flood risk system, which is part of the infrastructure layer that was designed in the 1950s and still partly under construction, having already fallen behind. The system is in need of a major reinforcement, though the model indicates that changes are necessary over a period of 50-100 years. On the other hand, it is no exception that buildings, which, in the theoretical model, are part of the flexible occupation layer, are, in reality, being preserved for centuries.

The use of the layer model as a conceptual framework, and the awareness of this discrepancy between theory and reality was very useful. In the case study location of Scheveningen, this helped to clarify that the occupation layer, which is usually considered the most flexible layer, is in fact a fixed layer. This actual deviation from the theoretical model (which is found in several flood defences in the Rijnmond-Drechtsteden area) is essential to understanding the current combined spatial quality and flood risk assignment. The relationship between the layer model and the current flood risk assignment (in various countries including the Netherlands), and a potential recalibration of the layer model is a valuable subject for a continued research effort.

Assessment Framework

The assessment of spatial quality based on criteria checklists can be a sensitive topic in the urban/ landscape design practice, as it could suggest the opinion that spatial quality is a quantifiable sum of scores in predefined criteria. In this research method, the checklist is not deployed to provide a mathematical equation for spatial quality, but to support expert judgement. The checklist ensures a wide perspective of aspects of spatial quality with each assessment. Moreover, it makes the spatial quality assessment verifiable and open to discussion.

During expert sessions in the research described in the fourth publication, two urban designers provided different judgements, demonstrating the challenges of obtaining reliable, consistent, and objective results. Assessments are dependent on individual, subjective opinions. This is unavoidable but underlines the importance of the verifiability of the assessment.

Design Optimisation

In the design exercise that was performed by students in the research described in Chapter 5, the spatial quality assessments became a starting point for the design assignment of optimising the spatial embedment of the flood risk management interventions. Based on initial assessment results, the students succeeded in mitigating the negative scores; their optimised designs scored better on spatial quality.

As a recommendation, a design optimisation should be included in the assessment framework approach. Such additional 'research-by-design' helps in identifying locations where flood risk management interventions can be mitigated by design optimisation, making the shift of the intervention to another location superfluous.

Assessment of the Impact on Spatial Quality at the Regional Scale

At the moment, the assessment framework is designed primarily for assessing the impact of both regional and local scale flood risk management interventions on spatial quality at a local scale. In order to apply the developed method for weighing different flood risk strategies at the scale of the delta, an assessment of the impact of flood risk management interventions on spatial quality at regional and national scales should be included.

In the application of the developed method as described in the fifth publication, and the description of the impacts and potentials related to the Netherlands' Delta Programme cornerstone strategies as described in the first paper, more regional aspects of spatial quality are already included in the expert judgement. Within this research, a supporting criteria list for the regional scale spatial quality has not been developed. Such a list could still be based on the same base principles for spatial quality (being utility, attractiveness, and robustness). However, the specific criteria resulting from those principles should be adapted to fit the regional scale level, in which more strategic aspects such as connectivity and competitiveness positions and economic vitality play an important role. In particular, the assessment of robustness could become more elaborate, since, for strategic choices, it may be necessary to reflect on different future scenarios.

In Tinbergen's assessment with regard to the two potential delta plans that where developed after the 1953 flood, such a regional assessment is, in a basic way, already included as part of the decision-making process with regard to the regional flood risk management strategy. In his report on the socio-economic aspects of the delta plan, Tinbergen (1961) includes aspects such as connectivity and potential for recreation.

Potential Synergy Between the Flood Risk and Spatial Assignments

In the developed method, next to an inventory of the current and potential flood risk protection strategies, an inventory of the spatial characteristics, assignments, ambitions, and potentials of the region is included as a step. The information concerning the assignments and ambitions for the area is needed to identify potential synergy between flood risk and spatial assignments during the assessment. Different approaches have been used for this, as shown in Chapter 4 with regard to the The Hague case study and Chapters 5 and 6 with regard to the Alblasserwaard case study.

In the Scheveningen case study, the analyses of the spatial characteristics, assignments, ambitions, and potentials are done in an detailed way. In terms of the ambitions and government policies, spatial analyses, and a stakeholder workshop, the spatial assignments and ambitions are inventoried and interpreted by means of a desk study. This approach, undertaken for the local scale case study site of Scheveningen, is time consuming and it would be excessive to extend it to the full Rijnmond-Drechtsteden case study area.

To be able to identify where a flood risk intervention could create synergy with spatial economic assignments or ambitions on the regional scale, a basic overview of assignments and ambitions is needed. To illustrate this, such a map is made for the Alblasserwaard-Vijfheerenlanden case study area, based on a series of workshops and interviews. The assignments and ambitions of the province are inventoried during workshop sessions with experts from different policy fields; those of the municipalities are collected in individual interviews with the different municipalities of the region. This results in an 'opportunity map' that shows a compilation of concrete plans, ambitions, challenges, conceptual ideas, and desires for the area. When combining this information with the expected flood risk reduction task, potential areas for synergy can be identified.

The 'opportunity maps' were deemed a successful tool for practice and have, after the application for the Alblasserwaard-Vijheerenlanden case study, as part of the Delta plan strategy development, been replicated for the Waal-Merwede rivers and for the river IJssel.

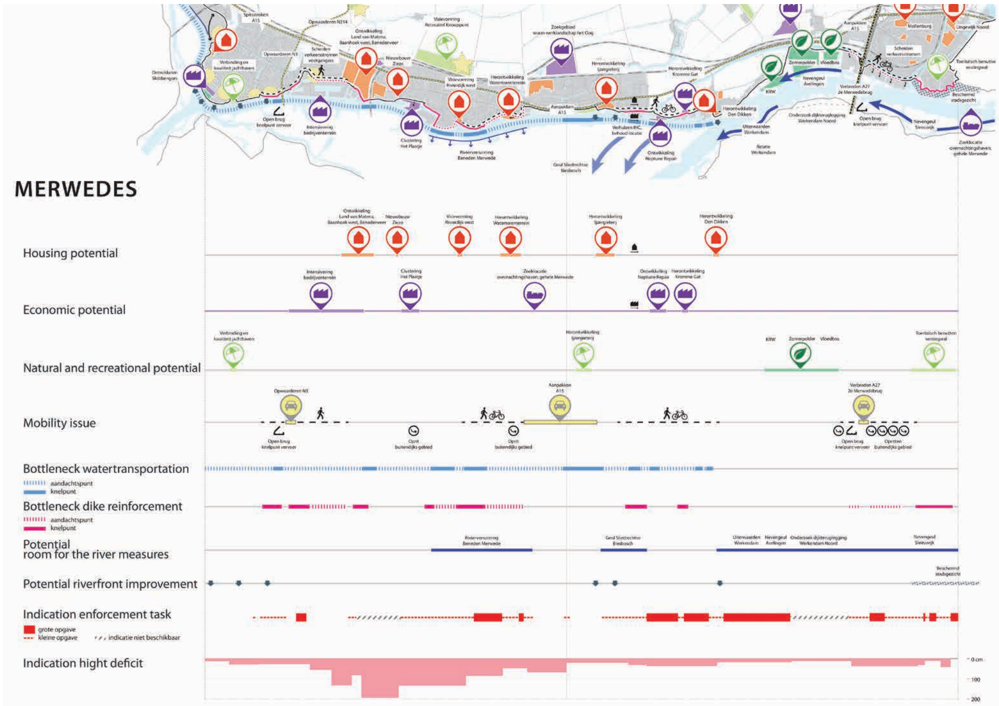

FIGURE 10.1 Zoomed-in area of the map indicating challenges and ambitions identified for the Alblasserwaard-Vijfheerenlanden area. Within the detailed image (which shows the area along the Merwede), the flood risk assignment is further elaborated by including an expert judgement from the water board with regard to the strength of the levee.

Delta Atelier Approach

The Delta Atelier work form, in which multidisciplinary experts worked together in design workshops or expert sessions, was deemed a very valuable approach for the development of integrated and innovative design proposals and strategies.

During the research period, a wide range of stakeholder and expert sessions took place. The exact approach of the sessions was not always similar; in the expert sessions described in Chapter 4 regarding the Scheveningen case study, the successful expert sessions where performed by a consistent core team of experts from different disciplines. In later expert sessions, in which there where frequent shifts within the expert team, it became apparent that having a continuous core team during a sequence of expert meetings is an important factor in the success of those sessions.

The power of the multidisciplinary expert sessions is that, gradually, a shared broad multidisciplinary understanding of the challenge is reached among multiple experts, allowing them to have a better, more holistic perspective on the challenge and with that the possible strategies. In this process there is an initial phase in which experts from different disciplines must explain to (and even educate) experts from other disciplines the basics of their profession (for instance, what 'business-as-usual' flood risk principles are available, how are future levee requirements calculated, etc.). This phase was described by some experts as feeling like a slow start, but one that pays off in a later stage where this shared foundation is a catalyst for holistic and innovative strategies.

In the expert sessions, w a big fluctuation of experts meant that much time was spent on repeating this initial phase of debating the work form and explaining basic principles and the steps made in previous sessions. Experts indicated that this resulted in a tiresome work process in which the beneficiary stage of multidisciplinary understanding of a challenge was either not reached or was achieved only after a delay.

Applicability of the Method in Other Deltas

The developed method can be deployed in other urbanised delta areas. The data sets used in this research are commonly used by engineering companies throughout the world. Although different companies use different models, the type of data used to support delta decisions are often similar. If data sets are not available, they can be replaced with expert judgements. When applying the method elsewhere, the criteria for spatial quality will have to be adjusted to the local situation, in collaboration with an expert panel. The results from the assessment of spatial quality may differ between regions as the methodology contains both objective and subjective qualitative criteria. In other deltas, the same criteria might be assessed or interpreted differently, since the assessment is subject to location, zeitgeist, and culture (Janssen-Jansen et al. 2009).

The method would be most valuable when applied in deltas with a risk-based flood risk reduction target, where the formulation for a flood risk management strategy is ongoing, and both probability as well as consequence reduction measures can be considered in a multi-layered flood risk management approach.

In the next sections, two examples of deltas in which flood risk reduction strategies are being developed are briefly discussed in terms of the applicability of the developed method: The Houston Galveston Bay area and Bangladesh Ganges delta.

Houston Galveston Bay Area

As described in Chapter 8, for the Houston Galveston bay area different alternative flood risk reduction measures are currently being explored. Technical research is still ongoing to determine whether the proposed probability reduction measures are indeed interchangeable from a flood risk perspective. The spatial impact of the alternative options at the different locations is expected to become an important feasibility criterion. For instance, the integration of the sea wall along Galveston and the Bolivar highway (lines F and G) as already demonstrated in Chapter 8, will influence the current unobstructed view from the islands to the ocean. The spatial impact of this intervention could be essential in the emergence of the resistance of local stakeholders. The alternative oyster reef (intervention D),might improve the landscape and recreational potential of the area. For this area, it is interesting to apply the developed method to investigate the impact of the interventions with regard to spatial quality. Of course, next to the inclusion of spatial quality as a decisive criterion, as done in the developed approach, in this practical case additional criteria such as costs, ecological impact, and land ownership will also be decisive criteria.

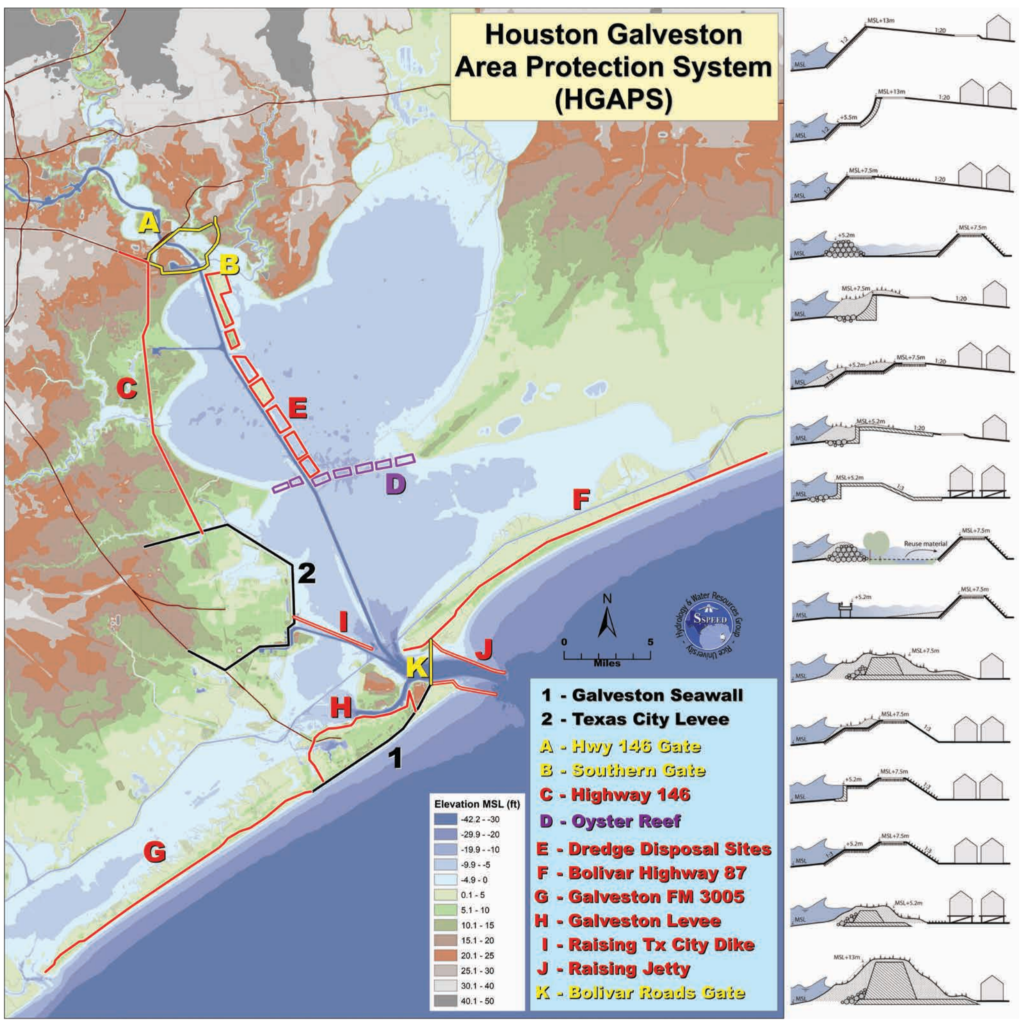

FIGURE 10.2 Above, an overview of different possibilities for flood proofing the Galveston Bay area as developed by the SPEED research centre. On the right, the first step of the developed method is applied, by making an inventory of the technical possibilities for the construction of a sea barrier along the Galveston coast and Boulevard Island (image by author. The content with regard to the technical possibilities is developed together with the Delft University of Technology and Royal-Haskoning-DHV).

Bangladesh Ganges area

For the Bangladesh Ganges delta, a national flood risk management strategy is being developed in, amongst others, the Bangladesh Delta Plan. In Bangladesh, the current flood risk reduction system is a mix of probability and consequence reduction measures. Within the strategy development, flood risk management interventions of both flood risk layers can also be considered. The developed method is very applicable here. A systematic 'research-by-design' process that explores different potential flood risk management interventions in relation to the spatial impact for the different regions would be valuable. However, the local spatial quality in this case will be less decisive in flood risk management strategy development. In the case study area of the Rijnmond Drechtsteden and the Houston Galveston Bay area, due to influential stakeholder opinions with regard to the impact that interventions would have on existing local scale spatial quality, such spatial quality is an important criterion. Bangladesh is still a country focussed on development. In the Bangladeshi situation, the impact on existing local scale spatial quality as a decisive criterion (with exception of the already urbanised centres) will be of limited importance. However, the regional scale impact of potential flood risk management interventions on spatial quality and the spatial composition of the country will be essential. The focus for applying the developed method for this region is on assessing the impact of alternative flood risk management interventions on the regional scale spatial quality.

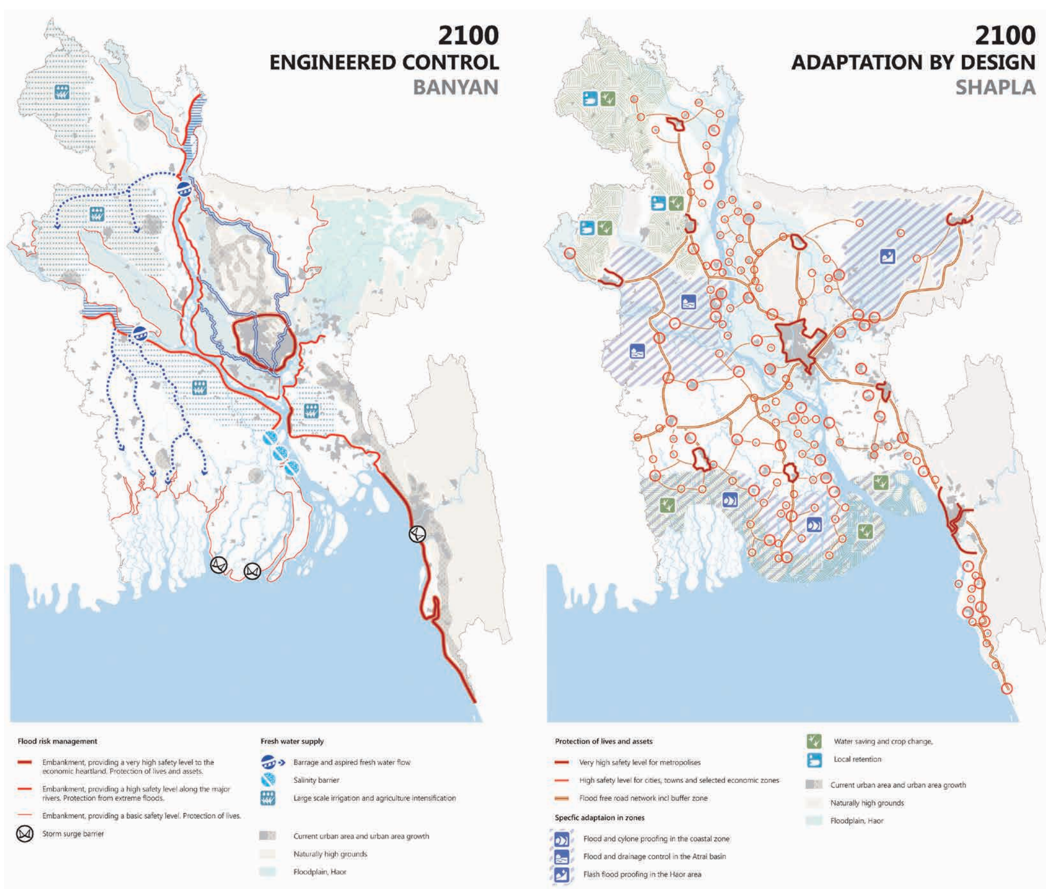

FIGURE 10.3 Above, two different potential strategies for flood risk reduction in Bangladesh. On the left, the strategy is focussed on protection by implementing dike-rings, while on the right, the strategy is based on a combined protection (around economic and urban centres) and consequence reduction approach. The proposed options will have a considerable impact on the potentials for, and characteristics of, the spatial quality and composition of the region. For instance, the dike-ring approach on the left could stimulate sprawl, while the one on the right could support a more compact township development (BDP2100 2016).