9 Conclusions

§ 9.1 Conclusions

Main Conclusion: The Developed Approach

Is it possible to define an integrated method for strategic flood risk management and spatial quality enhancement, in which spatial quality is a decisive ex-ante criterion, and what would be the key elements and steps in such a method? This constitutes the primary research question.

The publications that together form this dissertation describe such a method and thus provide a positive answer to the primary research question. A key principle in the approach is the inclusion of multiple interchangeable (effective) flood risk reduction interventions at varying locations, so that the criteria of spatial quality can become decisive in flood risk management strategy development.

The ability to assess the impact of different interventions on spatial quality is essential. In order to do so, an assessment framework was developed; it combines the approach of a spatial quality criteria checklist with expert judgement. The checklist supports expert judgement in that it keeps a wide, open perspective while assessing the spatial quality of a conceptual intervention, and thus allows verifiable and reproducible assessments.

The method developed employs research-by-design to systematically test different interventions at different locations. It includes the following steps:

- An inventory of current and potential flood risk protection strategies
- An inventory of a region's spatial characteristics, challenges, and potentials
- A qualitative assessment of existing situations and a spatial impact assessment of reference flood risk strategies, if any exist
- Systematic research on how flood risk management interventions at different scales can shift the location of a flood risk intervention; this includes qualitative assessments of interventions at various locations
- Systematic research on how flood risk management interventions in different flood risk layers can shift the location of a flood risk assignment; this includes qualitative assessments of interventions at various locations
- Selection of a combination of interventions that are preferred from a spatial quality objective

Sub-question: How do flood risk management interventions and spatial development influence each other?

There are many sources in literature that describe the strong, influential relationship between flood risk measures and spatial development. For example, with regard to the historical development of the Rijnmond-Drechtsteden area in the Netherlands, it is apparent that the shaping and cultivation

of the landscape, and the choice of locations for urban settlement, were strongly dependent on flood risk management interventions such as dams, canals, dikes, and polders polders (amongst others Palmboom, 1987, Steenbergen et al., 2009, Meyer et al., 2013).

In studies undertaken by the first and second Delta Committees that reflect on the potential impact of different systems of flood risk management interventions, such as Tinbergen (1961) and 'open closable Rijnmond' (De Hoog et al., 2010), there is a strong link between options for flood risk management interventions (such as a dammed or open delta) and opportunities for regional development.

On a local scale, the link is also apparent since different flood risk management interventions have a different spatial claim and therefore bring different conditions for (local) spatial development, as demonstrated and described in Chapters 3, 4, 5, 6, 7, and 8.

Sub-question: How can spatial quality can become an ex-ante aspect of flood risk management strategy development?

The key to making spatial quality an ex-ante criterion in flood risk development strategies is to define multiple interchangeable (effective) flood risk reduction interventions. When the base requirement of providing flood risk protection can be met with multiple different flood risk management interventions, the selection of an intervention can be based on additional criteria such as its impact on spatial quality. This allows spatial quality to become decisive in flood risk management strategy development.

In order to do so, the spatial impact assessment of different flood risk management interventions has to be included in the early research stages of flood risk protection strategy development. This requires the involvement of designers, who provide feedback—from a spatial quality perspective—on the flood risk management interventions under consideration before strategic choices with regard to the flood risk management strategy are made.

Sub-question: How can research-by-design be used as a basis for the proposed integrated approach?

Research-by-design was successfully employed to systematically estimate the impact of different flood risk management interventions on spatial quality at a local scale. Compared to other less rigorously systematic design approaches, research-by-design contributes positively to the verifiability and reproducibility of the performed design studies, which are important criteria for scientific design research (KNAW, 2010).

In this study, the initially applied research-by-design definition of systematically varying a single parameter (the flood risk intervention) while fixing other parameters (such as the context and the objectives from a spatial and flood risk perspective), leads to different options for embedding, which all meet predefined spatial requirements. Therefore, this method was less suited to identifying distinguishing opportunities and impacts for spatial quality related to flood risk management interventions.

The essential principle of including spatial quality as a decisive ex-ante criterion, is to create alternative, exchangeable options for flood risk reduction interventions at different locations. Subsequently, the narrower definition of research-by-design by Taeke de Jong (de Jong & vd Voordt

2002), which includes both the systematic evaluation of different interventions (varying design solutions) as well as the systematic variation of the intervention's location (their context), is applied within the method developed.

Sub-question: How can interchangeable measures for flood risk management interventions n be defined?

For flood risk management interventions to be interchangeable, there needs to be at least two possible interventions that are effective from a flood risk perspective. This principle was the basis for the 'Room for the River' approach in which, in addition to reinforcing levees, lowering water levels was introduced as a measure to reduce the likelihood of flood occurrence.

In this study, the amount of interchangeable flood risk management interventions is successfully increased by including different possible measures at different scales and different so-called 'flood risk layers'.

Flood risk is defined as the probability of a flood multiplied by its consequences (probability x consequence). Therefore, when addressing flood risk, interventions that reduce flood probability are interchangeable with interventions that reduce detrimental consequences. Potential flood risk management interventions can be formulated on different flood risk layers. The first layer of the (1) probability includes prevention measures such as dikes and barriers, and interventions that reduce the normative water level. The two other layers are related to consequences, namely (2) exposure, which includes interventions such as flood-proof buildings, the protection of vital infrastructures, compartmentalisation and restrictive building policies, and (3) vulnerability, which includes interventions that allow people to evacuate an area safely and allow for a rapid recovery after a flood (Expertise Netwerk Waterveiligheid 2012).

The approach of including interventions at different flood risk levels to shift flood risk management interventions to the most suitable locations, comprises the following steps:

1 Selection of flood risk management interventions, by an expert team, either having a positive effect on spatial quality and some effect on flood risk reduction, or a neutral impact on spatial quality and a considerable impact on risk reduction.
2 Risk map updates, defining new or remaining focus points of the risk assignment.
3 A second round of flood risk management interventions, addressing any remaining problematic risk areas while using design optimisation to embed the necessary interventions.
4 Risk map updates and, if necessary, repetition of steps 3 and 4.

Flood risk management interventions can also be implemented at different scales, varying from large scales, such as an entire delta system or region, and medium scales, such as polders and river branches, to local scales, such as a stretch of land or section of a dike within the delta, and small scales, such as a single building. When, for instance, the aim is to reduce the flood risk for a particular building, an intervention can be implemented at different scales: the building façade can be flood-proofed, a levee can be built around it (or around the region in which the building is located) or, on a larger scale, a dam or barrier can be built in the river that is causing the flood risk.

The approach of including interventions at different scale levels to shift local-scale interventions to the most suitable locations, includes the following steps:

1 Identification of relevant flood risk strategies on medium and large scales that are effective from a hydraulic point of view.

2 Visualisation of the impact on local normative water levels.
3 Description, by civil engineers, of appropriate flood risk management interventions at specific local sites, based on normative water levels.
4 Assessment, by an expert team, of the impact that interventions have on spatial quality.

Sub-question: How can the location of the necessary flood risk intervention be shifted by selecting measures on other scale levels or flood risk layers?

The interchangeable flood risk reduction measures at different scales and different flood risk layers will also (partially) affect multiple locations: by including a wide range of interventions at different scales and different flood risk layers, there will be a range of different locations where these interventions will have to be implemented. In Chapters 5 and 6, the ways in which the location of a necessary flood risk intervention can be shifted, by selecting measures at other scales or flood risk layers, are demonstrated in more detail.

Sub-question: How can a spatial assessment framework be developed to assess the impact of different technical interventions for flood risk management on spatial quality at the local scale?

The spatial assessment framework developed in this study is based on the spatial assessment framework 'Ruimtelijke Kwaliteits Toets' (RKT) as used during the 'Room for the River' project (Bos, Lagendijk & Beusekom 2004). Its approach combines a spatial quality criteria checklist and expert judgement. The original RKT method is improved and adjusted for the assessment of conceptual local scale flood risk management interventions in an urban setting.

The assessment criteria defined in this study are based on the definition of spatial quality as a combination of utility, attractiveness, and robustness. Derived from previous studies on qualitative criteria (Bos, Lagendijk & Beusekom 2004, Hooimeijer, Kroon & Luttik 2001; Gehl et al. 2006) and

an expert session, these criteria address aspects such as ecological functioning, maintainability, identity of the surroundings, recognition of structures, cultural recognition, alteration, logic of spatial arrangement, relationship to the water, reversibility, development opportunities, and uniqueness.

The assessment is performed by an expert team that uses the assessment framework as a support tool that helps to keep a wide, open perspective while assessing the spatial quality of a conceptual intervention and making the assessment verifiable and reproducible.

The developed approach for the qualitative assessment of flood risk management interventions on local scale spatial quality, as included in the combined approach for flood risk and spatial quality, includes the following steps:
1 Adaptation of assessment framework to specific conditions for a case study area
2 Visualisation, in a consistent and neutral fashion, of various (local-scale) locations that need to be evaluated
3 Assessment of the current situation as a reference, using an expert team and relevant criteria from the framework
4 Assessment of the new situation, related to the flood risk protection strategy, using an expert team and relevant criteria from the framework

Sub-question: How can the developed method be deployed for the Rijnmond Drechtsteden case study area?

Application of the method to the Rijnmond-Drechtsteden area is described in Chapters 4, 5, 6, 7, and 8. When applied to the Rijnmond-Drechtsteden case study area, the method resulted in a strategy that, compared to the reference 'business as usual' strategy, had an improved impact on spatial quality.

The method can be applied to other deltas. The spatial assessment framework must be adjusted to align with the scale of the assessment (local or regional) and to fit the local perception of spatial quality (see also Chapter 10 - Discussion & Recommendations).

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