FLOOD RESILIENCE THROUGH SPATIAL APPROACHES: PREPARING FOR THE FUTURE

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MSc Thesis
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Preface

I am proud to present my MSc Thesis "flood resilience through spatial approaches: preparing for the future". This thesis is the last step in the study Civil Engineering and Management in which I specialised in integrated water management.

I would like to thank my supervisors from the University of Twente Joanne Vinke – de Kruijf, Max de Vries and Karin Snel for their great guidance during my MSc thesis through inspiring discussions, invaluable feedback and support when needed. I would also like to thank my supervisors from Deltares, Annemargreet de Leeuw and Daan Rooze, for welcoming me in the company and brainstorming about my research. Furthermore, I would like to thank all interview participants for their time, expert insights and interesting conversations.

Lastly, I want to give a special thanks to my fiancé Laura and my parents without whom I would not have been able to achieve this. Their unconditional support during my studies has enabled me to get to where I am now.

I hope you appreciate and enjoy reading this report.

Ruben Bralts

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Summary

In the Netherlands, not only does climate change cause sea level rise, but it also increases the intensity of river floods and heavy rainfall events. As a result, the Netherlands faces increased flood risk. To reduce the chance of river floods, the Dutch Flood Protection Program invests in strengthening and heightening dikes. Despite being effective, investing in flood protection is becoming increasingly expensive and does not significantly contribute to spatial quality. In addition, pressure on the available space in the Netherlands is increasing. To deal with these challenges, merely focusing on flood prevention as a flood risk management strategy will not suffice and a shift towards more diversified flood risk management strategies, by also focusing on mitigating the consequences of a flood, is opted for. Flood resilience divides the diversification of flood risk management into three abilities: the ability to resist, the ability to absorb and recover and the ability to transform and adapt. A strategy to achieve more diverse flood risk interventions is by applying a spatial flood risk management approach. Spatial flood risk management approaches address both flood safety and spatial quality. Previously applied spatial approaches to flood risk management did not set flood resilience as its aim. To improve spatial flood risk management approaches to effectively address flood resilience, there is a need to evaluate flood risk management approaches with regard to flood resilience. Literature does not address such an evaluation, therefore this research addresses this knowledge gap to contribute to existing literature.

The main objective/aim of this research is to "evaluate and formulate recommendations for improving the process and output of two Dutch spatial flood risk management approaches with regard to flood resilience". To address this need, this thesis evaluates two cases applying a spatial flood risk management approach in the context of flood resilience. Two Dutch flood risk management projects are selected in which spatial measures are applied on a large scale using a differing methodology. The first case is the depoldering of the Noordwaard, which is part of the Room for the River program. In this project, flood safety and spatial quality are set as equally important goals and are addressed by applying spatial flood risk management interventions. The second case is an ongoing innovation project in Zwolle, applying the flood-resilient landscapes approach. The flood-resilient landscapes approach aims to improve flood safety using a system-based approach in which different possible futures are considered. For the case studies, data was collected by analysing documents and conducting semi-structured interviews.

Flood resilience cannot be measured immediately after the completion of a project, which stresses the need for an evaluation framework that measures the process and output of a project. The evaluation framework consists of two separate indicators for flood resilience which are assumed to have an influence on flood resilience based on literature. The first indicator, evaluating the output of a project, is forward-looking decisions. Forward-looking decisions are decisions taken in which possible future developments are anticipated. The second indicator, evaluating the process, is transformative climate governance. Along four capacities for transformative climate governance, the governance context can be evaluated with respect to climate adaptation. These capacities are stewarding capacity (identifying long-term change uncertainties and risk), unlocking capacity (identifying and changing unsustainable practices), innovating capacity (enabling and embedding novelty) and orchestrating capacity (creating synergies and avoiding trade-offs through multi-actor processes).

The results of the Noordwaard case show that all four transformative climate governance capacities are present. Furthermore, the decisions made are forward-looking, but only with regard to flood safety. For other issues, long-term challenges are rarely considered. The presence of transformative climate governance capacities and forward-looking decisions have enabled the creation of a design which has improved flood resilience. The design addresses both the ability to resist and the ability to absorb and recover by creating retention areas, lowering water levels in the rivers upstream. The results for the

Zwolle case too reflect that all four capacities for transformative climate governance are present. However, due to the Zwolle case being an innovation project, the need for unlocking capacity is limited in its current form and part of the orchestrating capacity cannot be assessed as there is no participatory process developed. The decisions made in the Zwolle project can be considered forward-looking. Similar to the Noordwaard project, the Zwolle project addresses both the ability to resist and the ability to absorb and recover by proposing spatial measures. In addition, the consideration of long-term challenges and the use of adaptation pathways to realise long-term goals improves the ability to transform and adapt.

Based on this research, three main recommendations can be made. First, the development and extensive sharing of knowledge, which is part of the stewarding capacity, is crucial in developing flood-resilient designs and should be invested in for spatial flood risk management projects. This is recommended because knowledge of future challenges is necessary to address them. Second, it is recommended to organise an extensive participatory process as this mitigates resistance against change and stimulates innovation through the sharing of local knowledge from stakeholders. The third recommendation is investing in good collaboration between the participating stakeholders in the project. This leads to more integral solutions and working together with people from different sectors makes it possible to share knowledge and get an understanding of each other's challenges. As a result, collaboration can give rise to solutions which address problems in multiple sectors which would otherwise not be considered.

Samenvatting

In Nederland zorgt klimaatverandering niet alleen voor zeespiegelstijging, maar verhoogt ook de dreiging van rivieroverstromingen en hevige regenval. Hierdoor neemt het overstromingsrisico in Nederland toe. Om de kans op rivieroverstromingen te verkleinen, investeert het Nederlandse Hoogwaterbeschermingsprogramma in het versterken en verhogen van dijken. Ondanks de effectiviteit hiervan worden investeringen in bescherming tegen overstromingen steeds duurder en dragen ze niet aanzienlijk bij aan ruimtelijke kwaliteit. Daarnaast neemt de druk op de beschikbare ruimte in Nederland toe. Om met deze uitdagingen om te gaan, is enkel focussen op het voorkomen van overstromingen als strategie voor waterveiligheid niet langer voldoende. In plaats daarvan wordt er gestreefd naar overstromingsveerkracht (flood resilience), door ook te focussen op het beperken van de gevolgen van een overstroming. Overstromingsveerkracht kan worden onderverdeeld in drie capaciteiten: de capaciteit om te weerstaan, de capaciteit om te absorberen en herstellen, en de capaciteit om te transformeren en aan te passen. Een strategie om meer diversiteit in oplossingen voor waterveiligheid te realiseren is kan een ruimtelijke aanpak voor waterveiligheid worden toegepast. Ruimtelijke aanpakken voor waterveiligheid richten zich zowel op waterveiligheid als op ruimtelijke kwaliteit. Eerder toegepaste ruimtelijke benaderingen voor waterveiligheid hadden echter niet als doel om overstromingsveerkracht te bevorderen. Om ruimtelijke aanpakken voor waterveiligheid te verbeteren en effectief bij te dragen aan overstromingsveerkracht is er behoefte aan het evalueren van dit soort aanpakken met betrekking tot overstromingsveerkracht. Er zijn echter geen publicaties die dit soort evaluatie behandelen. Daarom richt dit onderzoek zich op deze kenniskloof.

Het hoofddoel van dit onderzoek is het “evalueren en aanbevelingen doen voor het verbeteren van het proces en de directe uitkomsten voor ruimtelijke aanpakken voor waterveiligheid met betrekking tot overstromingsveerkracht”. Daarom evalueert dit onderzoek twee casussen die een ruimtelijke aanpak voor waterveiligheid toepassen in de context van overstromingsveerkracht. Twee Nederlandse waterveiligheidsprojecten zijn geselecteerd waarin ruimtelijke maatregelen op grote schaal worden toegepast, elk met een verschillende methodologie. De eerste casus is de ontpoldering van de Noordwaard, wat onderdeel is van het programma Ruimte voor de Rivier. In dit project zijn waterveiligheid en ruimtelijke kwaliteit als gelijkwaardige doelen gesteld en zijn ruimtelijke maatregelen voor waterveiligheid toegepast. De tweede casus is een lopend innovatieproject in Zwolle waarin waterveiligheidslandschappen wordt toegepast. Deze aanpak streeft naar verbetering van de waterveiligheid door middel van een systeemgerichte benadering waarin rekening wordt gehouden met verschillende mogelijke toekomsten. Voor de casestudies is data verzameld door het analyseren van documenten en het uitvoeren van semi-gestructureerde interviews.

Omdat overstromingsveerkracht niet direct gemeten kan worden na de voltooiing van een project is er een evaluatiekader opgesteld. Dit evaluatiekader bestaat uit twee afzonderlijke indicatoren voor overstromingsveerkracht, waarvan op basis van literatuur wordt aangenomen dat ze invloed hebben op overstromingsveerkracht. De eerste indicator, die de directe uitkomsten van een project evalueert, is vooruitziende beslissingen. Vooruitziende beslissingen zijn beslissingen waarin rekening wordt gehouden met mogelijke toekomstige ontwikkelingen. De tweede indicator, gericht op het proces, is transformatieve klimaatgovernance. Aan de hand van vier capaciteiten voor transformatieve klimaatgovernance kan de governance in een project worden geëvalueerd met betrekking tot klimaatadaptatie. Kennisbeheer (identificeren van langetermijnveranderingen, onzekerheden en risico's), doorbreken van barrières (identificeren en veranderen van niet-duurzame werkwijzen), innovatiemanagement (het mogelijk maken en verankeren van innovatie) en samenwerking (het creëren van synergieën en het vermijden van compromissen via multi-actorprocessen).

De resultaten van de Noordwaard casus laten zien dat alle vier de capaciteiten voor transformatieve klimaatgovernance aanwezig zijn. Verder zijn de genomen beslissingen vooruitziend, maar alleen met betrekking tot waterveiligheid. Voor andere kwesties worden lange-termijnuitdagingen zelden overwogen. De aanwezigheid van de capaciteiten voor transformatieve klimaatgovernance en vooruitziende beslissingen heeft bijgedragen aan het creëren van een ontwerp dat de overstromingsveerkracht heeft verbeterd. Het ontwerp richt zich zowel op de capaciteit om te weerstaan als op de capaciteit om te absorberen en herstellen door het creëren van retentiegebieden en het verlagen van het waterpeil in de rivieren stroomopwaarts. Ook de resultaten van de Zwolle casus laten zien dat alle vier de capaciteiten voor transformatieve klimaatgovernance aanwezig zijn. Omdat de Zwolle casus echter een innovatieproject is, is de behoefte aan het doorbreken van barrières beperkt in de huidige vorm en kan een deel van de samenwerking niet worden beoordeeld omdat er geen participatief proces is ontwikkeld. De beslissingen in de Zwolle casus kunnen als vooruitziend worden beschouwd. Net als het project in de Noordwaard richt het project in Zwolle zich zowel op de capaciteit om te weerstaan als de capaciteit om te absorberen en herstellen door ruimtelijke maatregelen voor te stellen. Daarnaast verbetert het rekening houden met lange-termijnuitdagingen en het gebruik van adaptatiepaden om lange-termijndoelen te realiseren het vermogen om te transformeren en aan te passen.

Op basis van dit onderzoek kunnen drie aanbevelingen worden gedaan. Ten eerste is de ontwikkeling en uitgebreide kennisdeling, die deel uitmaakt van de bestuurlijke capaciteit, cruciaal bij het ontwikkelen van veerkrachtige gebieden en dient er geïnvesteerd te worden in ruimtelijke aanpakken voor waterveiligheid. Dit wordt aanbevolen, omdat kennis van toekomstige uitdagingen noodzakelijk is om dit aan te pakken. Ten tweede wordt er aanbevolen dat er een uitgebreid participatieproces plaatsvindt, omdat dit weerstand tegen verandering vermindert en innovatie stimuleert door het delen van lokale kennis van belanghebbenden. De derde aanbeveling is om te investeren in goede samenwerking tussen de deelnemende belanghebbenden in het project. Dit leidt tot meer integrale oplossingen en door samen te werken met mensen uit verschillende sectoren is het mogelijk om kennis te delen en elkaars uitdagingen beter te begrijpen. Hierdoor kan samenwerking oplossingen opleveren die problemen in meerdere sectoren aanpakken, die anders niet overwogen zouden worden.

Contents

1. Introduction

1.1. Context

Located in a river delta, the Netherlands has been threatened by floods for centuries. As a reaction to the floods in 1953, water management in the Netherlands shifted towards an environment in which scientific and engineering solutions were dominant in decision-making. This is also known as a technocratic-scientific focus (Lintsen, 2002). Although the main water management problems were addressed in this period, resistance to the water management approach increased as it negatively impacted the environment and spatial quality. In 1986, Plan Stork (Dutch: Plan Ooievaar) proposed a vision for the design of the riverine area in which river management, nature development and spatial quality were integrated (van Rooij et al., 2020). This laid the groundwork for a transition towards a spatial approach to flood risk management. In 1993 and 1995 the Netherlands was hit by extreme water levels in its major rivers. The resulting floods required 12,000 and 250,000 people respectively to be evacuated (Rijkswaterstaat, n.d.-b). In reaction to this, the Room for the River program was initiated in 2006 (Olde Wolbers et al., 2018) and completed in 2019, addressing flood safety in the rivers IJssel, Waal, Nederrijn and Lek (Rijkswaterstaat, n.d.-b). Inspired by Plan Stork, the Room for the River was an integrated approach, combining flood safety, nature, spatial quality, housing and infrastructure development challenges and opportunities (van Rooij et al., 2020). As a result, the transition gained momentum to shift towards an integrated water management approach. Currently, the Dutch Flood Protection Program (HWBP) plays a major role in protecting the country from floods (Nationaal Deltaprogramma, n.d.). The aim of the HWBP, a consortium of the 21 water authorities and Rijkswaterstaat, is to strengthen all primary flood defences in the Netherlands by 2050 (Rijkswaterstaat, n.d.-a). The Room for the River program and the HWBP are effective at resisting an increased peak discharge. Although this approach reduces the risk of floods, it has a limited view of how to protect from floods as it only focuses on preventing floods. A multi-layered approach can be applied to reduce risk, focusing not only on prevention, but also on resilient spatial planning and disaster management (Algemene Rekenkamer, 2023; Bosoni et al., 2021). Since 2009, the Netherlands uses this multi-layered approach in flood risk management (Algemene Rekenkamer, 2023; STOWA, 2017). However, the implementation of this approach in the Netherlands is limited (Algemene Rekenkamer, 2023; Bosoni et al., 2021; Hegger et al., 2016). Next to this, an updated version of the multi-layered safety approach has been developed which, in addition to the original three layers, also includes recovery and water awareness (Beleidstafel Wateroverlast en Hoogwater, 2022). However, these additional layers are not yet implemented by the Dutch Ministry of Infrastructure and Water Management.

Despite the efforts made in the past 25 years, the Netherlands still faces flood risk due to increasing water levels. The KNMI projects an increase in sea level rise, increased peak river discharges and increased droughts in the upcoming 75 years (Van Dorland et al., 2023). Simultaneously, over 1.5 million houses need to be built to meet housing demands in the upcoming 25 years (ABF Research, 2023). This puts additional pressure on the available space in the Netherlands. Designing areas that can deal with these challenges requires another shift in flood risk management approach. To meet these demands, the concept of flood resilience can be applied. Flood resilience considers not only the capability to withstand stresses and shocks, but also the capability to absorb, recover, transform and adapt (Hegger et al., 2016). This leads to a range of new possible interventions that tackle the problem at hand like water retention areas or changes in governance to improve flexibility. Applying flood resilience in flood risk management is a fundamental change at a large scale and can thus be considered a transition (Molenaar et al., 2021). Deltares has developed a novel approach that does aim for flood resilience by designing with the goal to improve spatial quality of the area (Deltares, n.d.). This is called flood-resilient landscapes. The goal of this approach is to focus on designing for the situation in the future as opposed to the current situation. This should result in a future-proof flood risk management strategy (de Leeuw et al., 2022).

As stated, flood resilience can be applied in flood risk management to diversify flood risk management interventions. Multiple spatial flood risk management approaches exist which utilise a multi-layered approach to flood risk management. However, it is unknown to what extent spatial approaches contribute to flood resilience. In addition, it also unknown what improvements can be made to spatial approaches to flood risk management to more effectively improve flood resilience. Therefore, this research aims to evaluate and formulate recommendations for improving spatial flood risk management approaches with regard to flood resilience.

1.2. State of the art

As stated, currently flood risk management in the Netherlands is mostly focused on preventing floods. A transition towards a multi-layered approach is necessary to achieve flood resilience. A transition can be described using the multi-level perspective. The multi-level perspective consists of a hierarchy of three levels: the niches, the patchwork of regimes and the socio-technical landscape (Geels, 2002). In the niches novelties are developed, inspired by the needs of one or more regimes and the overarching sociotechnical landscape. Some of the novelties are adopted by a regime, evolving it. This can for example be a change in standard practices of a contractor. Similarly, the evolved regime can transform the landscape over time as the novelty becomes a new standard. Rotmans et al. (2000) divide a transition into four phases forming an s-curve. A transition starts with the creation of novelty in the pre-development phase, after which a threshold is reached, initiating the take-off phase. In this phase, novelty is starting to be adopted and the system is beginning to shift. In the acceleration phase, the adoption of the novelty rapidly increases after which the system has reached a new standard in the stabilisation phase.

In literature, different ways of stimulating and successfully completing transitions are discussed and proposed. An approach which can structure and guide the transition of a system is adaptation pathways. Different pathways can be constructed based on the tipping points of different interventions to form an adaptation pathways map. Tipping points are the conditions under which an intervention no longer meets the objectives (Haasnoot et al., 2013; Kwadijk et al., 2010). The choice of one of the pathways in an adaptation pathways map can lead to the exclusion of alternatives when a new decision needs to be made in the future. This is called path dependency (Haasnoot et al., 2013). When a decision excludes all available alternatives, this is also referred to as a lock-in (Haasnoot et al., 2013; Hanger-Kopp et al., 2022). Because path-dependencies and especially lock-ins can hinder transitions, they need to be avoided. Therefore, the use of adaptation pathways can be an important tool to realise the transition of a system towards a preferred state.

Another approach to achieving long-term goals is by making decisions focussed on long-term objectives. Decision-making can be visualised through a stream model. This model consists of four streams: the problem, solution, opportunity and politics streams. If these come together at a certain moment in time a crucial decision can be made (Howlett et al., 2016). By making long-term objectives explicit in this decision-making process, decisions better contribute to future goals. This can be achieved by making forward-looking decisions (Pot et al., 2018). Forward-looking decisions are decisions which include a long-term problem definition, are robust or flexible and can be justified based on long-term goals or future scenarios (Pot et al., 2024). Pot et al. (2018) have operationalised this, providing a framework which can aid in making forward-looking decisions.

Yet another approach to achieve long-term goals is by creating an environment which contributes to achieving the set goals. In literature, adaptive governance is proposed as a type of governance which deals with uncertainty and change in complex social-ecological systems (Folke et al., 2005; Olsson et al., 2006). This is especially useful in periods of abrupt change (Pahl-Wostl & Kranz, 2010). Hölscher et al. (2019) propose applying transformative climate governance to create the conditions for integrated, flexible and inclusive approaches to address climate change, sustainability and resilience. This can be divided into four capacities: stewarding capacity, unlocking capacity, transformative capacity and orchestrating capacity. Stewarding capacity refers to the capacity to identify long-term change, uncertainties and risks. Unlocking capacity describes the capacity of a system to stop or transform unsustainable practices. Transformative capacity indicates the capability to innovate. The fourth capacity, orchestrating capacity, focuses on integrated stakeholder management. The aim of stakeholder management in this context is to make sure stakeholders want to achieve the same goals and to utilise synergies.

Because the goal is to achieve flood resilience in the future, it is not possible to measure it in the short term. Instead, approaches which indirectly contribute to flood resilience are required to analyse the impact of a project on long-term flood resilience. Multiple approaches to achieve long-term goals can be identified in literature. However, no approach specifically proposes an approach which describes how future flood resilience can be achieved. Therefore, this research aims to address this knowledge gap to be able to evaluate the extent to which spatial flood risk management approaches contribute to flood resilience.

1.3. Problem statement

As the pressure on space in the Netherlands increases, the necessity to apply alternative approaches to flood risk management has become apparent. An alternative approach is to aim for flood resilience. To improve existing spatial flood risk management approaches in the Netherlands with regard to flood resilience, they should be evaluated. Currently, there is little information present on the effect of new and previously applied spatial flood risk management approaches on flood resilience. Moreover, it is not possible to measure flood resilience in the short term. Therefore, an evaluation framework that gives insight into the impact of a project on flood resilience is needed. This causes an additional problem, as it is unclear what characteristics of a spatial approach contribute to flood resilience and to what extent.

1.4. Aim and research questions

As discussed, there is a need for a spatial flood risk management approach with the goal of achieving flood resilience. However, it is not clear how to realise this. In this study, this will be explored. Therefore, the aim of this study is formulated as follows:

Aim: Evaluate and formulate recommendations for improving the process and output of two Dutch spatial flood risk management approaches with regard to flood resilience.

To achieve the aim of evaluating spatial flood risk management approaches with regard to flood resilience, an evaluation framework is necessary. From this need it follows that this research in part aims to design an evaluation framework that can be applied to give insight into the performance of a spatial flood risk management approach in regard to flood resilience. Based on this aim, the following research question is formulated:

RQ1: According to literature, how to evaluate the extent to which spatial flood risk management approaches contribute to flood resilience?

The result of the first sub-research question should be an evaluation framework that gives insight into the contribution to flood resilience of a spatial flood risk management approach. This can then be applied to the second and third sub-research question. The second sub-research question focuses on the evaluation of the approach applied in a Room for the River project and the flood-resilient landscapes approach. This leads to the following research question:

RQ2: In the selected spatial approaches, how are transformative climate governance capacities and forward-looking decisions reflected in spatial flood risk management approaches?

In addition to this, the influence of transformative climate governance capacities on forward-looking decisions is explored. Therefore, the third research question is formulated to address this:

RQ3: To what extent do transformative climate governance capacities influence forward-looking decisions?

The evaluation of the two spatial flood risk management approaches gives insight into the performance of both approaches. This can be used to propose recommendations to improve spatial flood risk management approaches to effectively achieve flood resilience. To do so, the fourth research question is formulated as follows:

RQ4: What can be learned from this research to improve spatial flood risk management approaches to enhance flood resilience?

1.5. Scope

In this research, the focus will be on two spatial flood risk management approaches. Spatial flood risk management approaches explore options for storing and discharging water outside the existing boundaries of water bodies. To analyse two spatial flood risk management approaches, two case studies will be selected: one applying the Room for the River approach, and a second one applying the flood-resilient landscapes approach. Furthermore, this research will be focused on Dutch spatial flood risk management approaches. This means both study cases will be a Dutch project. For the established flood risk management approach in the Netherlands, a project, which is part of the Room for the River program, will be used. As the Room for the River program is completed, an evaluation after the completion of the project will be conducted. Currently, no implemented project has applied the flood-resilient landscapes approach. Therefore, an ongoing project will be used for the second case. As a consequence, it is not possible to evaluate a finished project for the flood-resilient landscapes approach. Instead, an evaluation while the project is still ongoing will be conducted.

In this research, the focus will be on evaluating process elements and the output of the process. The effectiveness of measures and to what degree they contribute to flood resilience will not be measured. As a consequence, no quantitative assessment of the case study is made.

1.6. Reading guide

This report consists of six chapters. Chapter 2 starts by explaining the theoretical basis related to evaluation research, transformative climate governance capacities and forward-looking decisions. Chapter 3 then covers the research strategy, including the introduction of the two case studies, methods of data collection and the method for data analysis. The results of this study are presented in Chapter 4, followed by a discussion of the results in Chapter 5. In Chapter 6 the conclusions and recommendations are discussed.

2. Theory

In this chapter, the theoretical basis for this research is explained. First, evaluation research is discussed, after which the evaluation model used in this research is presented. Using this model, the components of the evaluation framework, flood resilience, forward-looking decisions and transformative climate governance capacities are then elaborated on. In the last section, the full evaluation framework used for the evaluation of the case studies is presented.

2.1. Evaluation

A core part of this research is to evaluate. An evaluation assesses the value or worth of an intervention, or in this context, an approach to flood risk management (Uitto et al., 2017). Posavac and Carey (1980) define four major types of evaluation: evaluation of need, evaluation of process, evaluation of outcome and evaluation of efficiency. An evaluation of need is conducted to get insight into the needs of a system. It explores whether an intervention is necessary and if so, what intervention is suitable. An evaluation of process evaluates an ongoing project. It evaluates whether a project has been implemented as planned. An evaluation of outcome assesses whether the targets of the project have been achieved. An efficiency evaluation considers not only whether intended goals have been met, but also aims to gain insight into the costs and benefits of the project. In addition to the four types of evaluation defined by Posavac and Carey (1980), a fifth type can be added: an evaluation for knowledge generation. Evaluations for knowledge generation have the main purpose to "describe the nature and effects of an intervention as a contribution to knowledge" (Rossi et al., 2019, p. 12).

2.2. Evaluation model

A tool to evaluate the effectiveness of a planning approach is an evaluation framework. The evaluation framework used in this study is inspired by the structure applied by Vinke-de Kruijf (2013). Vinke-de Kruijf (2013) separates the evaluation into three parts: process, output, and ultimate outcomes. The process refers to indicators as the project is ongoing and influences the output. The output can be evaluated immediately after the completion of the project and has an influence on the ultimate outcome. Ultimate outcomes refer to the outcome in the long term. In this research, it is assumed based on literature that both the process and output of a project directly influence the ultimate outcome. In addition, it is theorised that the process and output influence each other as well. The structure of this evaluation model, shown in Figure 1, is especially useful when it is not possible to measure the ultimate outcomes. Instead, the process and output can be evaluated and used as indicators for the success of the project.

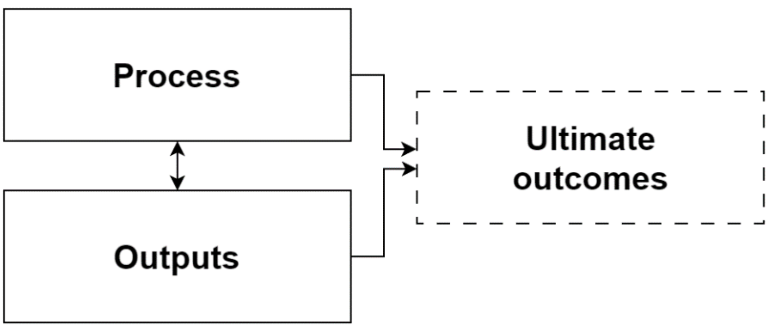

Figure 1: Evaluation model using process, outputs and ultimate outcomes. Adapted from Vinke-de Kruijf (2013).

2.3. Ultimate outcomes: flood resilience

The ultimate policy goal in flood risk management is for an intervention to contribute to increased flood safety. However, the definition of flood safety can vary. In this research, flood resilience is used as the ultimate outcome, because it applies a holistic approach, looking beyond just preventive measures.

Resilience is a broad which is applied in a broad range of fields. For example in environmental science resilience can defined as the ability of a social-ecological system to maintain human well-being in changing conditions by absorbing shocks and through adaptation (Biggs et al., 2015). In the context of spatial planning, resilience is often referred to as urban resilience. Urban resilience can roughly be divided into four parts: the capability to prepare (Wardekker et al., 2020), the capability to absorb and endure (Coaffee, 2013; Romero-Lankao & Gnatz, 2013; Wardekker et al., 2020), the capability to recover (Coaffee, 2013; Wardekker et al., 2020) and the capability to adapt (Wardekker et al., 2020) to shocks and stresses in an urban area. In the context of flood risk management, flood resilience can be applied. Flood resilience can be described using three capabilities: the capability to resist, the capability to absorb and recover, and the capability to transform and adapt (Hegger et al., 2016). The types of shocks and stresses can differ from an extreme water level in a river to an extreme rainfall event. The first capability, the capability to resist, refers to the ability to avoid negative impacts from floods. The capability to absorb and recover can be defined as the ability of a system to remain functional while experiencing a flood and recovering from the effects of a flood. The capability to transform and adapt refers to the ability of a system to adapt to changing conditions. An overview of the three capabilities for flood resilience is shown in Table 1.

Table 1: Three capacities of flood resilience. Adapted from Hegger et al. (2016).

Capability	**Definition**	**Example of intervention**
Capability to resist	The ability not to be adversely affected by floods, by increasing the threshold above which floods can cause harm.	Strengthening river dikes
Capability to absorb and recover	The ability of a flood-affected system to remain functioning, respond to a flood, and recover (without shifting to a different system state).	Constructing emergency escape roads
Capability to transform and adapt	The ability of a system to adjust to external drivers affecting the exposure of people and economic assets to floods (including climate change, climate variability, and changes in extremes, demographic changes, and changes in urbanization patterns) to moderate potential damages, to take advantage of opportunities, to make deliberate small-scale changes, or to cope with the consequences.	Recognising a new or increased threat and adapting policy goals to address this threat

2.4. Output: forward-looking decisions

It is not possible to measure flood resilience at the moment of completion of a project, because it is an ultimate outcome. Therefore, a direct output of a project indicating the contribution to flood resilience is used. An inherent part in stepping from realising interventions to achieving long-term goals is deep uncertainty. Deep uncertainty is referred to as uncertainties in which there is either (1) only knowledge about a set of possible futures without an indication of their likelihood or (2) no knowledge about the future state at all (Walker et al., 2012). There are multiple approaches to dealing with this uncertainty. An approach which structures sources of uncertainty and gives insight into how to take them into account is adaptation pathways. By making possible pathways, path-dependencies and lock-ins explicit, decision-makers are better able to select interventions which contribute to flood resilience. However, adaptation pathways planning is a tool which aids in achieving a long-term goal. The creation of adaptation pathways does not indicate that the desired outcome will be reached. Because of this, evaluating projects on the implementation of adaptation pathways and the resulting adaptation pathways map by itself is not a sufficient indicator for achieving flood resilience. Alternative approaches which focus on dealing with deep uncertainty by applying a quantitative approach (e.g. Ben-Haim, 2006; de Neufville et al., 2019; Lempert et al., 2006) are not considered as they are not suitable for the evaluation framework for flood resilience, because a quantitative evaluation falls beyond the scope of this research.

Instead of evaluating a method for dealing with uncertainty, the decisions taken can be evaluated. As output in the evaluation framework for flood resilience, forward-looking decisions by Pot et al. (2018) is used. Forward-looking decisions are selected, because they evaluate the decisions taken in a project and whether they anticipate possible future developments (Pot et al., 2018). The goal of achieving flood resilience is grounded in the idea that it is necessary to have a flood-resilient system to deal with future developments like climate change. Therefore, it is assumed that forward-looking decisions contribute to flood resilience. Despite anticipating future developments, forward-looking decisions do not have to be long-term decisions. Forward-looking decisions can also be decisions that have an immediate impact. However, the decisions should consider the impact of the decision in the long term in a changing context. For a decision to be forward-looking, three criteria must be met: a forward-looking problem, a forward-looking solution, and a forward-looking justification. First, the problem to be decided on should consider the situation in the future. To meet this requirement future challenges and/or needs should be considered for a time horizon of at least 10 years. Second, the solution itself should be forward-looking. This means that the decision is robust and/or flexible to cope with or adapt to future developments. Third, the decision made should be justified based on future developments. This requirement can be met by connecting the decision to future goals or a future vision, or this requirement can be met by deciding based on future scenarios. A detailed overview of the three criteria is shown in Table 2. In this research, the category forward-looking solution is split into two separate criteria: robustness and flexibility. This is because these may have different effects on the output and ultimate outcome, and may have different process indicators.

Table 2: Criteria for forward-looking decisions (Pot et al., 2018, p. 177).

Criterion	Elements	Description
1. Forward-looking problem	Future orientation and long time horizon	- The problem definition includes future challenges and/or future needs. - The time horizon of the problem definition is minimum 10 years.
2. Forward-looking solution	Robustness	- The solution remains functionally effective during its technical lifetime when tested against an extreme case scenario. - Pilots or experiments of one or more solutions were executed to test robustness.
	and/or flexibility	- The solution can be adapted to changed circumstances and insights during its lifetime, or supplemented by other measures to secure long-term effectiveness. - There is an agreement to establish a monitoring process to secure the effectiveness of the chosen solution. - There is an agreement to establish an iterative decision process for adaptation of the solution.
3. Forward-looking justification	Long-term goals/visions	- The decision is connected to future goals or a future vision.
	and/or future scenarios	- The decision relies on multiple scenarios for one future development. - The decision relies on scenarios to understand multiple future developments.

2.5. Process: Transformative climate governance capacities

In addition to the evaluation of output, the process is evaluated. The governance context of a project can be evaluated to get insight into the circumstances under which plans are developed to contribute to flood resilience. It is assumed that systemic change is required to adopt a flood risk management approach focused on flood resilience. This can also be described as a transition. A way to develop the right conditions for a system to go through a transition is by creating the right governance context. One such approach is the application of adaptive governance (Tompkins & Adger, 2004). The purpose of adaptive governance is to deal with uncertainty and change in complex social-ecological systems (Folke et al., 2005; Olsson et al., 2006). Adaptive governance can be defined as "a systemic process for improving management policies and practices by systemic learning from the outcomes of implemented management strategies and by taking into account changes in external factors in a pro-active manner" (Pahl-Wostl et al., 2010, p. 573). Based on this definition, learning can be recognised as a major driver for adaptive governance. Learning, also known as social learning (e.g. Baird et al., 2014; Ison et al., 2015), can be defined as the ability of a group of actors to learn resulting in shared rules and practices (Pahl-Wostl et al., 2010). This can be achieved through the maximisation of the approval of stakeholders by examining, analysing and modifying their beliefs (Krywkow, 2009). In addition, the continuous monitoring of implemented strategies to gain knowledge on how to improve them is an essential part of learning (Pahl-Wostl, 2007). Pahl-Wostl et al. (2007) stress that social learning is essential in water management as it is necessary to negotiate about shared goals and how to translate them into action. To evaluate adaptive governance, the adaptive capacity wheel can be used (Gupta et al., 2010). Using the adaptive capacity wheel, the adaptive capacity of a governance context can be evaluated along six dimensions: variety, learning, room for autonomous change, leadership, resources and fair governance. Despite the influence of adaptive governance on resilience, an evaluation framework for adaptive governance only gives insight into specific parts of the process. Therefore, this method is not selected as part of the evaluation framework for flood resilience. By extension, applying a framework for social learning is not selected as it too gives limited insight into the full governance context. Instead, in the evaluation framework for flood resilience, the transformative climate governance capacities by Hölscher et al. (2019) are used. Hölscher et al. (2019) states transformative climate governance directly contributes to resilience. Furthermore, transformative climate governance has a broader scope of the governance context compared to adaptive governance. To get insight into the possible influence of the different aspects of governance on flood resilience, a broader scope is desirable. Therefore, transformative climate governance capacities are selected as the process indicators in the evaluation framework for flood resilience.

In transformative climate governance, four capacities are identified: stewarding capacity, unlocking capacity, transformative capacity and orchestrating capacity (Hölscher et al., 2019). Stewarding capacity refers to the capacity to identify long-term change, uncertainties and risks. Stewarding capacity is necessary as without knowing the potential threats, it is impossible to prepare and react to them. The second capacity, unlocking capacity describes the capacity of a system to stop or transform unsustainable practices. Common practices that have been used for decades can be hard to change. Such practices must be 'unlocked' to be able to change them or to reduce the comparative advantage to more sustainable practices (Hölscher et al., 2019). Transformative capacity refers to the capability to innovate. Not only is it important to discover or invent, but implementation is also necessary to achieve transformation. Last, orchestrating capacity is stated. Orchestrating focuses on integrated stakeholder management. The aim of stakeholder management in this context is to make sure stakeholders want to achieve the same goals and to utilise synergies. Each capacity is linked to a purpose and has three enablers (Hölscher, 2019), as shown in Table 3. Despite not explicitly including adaptive governance or social learning, multiple aspects of these contributors to resilience can be recognised in the stewarding and orchestrating capacity. Social learning can be linked to the enablers monitoring and continuous learning, strategic alignment and mediating across scales and sectors while adaptive governance can e linked to strengthening self-organisation.

Table 3: Conceptual framework of capacities for transformative climate governance (Hölscher, 2019).

Governance capacity	Description	Enablers
Stewarding capacity	The ability to anticipate and respond to long-term change, uncertainty and risks.	- Generating knowledge about system dynamics - Strengthening self-organisation - Monitoring and continuous learning
Unlocking capacity	The ability to recognise and dismantle unsustainable path-dependencies and mal-adaptation.	- Revealing drivers of unsustainable path-dependencies and mal-adaptation - Undermining vested interests and incentive structures - Breaking open resistance to change
Innovating capacity	The ability to create and embed novelties	- Enabling novelty creation - Increasing visibility of novelty - Anchoring novelty in context
Orchestrating capacity	The ability to coordinate multi-actor processes to create synergies and avoid trade-offs.	- Strategic alignment - Mediating across scales and sectors - Creating opportunity contexts

Instead of transformative capacity, the third capacity will be named innovating capacity in this evaluation framework. This is because the enablers of this capacity all refer to the creation of novelties or in other words innovation. This should not be confused with the set of four transformative capacities of which innovating capacity is one. The naming of innovating capacity is in line with definitions in other literature. Wolfram (2016) states one of the capacities for the overarching urban transformative capacity is innovation embedding and coupling. This is comparable to the third capacity in the conceptual framework for transformative climate governance by Hölscher (2019).

2.6. Evaluation framework

By combining the transformative climate governance capacities, forward-looking decisions and flood resilience in the evaluation framework, the evaluation framework for flood resilience is created. The transformative climate governance capacities themselves are not suitable to be used in the evaluation framework for flood resilience, because these terms are too broad. Instead, the enablers of the capacities are used as they represent the operationalisation of the capacities. The proposed evaluation framework is shown in Figure 2. The ultimate outcome is demarcated with dashed lines, because it is not evaluated in this research.

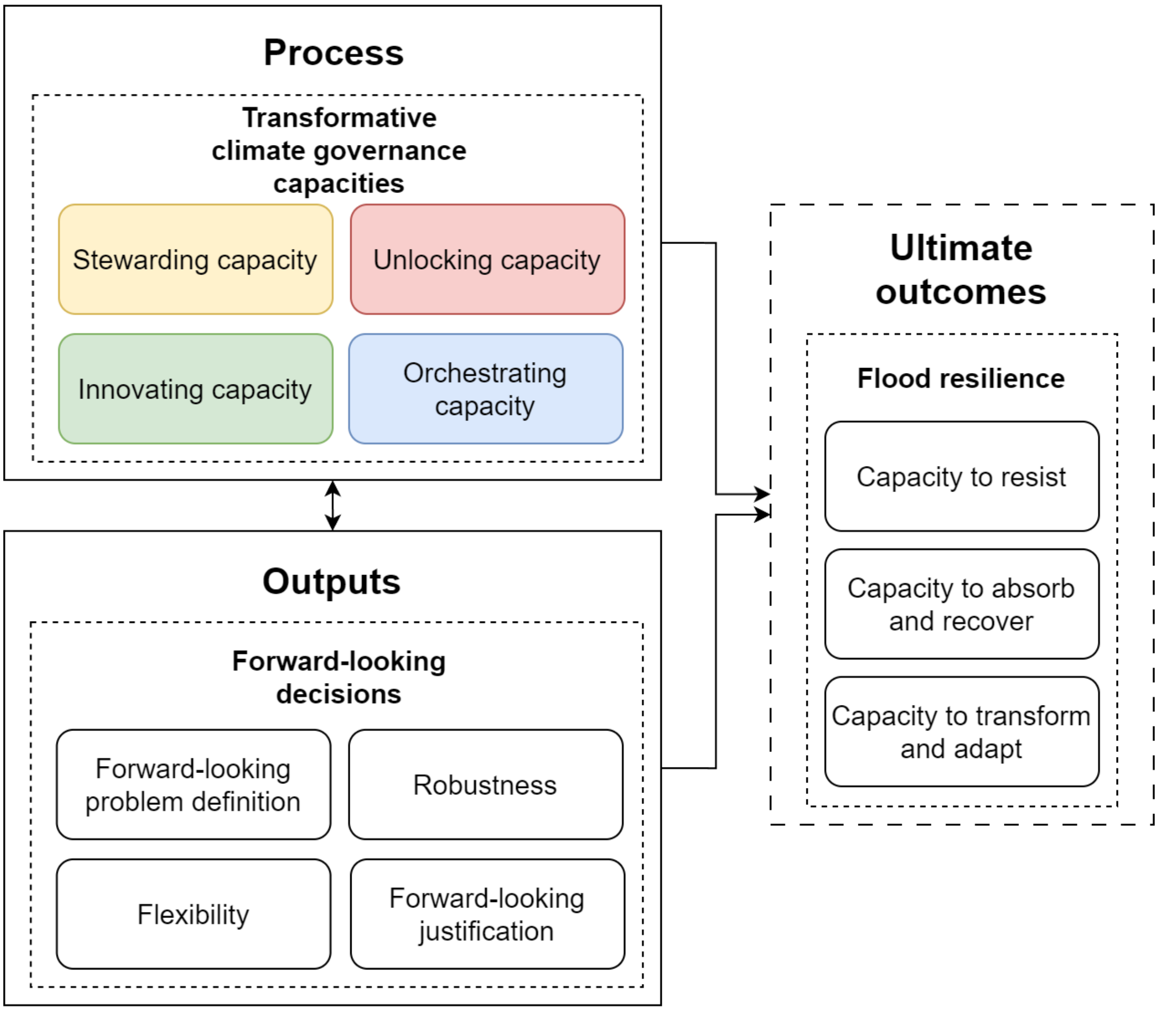

Figure 2: Evaluation framework for flood resilience.

3. Method

In this chapter, first, the overall research strategy is described. Following this, the two study cases for this research are introduced. Third, the data collection methods are explained, after which the chapter concludes with the approach to data analysis.

3.1. Research strategy

This research addresses spatial flood risk management approaches that are applied in a complex situation where behaviour and social interactions in part drive the decision-making process. Because of this, a qualitative research method is used as it can be applied to address 'why' and 'how' questions, explore new topics, understand complex issues, explain behaviour and identify social or cultural norms (Hennink et al., 2020). The focus of this research is on evaluating and formulating recommendations for two spatial flood risk management approaches. Therefore, this study takes the form of an explanatory case study. This method best fits this research method as it does not require control of behavioural events and the focus is on a contemporary event (Yin, 2014). The case study is explanatory as the research aims to answer a 'how' question. In order to address the 'how' questions, two case studies are evaluated and reflected upon. Therefore, this research is considered a multiple-case study (Yin, 2014). The first case is a project from the program Room for the River: the depoldering of the Noordwaard. The second case applies the flood-resilient landscapes approach in an innovation project. This project is still in progress as there is no finished project that has used the flood-resilient landscapes approach. As a result, the evaluation of the flood-resilient landscapes case will not be complete. Despite this difference, both cases are evaluated using the same evaluation framework as many parts of the evaluation are still of significant interest. In addition, as part of the data collection it will be investigated which parts of the case can not yet be evaluated and for what reason. This avoids drawing wrong conclusions.

The research is structured in line with the three research questions stated in Section 1.4. First, an evaluation framework is developed with which a project can be evaluated. This framework is presented in Section 2.6. After this, the two cases are evaluated by applying the evaluation framework. Using the data gathered in the evaluation of the two cases, advice will be formulated to improve planning approaches to achieve flood resilience. An overview of the research strategy is shown in Figure 3.

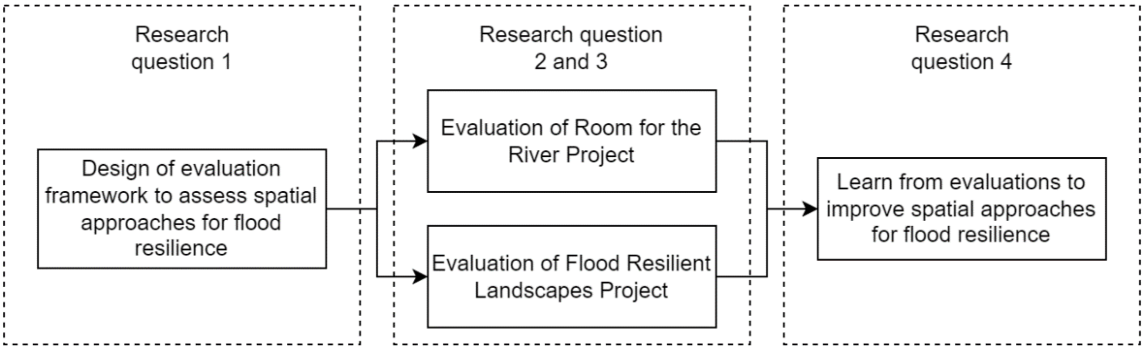

Figure 3: Research strategy.

3.2. Introduction of the case studies

Both study cases are a project in the Netherlands. The first case is a project which is part of the Room for the River program called Project Noordwaard. This project is indicated in Figure 4 by the number 1. The second case implements the flood-resilient landscapes approach. This case is a project located in the municipality of Zwolle and is marked as 2 in Figure 4. Both study cases are described in more detail below. The project in Noordwaard is selected because it applied a design process in which local stakeholders were intensively involved, leading to a result in which a multi-layered safety approach plays a major role. The project in Zwolle is selected as it is one of only a few trial projects working with the flood-resilient landscapes approach. What makes this case interesting is the presence of a river in the area, which is not the case in other flood-resilient landscapes trial projects.

Figure 4: Location of the two study cases. Adapted from Blokplan Plattegronden (n.d.).

3.2.1. Depoldering of the Noordwaard

Project Noordwaard is a project in a polder called the Noordwaard, located to the east of Dordrecht. The project, which is part of the Room for the River program, was completed in 2015. As it is part of the Room for the River program, the main aim of the project is to increase flood protection in the area surrounding the section of the Nieuwe Merwede River. In Room for the River projects the aim is to achieve this not by simply heightening and strengthening dikes, but to do so by creating more space for the river. In the case of the Noordwaard, this meant partly opening the dike ring protecting the Noordwaard to allow for water to flow freely when the water level in the river is sufficiently high, as is shown in Figure 5. To incorporate the needs of inhabitants, a design was proposed and realised in which smaller areas are still protected using low dikes and mounds (Kennisportaal Klimaatadaptatie, n.d.).

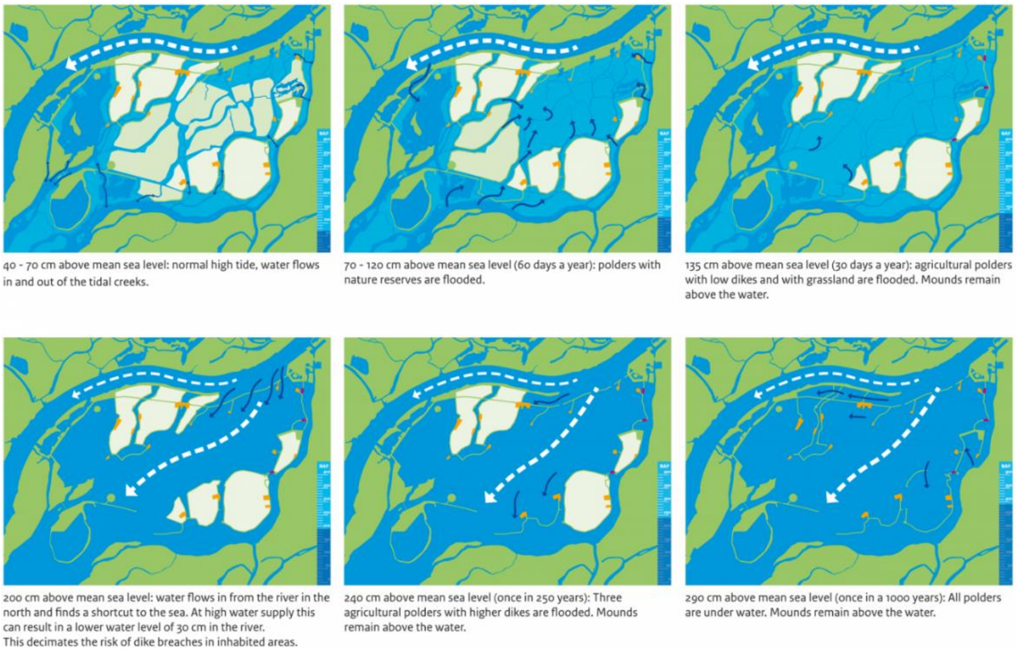

Figure 5: Study area of case 1, Noordwaard, at different water levels (Mijs cartografie en vormgeving, 2015).

The Room for the River program had the double objective of achieving renewed river flood safety standards and improving spatial quality in the region in the middle of the Netherlands in which the Rhine and Meuse, and their distributaries flow (PKB Ruimte voor de Rivier, 2006). An important aspect in the organisation of the projects in the Room for the River program is the extensive involvement of local authorities. This too is the case for the depoldering of the Noordwaard with the involvement of the water authority, three municipalities and two nature conservation organisations. Along with Rijkswaterstaat, these organisations participated in design sessions to explore possible interventions in the area. To aid in this process, the planning kit, (Dutch: Blokkendoos) was developed. This software tool calculates the impact of different (sets of) interventions on the water levels in the river system, giving insight into the feasibility of the proposed interventions (Bötger & Beekmans, 2017). Furthermore, a separate spatial quality team was introduced into the program structure which consulted project teams to improve spatial quality (Olde Wolbers et al., 2018).

3.2.2. Innovation project Flood-Resilient Landscapes Zwolle East

The second study case is a flood-resilient landscapes innovation project based in the east of Zwolle. This study case aims to learn about the flood-resilient landscapes approach by applying it in an innovation project focussed on the area roughly demarcated in Figure 6. In the Zwolle region there is a high demand for housing. In addition, this region deals with flood safety and water quality issues in the proposed area for housing in the east of Zwolle. Furthermore, the river Vecht and the Sallandse Weteringen flow through the area. In the future, the effects of climate change will worsen the water management challenges in the area. Because the current practice might not be sufficient in dealing with these challenges, an integrated approach is proposed to address this set of challenges: flood resilient landscapes. The objective of this innovation project is to contribute to the development of the flood-resilient landscapes approach.

Figure 6: Study area of case 2, Zwolle East. Adapted from Vector-map (2020).

The flood-resilient landscapes approach applied in the study case is Zwolle is centred around the current and future values of the area (Deltares, n.d.). The goal of this approach is to focus on planning for the situation in the future as opposed to for the current situation. This should result in future-proof flood risk management (de Leeuw et al., 2022). This strategy not only considers flood risk and current challenges, but also recognises the importance of long-term resilience. When designing flood-resilient landscapes, the Reframing Method is used. The Reframing Method consists of five steps: deconstruction, future context, positioning, design and transition (Reframing Studio, n.d.). In the deconstruction phase, the reason behind the current solutions is explored. This gives insight into the performance of the current systems in place. The second step, future context, focuses on envisioning plausible futures, known as narratives. This is the frame of reference for the possible solutions. The third step is positioning. In this step, a preferable future is envisioned. The goal is to create an ambitious vision for what the most desirable future would look like within the realm of possibilities. In the fourth step, design, new products, systems, services or environments are developed that contribute to transitioning towards the preferable future. The last step is the transition. In this phase, a transformation path is established. This transformation path will describe the steps necessary to change from the current situation to the desired future.

Reframing Studio and Deltares (2022) have applied the Reframing Method described narratives for the Netherlands. Reframing Studio and Deltares (2022) describe eight narratives based on three underlying dimensions concerning water safety. The first of these is the matterscape (de Leeuw et al., 2022). This dimension questions whether people are controlling or adapting to nature in the future. The second dimension is the powerscape. Within the powerscape, society could either move towards a horizontal or a vertical power structure. Last, there is the mindscape. In this dimension the past and future are opposites. It questions how society responds to a changing world. Will society look to the past and fall back on methods that have proven effective, or will society instead be innovative and future-minded? The divides in each dimension or combined to create eight possible futures. These can be applied to spatial flood risk management projects in the Netherlands.

3.3. Data collection

To improve the quality of the case study, it is advisable to have multiple data sources (Yin, 2014). Following this advice, this research will utilise three data collection methods: conducting interviews, analysing documents and observations.

The first data collection method is the document analysis. As part of the document analysis, action plans, evaluations, news articles, policy documents and design documents, among others were analysed. Similar to the literature review, the document analysis is used to formulate interview questions that are relevant to the context of the cases. The second data collection method is observations. Information was gathered by participating in four design sessions of the flood-resilient landscapes project in Zwolle. This gives more insight into the process applied in this study case. In the first design session, the three main narratives for which a design was made were selected. In the second session, respondents were asked to give feedback on the design of the area in each narrative. At the end of the second session and continued in the third session is the creation of an assessment framework based on values. Furthermore, the initial designs for the area are presented in the third session. In the fourth session, adaptation pathways for the area are presented and given feedback on. Because the Noordwaard case study is a completed project, no observations were conducted for this case.

For both cases, data were further collected through semi-structured interviews. Semi-structured interviews were used as it ensured all relevant topics are discussed while allowing space for the interviewees to elaborate on topics they deem important (Atkinson, 2017; Klenke, 2016). To ensure that the data is diverse and covers all perspectives within the study cases, respondents were selected who have differing specialties and positions and work for different organisations (Eisenhardt & Graebner, 2007). The position of each respondent in their respective project is shown in Table 4. To prepare the interviews for data analysis, all interviews were recorded and fully transcribed.

Table 4: Position of each respondent in their respective project.

#	Position of respondent during project	Project	Date of interview
R1	Senior advisor flood defences at Waterschap Alm en Biesbosch (now part of Waterschap Rivierenland)	RvR: Noordwaard	May 30, 2024
R2	Legal advisor at the Corporate Services Department of Rijkswaterstaat	RvR: Noordwaard	May 29, 2024
R3	Advisor river engineering at Waterloopkundig Laboratorium (now Deltares)	RvR: Noordwaard	May 30, 2024
R4	Project, stakeholder and technical manager at Rijkswaterstaat	RvR: Noordwaard	July 10, 2024
R5	Department head civil engineering and spatial planning at the Municipality of Werkendam (now part of Municipality of Altena)	RvR: Noordwaard	June 27, 2024
R6	Coordinating legal advisor of the Room for the River program management	RvR: Noordwaard	June 17, 2024
F7	Strategic director at Waterschap Drents Overijsselse Delta	Flood-resilient landscapes	July 2, 2024
F8	Policy implementer water and climate change at Provincie Overijssel	Flood-resilient landscapes	June 11, 2024
F9	Senior design strategist at Reframing Studio	Flood-resilient landscapes	July 8, 2024
F10	Senior advisor levees at Deltares	Flood-resilient landscapes	June 24, 2024
F11	Advisor spatial adaptation at Municipality of Zwolle	Flood-resilient landscapes	July 24, 2024
F12	Project manager of the flood-resilient landscapes innovation project	Flood-resilient landscapes	June 14, 2024 (online)
B13	Innovation coordinator of the HWBP program management	Both projects	June 28, 2024 (online)

Each interview took around 90 minutes and was divided into three parts. In the first part of the interview the degree to which each transformative climate governance capacity is present in the project was discussed. Questions were formulated based on the enablers of each capacity. The second part covered the output of the project along the four criteria for a forward-looking decision. The questions used in this part are based on the description of each forward-looking decision component presented in Table 2. In the third part, the relationship between transformative climate governance capacities and forward-looking decisions was discussed. Inspired by slider scales in digital surveys (Roster et al., 2015), this was done with the use of four slider scales representing the criteria for a forward-looking decision and coloured stickers representing the transformative climate governance capacities. Respondents were asked to put stickers on each slider scale to indicate how large they perceive the influence of the capacity on one of the criteria for a forward-looking decision to be, ranging from no influence to a very large influence. An example of an outcome of this part is shown in Figure 7. During the this part of the interview the respondents were asked to elaborate on why each ranking was given to understand the reasoning behind the rankings. The reasoning is considered more important than the ranking itself. The interview protocol used for the interview can be found in Appendix A. The method for conducting interviews and selecting respondents has been ethically approved by the University of Twente.

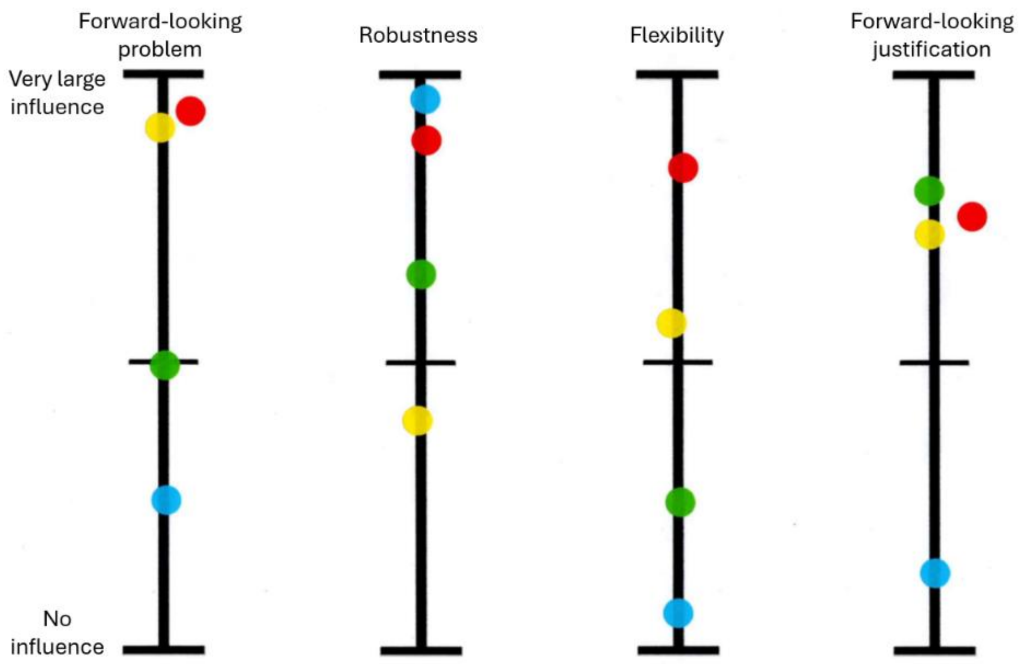

Figure 7: Example of a set of stickered slider scales.

3.4. Data analysis

The data retrieved in the interviews was analysed using deductive thematic analysis. The predetermined codes for this analysis are based on the transformative climate governance capacities and forward-looking decisions. An overview of the code tree is shown in Appendix B: Code tree. For the evaluation of the process and output, for each transformative climate governance capacity and forward-looking decision criterion all quotes were analysed. Next to this, to obtain insight into the influence of the transformative climate governance capacities on forward-looking decisions, a thematic analysis of co-occurring codes from the third part of the interviews was conducted. The quotes resulting from the co-occurrence of the governance capacities and forward-looking decisions were used to find relevant information on relationships between transformative climate governance capacities and criteria for forward-looking decisions. Using this search strategy the reasoning behind the extent of the influence of each governance capacity on each forward-looking decision component was found. The full coding process was done using the software ATLAS.ti.

First, the evaluations were analysed separately. The outcomes of both case studies were analysed after the completion of the separate evaluations. All quotes were put in perspective by comparing them to the other respondents. If respondents contradict each other, this was also stated. Where available, the contradictions were elaborated on by explaining the reasoning behind statements. As a validation step, all interview respondents were given the opportunity to view the results of the evaluation to ensure the interpretation of the interviews is in line with the perspectives of the respondents. Furthermore, the results of both evaluations have been reflected upon together with a flood-resilient landscapes expert from Deltares.

The third part of the interview on the influence of transformative climate governance capacities on forward-looking decisions not only addressed the third research question, but it also served as partial validation for the evaluation framework.

4. Results

This chapter presents the results of the two case studies. First, the evaluation of the Noordwaard case study is discussed, after which results are presented for the Zwolle case study. The chapter concludes with a synthesis of the results of both case studies.

4.1. Depoldering of the Noordwaard

This section presents the outcomes of the evaluation of the Noordwaard case study. It begins with presenting the results of the evaluation of transformative climate governance capacities, followed by the results with regard to forward-looking decisions. The section concludes with the influence of transformative climate governance capacities on forward-looking decisions in the Noordwaard case study. The part on transformative climate governance capacities and forward-looking decisions both start with a table listing the main strengths and weaknesses according to the respondents for that part of the evaluation.

4.1.1. Transformative climate governance capacities

Overall, the interview respondents recognise a strong presence of the four transformative climate governance capacities in the Noordwaard project. For each capacity, multiple enablers can be distinguished, in addition to a few weak points and cautionary notes identifying room for improvement. The contributing factors to each capacity are described in this section. In addition, the major strong and weak points in the Noordwaard project for each capacity is listed in Table 5.

Table 5: Evaluation of the process indicators for the depoldering of the Noordwaard.

Transformative climate governance capacity	Strong (+) and weak (-) points
Stewarding capacity	+ Extensive research on flood safety of different measures. + Cross-sectoral knowledge sharing and development through design sessions. - Knowledge is lost after the completion of the project.
Unlocking capacity	+ Increased support by integrating spatial quality + Large governmental investment in Room for the River program
Innovating capacity	+ Stimulation of innovation due to the double objective
Orchestrating capacity	+ open and elaborate collaboration between involved parties + Early and good participatory process + Equal importance of flood safety and spatial quality in decision-making

Stewarding capacity

Based on the responses of the interview participants, the most important enabler for stewarding capacity in the Noordwaard case was generating knowledge. According to three respondents, an extensive analysis was made of the study area prior to the design phase (R1, R3 and R4). Apart from the water system, this included information on spatial planning, nature (R1, R3 and R4) and economic development (R4). The impacts of droughts and sea level rise were not considered (R1 and R3). Instead, the flood safety goal in the Room for the River projects was limited to the increase in normative discharge of the river Rhine (R1). This aspect of flood safety was researched extensively (R3). In terms of the possible development of the area in the future, research was mainly focussed on the changing climate and the impact on the discharge of the River Rhine (R2). A member of the Room for the River program management further states the program management consisted of people with different backgrounds to anchor knowledge from different disciplines, varying from river engineering and spatial planning to cultural history, archaeology, finance and law, contributing to the knowledge available on different issues (R6). As possible improvement, a respondent notes that social matters and inclusivity could have been considered more thoroughly (R2).

Expertise and knowledge were considered important by all interview respondents and was invested in, further stressing the importance of the enabler generating knowledge. For example, to improve the quality of the process in the Room for the River program, the national lawyer (Dutch: Landsadvocaat), aiding the Dutch government in legal issues, was made available for all government bodies that participated in the program. This gave the projects judicial knowledge to aid decision-making and to increase the chance of the projects being realised (R2 and R6). Next to this, to enable the projects in the Room for the River program to test spatial interventions, new hydraulic models were developed (R4).

Sharing knowledge between the involved parties is also considered a contributing factor to a strong stewarding capacity by multiple participants (R1, R2, R3 and R6) and was done extensively in the Noordwaard study case (R3). An example of knowledge sharing is the use of the planning kit (Dutch: Blokkendoos) (R1, R3 and R6). This software tool was used to calculate the impact of different (sets of) interventions on the water levels in the river system. Three respondents recognise the importance of the planning kit as it allowed all parties to test different interventions and communicate them to each other (R1, R3 and R6). This gave all stakeholders the possibility to test different interventions and to assess their feasibility. In addition, the river engineering advisor from the Waterloopkundig Lab states the planning kit also experienced improved trust in available knowledge among stakeholders (R3). Furthermore, a respondent notes knowledge gained in projects within the program was shared with the other projects in the program (R2). This gave the opportunity to apply lessons learned in other Room for the River projects in the Noordwaard project.

During the project, the enabler continuous learning is addressed well as knowledge was generated throughout the project. However, a flood defences advisor for the water authority states that after the completion of the Room for the River program, knowledge is gradually lost, because the approach is not applied anymore and the people with experience gradually retire (R1).

Unlocking capacity

The responses of the interview participants suggest that the main enabler for the unlocking capacity in the Room for the River program was breaking open resistance to change. Multiple respondents state this was initiated by the highwaters of 1993 and 1995 (R2, R3 and R5). These highwaters created a perceived urgency among the population and reduced resistance in politics (R2 and R3). One of the respondents states this was acted upon well, which led to the realisation of the Room for the River program (R2). On a regional level, governmental bodies were convinced by closely involving them in the project in their region (R2) while national governmental bodies were responsible for most of the costs and risks (R4, R5 and R6). This motivated regional governments to approve of the project (R4, R5 and R6).

The double objective of flood safety and spatial quality made the program considerably more complex, because the spatial component automatically caused more parties and governmental bodies to be involved (B13). However, the objective of improving spatial quality in the area increased support for the project among stakeholders (Commissie VBIP, 2008). Furthermore, all seven respondents state that listening to the input of local stakeholders plays a large role in breaking open resistance to change. In the Noordwaard, the initial plan was the creation of a side channel going through the area, which local stakeholders did not find desirable. Instead, they supported the idea to depolder the area, which ended up being implemented (R1 and R4). Six respondents state that an important factor in realising a novel design was that people working on the project were willing to put effort in this idea (R1, R2, R3, R4, R6 and B13). This effect was perceived to be strengthened by the setup of the program as it was a separate organisation (R4). Furthermore, a project manager states that the project team was flexible and less likely to be stuck in traditional practices due to the high number of young people involved in the project (R4).

A second enabler for the unlocking capacity in the Noordwaard project is revealing drivers of path-dependencies. A river engineer notes that people working in the water management sector recognised that the standard practice of continuously heightening dikes was not sustainable in the long term due to climate change (R3). This led people to explore other ways to achieve flood safety (R3). Although path dependencies were not considered explicitly, the reasoning behind strategic choices made did take this into account (R3 and R4). Next to this, path-dependencies within the project were revealed early due to the use of the planning kit in the exploration phase. According to a flood defences advisor from Waterschap Alm en Biesbosch, investigating the feasibility of multiple alternatives gave insight into which design seemed optimal, reducing the chance of having to alter the design in later phases to improve it (R1).

Innovating capacity

All three enablers for innovating capacity were mentioned by interview respondents for the Noordwaard project. The first enabler for innovating capacity in the Noordwaard project is enabling novelty creation. According to multiple respondents, the double objective of improving flood safety and spatial quality formed the basis for an innovative environment as it led to a broader perspective on the challenges at hand (R2 and R4). In addition, a respondent notes that the number of different stakeholders closely involved led to an environment in which innovation was stimulated as more different and novel ideas were suggested (R1), leading to an increased visibility of novelty. This was further strengthened by the serious consideration of the needs and wishes of inhabitants of the area in decision-making (R3). An example of this was the use of willows to break waves to avoid the need to further heighten the dike. This was done after inhabitants complained a higher dike would ruin the view. The objective to improve spatial quality and the goal to consider the needs and wishes of inhabitants in the decision-making process made people search for different and sometimes innovative ways to achieve both spatial quality and water safety (R1, R3, R4, R5 and R6). Because this was developed and implemented, not only did this contribute to enabling novelty creation, but it also fits the second and third enablers: increasing visibility of novelty and anchoring novelty in context.

According to a respondent, the application of the method for project management used in the Noordwaard project can be considered the anchoring of a novelty in context. The respondent notes the method used in the Room for the River program in itself was innovative, because it applied new rules on how to collaborate with other stakeholders (R1). A research by design method was applied, which the respondent states was an innovative approach in the work field on this scale and also enabled innovation (R1).

According to respondents, perceived necessity for innovation among stakeholders also contributed to increased innovating capacity. A flood defences advisor from Deltares states there was a need to change the flood risk management approach as the current approach of continuously strengthening dikes was no longer desirable (R1). Furthermore, people working on the project should dare to take risks as this is necessary to achieve innovation, which was the case for the project in the Noordwaard (R3).

Orchestrating capacity

An important enabler for orchestrating capacity is perceived to be mediating across scales and sectors. Parties participated in interactive design sessions in which needs, wishes and opinions were shared

(R1, R4 and R5). This helped the parties understand different perspectives (R1) and led to a design in which all needs, wishes and opinions were considered (R3), increasing support for the design among stakeholders. These parties were a serious partner in the project as opposed to a party that simply needed to be involved (B13). They could use the resources of the program and were given money to do research when necessary (B13). The collaborative process between participating organisations went well overall and no major conflicts arose (R1, R2, R3, R4, R5 and R6).

In addition to mediating between parties involved in the design process, the involvement of local stakeholders through a participatory process is also stated as a contributing factor to the orchestrating capacity. Five respondents state close and personal involvement of interest groups and inhabitants on a personal level was intentionally sought after and was invested in from the early stages of the project (R2, R3, R4, R5 and R6). Several respondents explain this helped mitigate possible resistance (R2, R3, R4 and R6) as it made them feel heard (R2, R4 and R5), allowed designers to explain design choices (R2 and R3) and it increased transparency (R4). Next to this, it avoided scenarios in which opinions of inhabitants were assumed. A stakeholder manager states this avoided resistance from inhabitants (R4). Moreover, the stakeholder manager explains the participatory process allowed inhabitants and interest groups to share knowledge and design ideas (R4). An important factor in the success of the participatory process is perceived to be the fact that the stakeholder managers stayed the same throughout most of the project (R5). A department head of a municipality states that the constant change of people leads to a loss of local knowledge and relationships between the project organisation and local stakeholders, as was experienced in the early phase of the project (R5).

Orchestrating capacity is also enabled through strategic alignment. To ensure equal treatment of water management and spatial design, the Ministry of Infrastructure and Water Management, the Ministry of Housing and Spatial Planning and the Ministry of Agriculture, Nature and Food Quality had equal responsibility in the Room for the River program (B13). This forced the different fields to work together and achieve integral solutions (B13).

4.1.2. Forward-looking decisions

Decisions made in the Noordwaard projects with regard to flood safety can be considered forward-looking based on the responses of the interview participants. However, decisions made regarding other aspects like spatial quality are mostly focused on short-term goals. An overview of the strengths and weaknesses with regard to the forward-looking decision components in the Noordwaard project is presented in Table 6.

Table 6: Evaluation of the output of the depoldering of the Noordwaard.

Forward-looking decision criterion	Strong (+) and weak (-) points
Forward-looking problem	+ Future flood safety risks are addressed + Spatial design choices are driven by development of the area, benefiting future spatial quality
Robustness	+ Multiple alternatives are tested for flood safety in an extreme scenario, even beyond the target norm
Flexibility	+ Space is strategically left for additional flood safety measures - No iterative decision process for future changes
Forward-looking justification	+ Forward-looking flood safety goal + Use of a future scenario for river discharge - No explicit future goals for issues besides flood safety

Forward-looking problem

Immediately after the highwaters in 1995, flood prevention measures were installed in the most critical locations (R5). After this, goals for the middle and long term were formulated that formed the basis for the Room for the River program (R5). In terms of flood safety, multiple respondents state that the future was taken into account well in the problem statement as one of two main goals was to protect from increased discharges in the river (R1, R2 and R3). However, a river engineer from Deltares adds the problem statement did not consider significant sea level rise, which could impact the effectiveness of the measures taken in the future (R3). The Room for the River program design was based on a normative discharge at Lobith of 16.000 m^3/s in 2015 while taking into account the possible necessity for extra measures for a discharge of 18.000 m^3/s (R3, R6, Olde Wolbers et al. (2018) and PKB Ruimte voor de Rivier (2006)). Instead of taking multiple small measures along the river, the choice was made to do one set of big measures in the Noordwaard to solve potential flood safety issues up until 2040 (R4 and R6). This was more efficient and avoided the need for additional water safety projects along the rivers (R4 and R6).

Spatial quality is considered to be taken into account in the problem statement well as it is one of the two goals of the project (R2 and R5). However, no long-term targets were explicitly considered. Instead, the focus on improving the spatial quality of the Noordwaard in the short and medium term (R2 and R5). A respondent suggests that with the knowledge of climate change we have now, it is probably better to look further into the future (R1).

Robustness

Overall, all respondents state the depoldering of the Noordwaard is a robust design. During the early design phase, the planning kit was applied to test multiple alternatives for robustness. The design was thoroughly tested using 2D hydraulic models (R3). The design was not only tested for the normative discharge, but was also tested for even more extreme situations to get insight into the effectiveness of measures beyond the normative discharge (R3). The area is designed in such a way that nature can develop without exceeding safety limits (R4). In 2017 the failure norms for dikes were increased. Therefore you could say Room for the River is less robust compared to upcoming projects (B13). However, it is difficult to determine if the Noordwaard really is robust, because there has not been a normative discharge (R6).

Flexibility

According to the interview respondents, flexibility is considered in the design of the Noordwaard. Measures that create space are more flexible compared to measures that deepen the river (R3). Because of this, the Noordwaard is a flexible design (R3). Apart from this, future changes are not strategically planned or considered (R2 and R3), despite the inclusion of a directive stating that measures in the Room for the River program should be adaptable and flexible in time (Olde Wolbers et al., 2018). After the completion of the project, management of the area is given back to the local governments. Because of this, the integrated way of working as applied in Room for the River is lost (R2). To make new changes in the Noordwaard a new project has to be started. However, space is left for additional measures to be taken (R4, R6 and B13) (PKB Ruimte voor de Rivier, 2006).

Forward-looking justification

Six respondents state future flood safety threats from rivers are considered well (R1, R2, R3, R4, R5 and R6), suggesting a forward-looking justification. However, no long-term spatial design vision is created for the Noordwaard (R1, R3 and R6). This is because a long-term vision for an area is difficult as the political climate can change, changing such a vision (R6). Therefore, the justification of the depoldering of the Noordwaard can only be considered forward-looking with regard to flood safety.

4.1.3. Influence of transformative governance capacities on forward-looking decisions

As can be seen in Figure 8, the consensus between the interview respondents is that stewarding capacity has a significant influence on forward-looking decisions. Stewarding capacity is important for a forward-looking problem and a forward-looking justification to be able to identify if there is a problem and how it will develop over time. For robustness and flexibility, stewarding capacity is impactful as knowledge on designing robust and flexible areas is required. The low outlier for the forward-looking problem and forward-looking justification are scores given by the same interview respondent. This respondent states that stewarding capacity is important to identify the problem, but that it is only a small component of stewarding capacity. Therefore, relative to robustness and flexibility, stewarding capacity has less influence (R4). The below halfway score for robustness is based on the fact that knowledge to design a robust area is common. Because of this, the need for stewarding capacity is lower (R3).

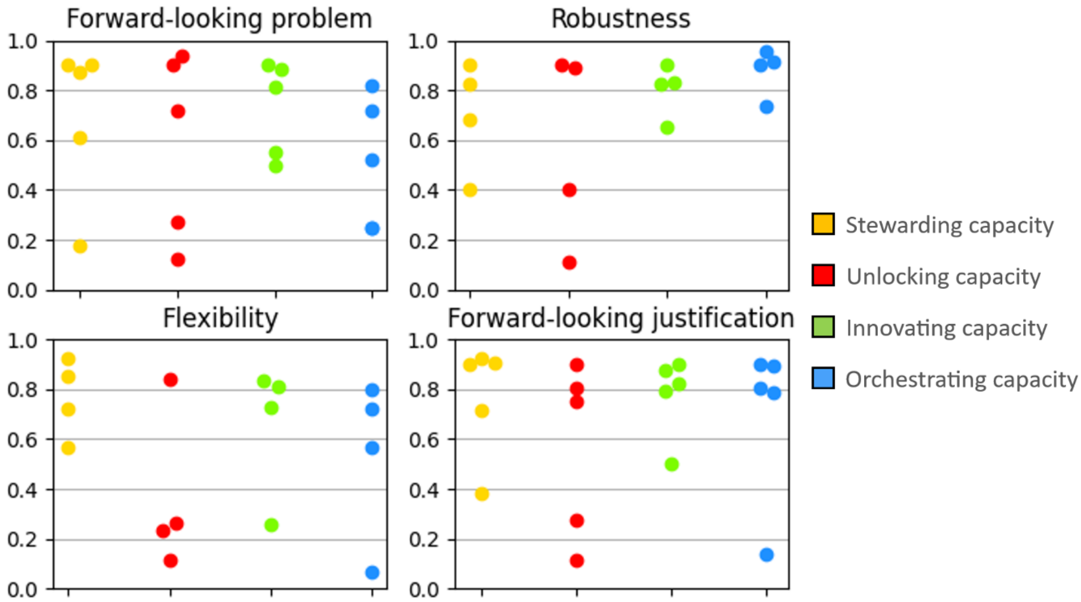

Figure 8: Influence of transformative climate governance capacities on forward-looking decisions according to the interview respondents for the Noordwaard project.

Unlocking capacity is perceived as an important factor for a forward-looking problem definition and justification by all interview respondents for the Noordwaard project, because the sense of urgency to change the way of working by implementing spatial flood safety measures is considered an enabler of the Room for the River program (R1 and R3). The spread of the unlocking capacity for the four criteria for forward-looking decisions as shown in Figure 8 is deceiving. This is due to the interpretation of the question of whether unlocking capacity has had a large influence on the project. Two interview respondents state that unlocking capacity has little influence on forward-looking decisions, because resistance was mitigated before it could arise (R4 and R6). With this reasoning, it can be concluded that the unlocking capacity present in the project was applied early and therefore resistance during the project did not become apparent. Moving these two data points up in all four graphs shows that overall the unlocking capacity is an important factor in achieving forward-looking decisions in the depoldering of the Noordwaard.

For innovating capacity, the main contributor to the high scores is the innovative project design. Without innovation, Room for the River would not have been possible. Instead, the course of action would probably have been to improve the dikes again (R1). Innovating capacity was important to include the spatial goal of Room for the River (R2). This reasoning is stated as motivation for the high scoring of the influence of innovating capacity on both a forward-looking problem and a forward-looking justification. For robustness and flexibility, the high scores are motivated by the importance of innovation in physical solutions.

There is a large spread of the rankings of the influence of orchestrating capacity on a forward-looking problem. This is due to the different types of cooperation the respondents consider. The participation process with local stakeholders has no influence yet, while collaboration between government agencies and NGOs does play a significant role (R4). Furthermore, there are fewer parties involved in the early stages of the project. As a result, the orchestrating has a lower influence on the project outcome compared to other stages of the project (R3). All respondents are of the opinion that orchestrating capacity has a large influence on robustness. This is because the cooperation and participation process as applied in the depoldering of the Noordwaard led to the design as it is. Three respondents reason orchestrating capacity has a similar effect on flexibility, although to a slightly lower degree. The respondent stating orchestrating capacity has little to no influence on flexibility reasons that flexibility of the physical area is a purely water system-based decision where stakeholders other than water managers have no influence on decisions made (R3). Four interview respondents state orchestrating capacity has a large to very large influence on the forward-looking justification, because the vision for the area was created together with all stakeholders. The fifth respondent too states the influence of orchestrating on the justification for the design is high. However, it does not influence the forward-looking component of the justification, because stakeholders do not consider long-term goals and challenges (R3).

4.2. Case study Flood-Resilient Landscapes Zwolle

This section presents the outcomes of the evaluation of the Flood-Resilient Landscapes case study. It first discusses the transformative climate governance capacities, followed by an analysis of forward-looking decisions. The section concludes with an evaluation of the influence of transformative climate governance capacities on forward-looking decisions.

4.2.1. Transformative climate governance capacities

Overall, the interview respondents acknowledge a solid presence of the four transformative climate governance capacities in the Zwolle project. However, due to the Zwolle case being an innovation project, the need for unlocking capacity is limited in its current form and part of the orchestrating capacity cannot be assessed as there is no participatory process developed. Similar to the Noordwaard case, multiple enablers are identified for each capacity. The factors contributing to each capacity are elaborated on in this section. Table 7 presents the main strengths and weaknesses of each capacity within the Noordwaard project.

Table 7: Evaluation of the process indicators for the flood-resilient landscapes project in Zwolle.

Transformative climate governance capacity	Strong (+) and weak (-) points
Stewarding capacity	+ A wide range of topics and its future development is analysed - Not all topics are studied thoroughly, because it is an innovation project
Unlocking capacity	+ The use of adaptation pathways ensures lock-ins are recognised *Note: Because the Zwolle case is an innovation project, resistance is minimal. As a result, unlocking capacity cannot be fully evaluated.*
Innovating capacity	+ System-level approach enables novel solutions combining water safety with other challenges
Orchestrating capacity	+ Organisations from different sectors are involved - Project is not prioritised by individuals, leading to absentees and personnel changes - No participation process developed

Stewarding capacity
The main enabler for stewarding capacity based on the interview respondents is generating knowledge. In the flood-resilient landscapes project a broad range of knowledge is collected. This not only includes flood safety, drought and spatial quality, but also cultural history and how the area could develop culturally in the future (F9). An analysis is made of the entire area, including the impact of climate change and analyses of possible effects on interventions in other areas (F12). A Deltares employee states that because of the extensive consideration of multiple issues like water safety and spatial quality, the people involved can learn about other work fields (F10). In addition, another respondent states the flood-resilient landscapes approach widens the scope, leading to a more diverse range of solutions being considered (F8). However, multiple respondents note that because this is an innovation project, not all topics are studied thoroughly (F8, F9 and F10) and more elaborate research should be conducted if the flood-resilient landscapes approach is to be implemented in a project that will be realised (F9 and F10).

A perceived weak point with regard to the stewarding capacity in the flood-resilient landscapes innovation project mentioned by one of the respondents is that not all involved parties are well represented. The respondent explains that because of this, not all available knowledge is shared with the flood-resilient landscapes project (F8). The respondent suggests this might be, because it is an innovation project which could cause people to prioritise other work (F8). Two other respondents note that the retention of knowledge too could be improved. Currently, knowledge is not always documented well which can lead to the loss of information (F9 and F11).

Unlocking capacity
Based on the responses of the interview participants, breaking open resistance to change can be considered the most important enabler for unlocking capacity in the Zwolle case. Because the project currently is an innovation project focussed on developing the methodology, there currently is little resistance surrounding the project. However, multiple respondents expect resistance to increase if the project has the goal for the design to be implemented (F7, F8, F9 and F12). Multiple respondents state a strong case and a good explanation is necessary to convince people that a methodology like flood-resilient landscapes is the right way to go (F7 and F12). Otherwise, this might lead to a significant amount of resistance (F7 and F12). One of these respondents further explains a good method to achieve change is to make gradual changes as this helps people to get adjusted to new developments (F7). Another respondent states a second method is showing people how things have changed over time in the past which proves change is of all times (F9). This is applied in the flood-resilient landscapes approach as part of the knowledge generation. A feel of urgency is also noted as a contributor to lowered resistance (F12). The respondent states a new disaster might be necessary before people realise change is necessary (F12). Until then, it might not be possible for flood-resilient landscapes to be applied (F12).

The interview respondents also stress the need for unlocking capacity by being able to break open resistance to change. Multiple respondents state current norms on flood protection in the Netherlands make it difficult to implement measures beyond the use of dikes, because it is based on current practices (F7 and F11). However, two respondents state it is necessary to take other measures as for example heavy rainfall is a threat too which requires different measures (F7 and F12). One of the respondents further explains that currently, the national government does not seem to be open to implementing measures that utilise larger areas (F7). This is seen as a missed opportunity, because a one-dimensional problem definition hinders the possibility to find cross-sectoral solutions. The respondent elaborates that in the current way of working, regional governments regularly view each other's issues as hindrances. Instead, these governments should aim to combine objectives and view it as a chance to find an integral solution (F11). Furthermore, another respondent states that a broader perspective is required to achieve a spatial approach to protecting from floods (F7).

In addition to breaking open resistance to change, revealing drivers of unsustainable practices is also stated as an enabler for the unlocking capacity. Multiple respondents explain the consideration of alternative pathways in the flood-resilient landscapes approach reveals possible lock-ins which makes it possible to avoid them (F9 and F12). This includes pathways to the designs created using the different narratives and intermediate designs or interventions. Furthermore, two respondents state it is also good to focus on comparing interventions with a scenario in which everything stays the same (F7 and F9). This can be used to show doing nothing is problematic and doing something is better than doing nothing (F7).

Innovating capacity

The first enabler for innovating capacity is enabling novelty creation. Based on the responses, this can be considered an enabler in the Zwolle project as well. Three respondents state that the concept of flood-resilient landscapes itself is innovative (F7, F8 and F10). The current setup of the project is aimed at innovation as it was initiated in the context of a multi-project plan with the idea of developing the methodology (F9). This innovation project has gradually emphasised different forms of governance (F9 and F12), because multiple people involved in it noticed the importance of this (F9 and F12). This is an example of having the freedom to explore innovative ideas in the project. A respondent explains the involvement of knowledge institutions further aids innovation as they might have better insight into new developments (F8). Moreover, the respondent states they help the project organisation have a broader view (F8). Another aspect enabling novelty creation is the influence of attitude and qualities of individuals. Two respondents state that at innovation is driven by creative individuals (F7 and F11) who are motivated to innovate (F11) and capable of doing so (F11). People in the flood-resilient landscapes project are selected in part for this reason (F11).

Multiple respondents also discuss the enabler anchoring novelty in context. For innovation to become mainstream, it should be spread to other organisations. A respondent explains this can be done by going to congresses and meetings both within the water management sector and in other sectors (F7). Furthermore, the respondent states that within governmental bodies like water authorities and municipalities knowledge should be spread to establish the knowledge gained during the innovation project (F12). A respondent notes that people, even within the work field, do often not understand what it really means to apply a spatial approach to flood safety (F10). People might think it is already done as the area surrounding a dike is considered in projects, but this is different to utilising an entire region (F10). Two respondents suggest that with the integrated approach used in flood-resilient landscapes it is possible to find opportunities to make smart combinations of interventions to tackle multiple problems in an area (F10 and F11). Despite the increased complexity, it is expected to still be worth the opportunities it provides (F11).

As opposed to small-scale technical innovations, flood-resilient landscapes focusses on system-level change, which is perceived as necessary in the context of a changing climate (F7). A respondent notes it is difficult to implement innovation when a project is already ongoing (F11). Therefore, the respondent suggests possibility of innovating should be considered before the start of a project.

Orchestrating capacity

The enabler mediating across scales and sectors has significant impact on the orchestrating capacity in the Zwolle case. There have been multiple changes in the people involved from the participating parties, in addition to multiple changes in the project manager. A respondent states this has made it more difficult to maintain support within organisations (F9). As the project progresses, the design becomes more concrete. According to the same respondent, this should make it easier to get people involved, but it could also lead to more resistance (F9).

According to respondents, the importance of mediating across scales and sectors is further emphasised by the spatial component of the project. The project manager states that the difference between projects on a line element such as a dike reinforcement and projects concerning an area is the degree of collaboration required between different sectors (F12). The project manager further adds that in a dike reinforcement project, small opportunities might be included if they present themselves, but in a spatial project the scope is as broad as possible to include all kinds of challenges (F12). A respondent from the local water authority states there are many different sectors like agriculture, housing and water management that all have challenges and considers it a great opportunity to combine these and find smart solutions (F7). A constraining factor in mediating between local authorities is the fact that a water authority currently is dependent on municipalities to make necessary spatial changes (F12). The project manager suggests it might be necessary to change the governance structure in the Netherlands to give the water authority the power to develop a flood-resilient landscape (F12).

Goals were formulated at the start of the project which, according to the project manager, contributed to the second enabler strategic alignment (F12). Reflection meetings are held to ensure people still share the same goals (F12). However, sometimes it seems not everyone is aware of what exactly the goals are, but only have a global idea (F9). Moreover, the goals have shifted slightly over time (F9).

The third enabler, creating opportunity contexts is also addressed by the interview respondents. Two respondents state one of the most important aspects of the flood-resilient landscapes approach in its current form is for different sectors to be in continuous contact (F10 and B13). They explain knowing of each other's challenges makes it far more likely to discover and utilise opportunities to combine these challenges (F10 and B13). Key to achieving this is to understand each other (F10). A levees advisor from Deltares suggests this can be achieved by investing in how people with other expertise think and learning what jargon they use (F10).

4.2.2. Forward-looking decisions

Future plays a central role in the flood-resilient landscapes approach. As a result, decisions made in the Zwolle project can all be considered forward-looking. According to the interview respondents, decisions made take into account well all four components of forward-looking decisions. An overview of the strengths and weaknesses with regard to the four forward-looking decision components is shown in Table 8.

Table 8: Evaluation of the output of the flood-resilient landscapes project in Zwolle.

Forward-looking decision criterion	Strong (+) and weak (-) points
Forward-looking problem	+ Challenges for a wide range of issues up to 100 years in the future is addressed
Robustness	+ The different alternatives will be tested for high flood safety norms
Flexibility	+ The spatial system-level approach allows for a wide range of possible solutions + Adaptation pathways are used for the next 100 years
Forward-looking justification	+ Narratives for the future are used to develop alternatives

Forward-looking problem

The problem statement in the Zwolle project is considered forward-looking by all respondents. As part of the methodology, the area is designed using multiple narratives for the future (F8). Because of this, the future is considered an inherent part of the design process (F8). In the problem statement the final designs, including the pathways, look ahead 100 years into the future (F9 and F11). Multiple respondents state this does not only include water safety, but also other climate change-related challenges and social issues like population growth (F9, F10 and F11).

Robustness

Because there is no final design in the Zwolle case, it is difficult to say how robust the final design will be (F8). A respondent states this also depends on which narrative will be chosen (F8). Another respondent explains that if robustness is defined as the three aspects of flood resilience, each narrative takes this into account well (F9). The balance between the three aspects differs per narrative (F9). In addition, another respondent explains the robustness differs per location in the region as an urban could be protected in a different way than a rural area (F10). Overall, flood-resilient landscapes are considered more robust by two of the respondents than how society currently approaches flood safety (F8 and F11). This is mostly because these respondents expect flood-resilient landscapes are better prepared for floods if they do occur (F8 and F11). Moreover, a respondent elaborates that flood-resilient landscapes focusses on the robustness of different types of infrastructure regarding climate change. This includes among others energy, food supply and transport (F10).

Flexibility

All respondents state that flexibility is considered well in the Zwolle project. Multiple respondents explain that by applying spatial measures for flood safety the system becomes more flexible as it is possible to invest in different types of measures (F7, F8 and F11). One of the respondents further adds that it makes the area less reliant on the national flood safety measures (F11). Another interview respondent is of the opinion that flexibility important, because new knowledge might present itself, requiring a change of course (F10). Because adaptation pathways are used in the flood-resilient landscapes approach, flexibility can be incorporated into the long-term planning of the area (F9 and F10). One of the respondents explains that, similar to robustness, flexibility can differ per narrative and area within a flood-resilient landscape (F8).

Forward-looking justification

The forward-looking justification is integrated into the methodology of flood-resilient landscapes. Narratives for the future are formulated to develop design alternatives (de Leeuw et al., 2022). One of the interview respondents states future challenges are seen as a major part of the problem statement as topics like climate change and population growth are all taken into account in the flood-resilient landscapes approach (F9). As a result, system-based decisions can be made. Another respondent states explains this allows for creating synergies and avoiding trade-offs (F7). An example is housing. If flood safety is not considered a large neighbourhood could be built in a location that is difficult to protect from floods in the future. Furthermore, the project manager stresses the importance of linking decisions to goals for the future (F12). It is seen as important that once a goal is set, the government sticks to that goal (F12). The project manager suggest that otherwise, it could result in a failed project similar to Lelystad Airport (F12).

As part of the flood-resilient landscapes innovation project, research is done on how to evaluate which alternative is best (F9). Instead of using traditional metrics like efficiency, values like sustainability are used instead (F9). A respondent states this causes designs to be evaluated based in part on the needs of the next generations (F9). Therefore, evaluating based on values like sustainability should lead to a more forward-looking justification.

4.2.3. Influence of transformative governance capacities on forward-looking decisions

Stewarding capacity has a large influence on forward-looking decisions, as is shown in Figure 9. With one exception every respondent states generating knowledge to get insight into the problem in the first place. This explains the high influence of stewarding capacity on a forward-looking problem. For the influence of stewarding capacity on robustness and flexibility the interview respondents give similar answers. For both criteria, stewarding capacity is necessary to apply knowledge to achieve a robust and flexible design. The respondents have opposing views on the influence of stewarding capacity on forward-looking justification. One explanation is that stewarding capacity is important, because an understanding of the problem and possible solutions is necessary to justify design choices (F9 and F11). On the other hand, if viewed as a political issue, justification can be based on the desires of voters. In that case, stewarding capacity has little influence on forward-looking justification (F10).

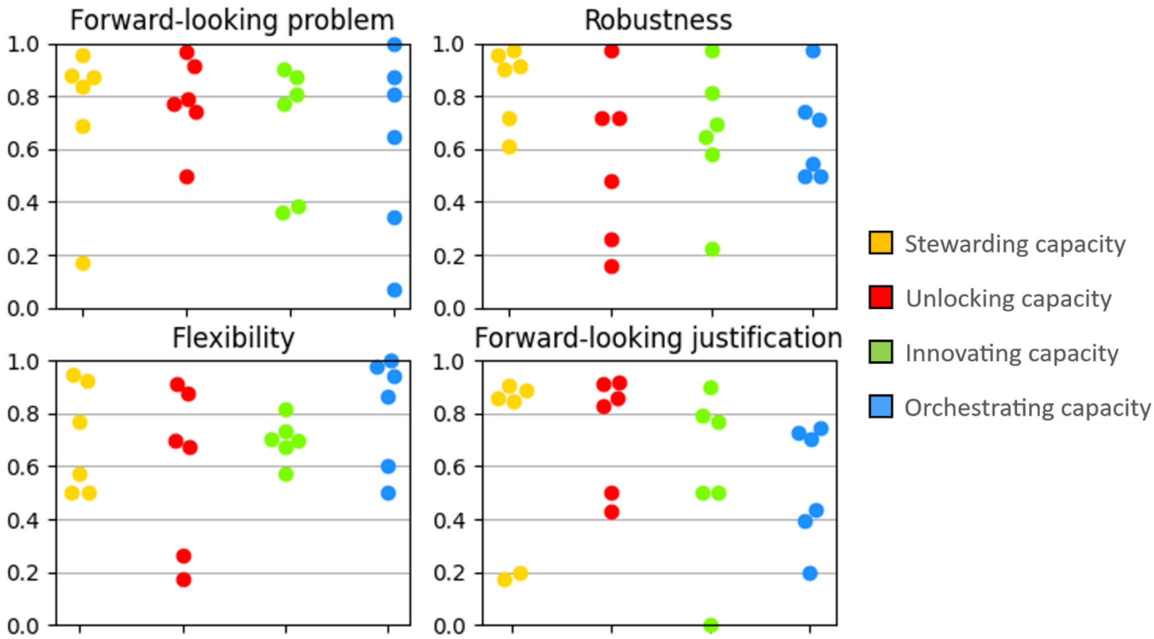

Figure 9: Influence of transformative climate governance capacities on forward-looking decisions according to the interview respondents for the flood-resilient landscapes project in Zwolle.

The influence of unlocking capacity differs between the four criteria for forward-looking decisions. For a forward-looking problem and justification, the unlocking capacity is rated higher overall. The importance of a forward-looking problem is rooted mainly in politics. Politicians must support a forward-looking problem statement. Otherwise, it will simply be rejected. For a forward-looking justification, a change in attitude by society towards future problems in general is mentioned as a major factor in the justification of a future-oriented design. The influence on robustness depends on the interpretation of robustness. When interpreted as being able to keep out water, the unlocking capacity has little influence as this is current practice. However, unlocking capacity has a larger influence if robustness is interpreted as a multi-layered safety approach, because this requires a change in approach.

According to four respondents, innovating capacity is an important factor since a change of approach is necessary. Similar to the unlocking capacity, the definition of robustness influences the rating. For common practices, no innovation is necessary, while for spatial approaches the influence of innovating capacity is large. The respondents give varying reasons for ranking the influence of innovating capacity on a forward-looking justification. It can be considered not so influential, because it is not about innovation, but about applying existing knowledge (F7). However, its influence also depends on the applied methodology for a project. A respondent states that if the approach requires innovation it has a larger influence compared to an approach that is based on common practices (F8). An example of this is the adaptation pathways, which is a relatively new concept. Another respondent states innovating capacity is necessary to successfully implement adaptation pathways, which is a major contributor to the flexibility of the area (F9).

There is a large spread in the rating of the influence of orchestrating capacity on a forward-looking problem statement, ranging from cooperation being a key factor to little influence, because a problem statement can also be created without cooperation. Figure 9 suggests the orchestrating capacity has a significant to very large influence on both robustness and flexibility. For a forward-looking justification, orchestrating capacity also is perceived to have a significant influence, albeit to a lesser degree compared to the other forward-looking decision criteria. The influence is mostly attributed to forming shared goals.

4.3. Synthesis

4.3.1. Transformative climate governance capacities

In both case studies, the interview respondents recognise the presence of all four transformative climate governance capacities. The main enablers for stewarding capacity are considered generating and sharing knowledge. In both projects, design sessions are part of the process. These sessions appear to stimulate knowledge sharing as it brings together the stakeholders from different sectors. In the Noordwaard project, alternatives were tested for feasibility. The interview respondents state that this was an important tool in making design choices. A possible pitfall which is mentioned for both projects is the lack of a consistent project team. In the Noordwaard case, a respondent mentions changes in stakeholder managers as a cause of knowledge loss. In the Zwolle case, a similar trend is visible. Multiple respondents state the lack of consistent presence of all involved parties is a reason why not all knowledge is shared in the project and within participating organisations. Therefore, it is important to avoid this pitfall.

In the flood-resilient landscapes project the unlocking capacity, or more specifically, managing resistance has not been considered yet. In that regard, the flood-resilient landscapes approach can learn three main lessons from the Noordwaard project. First, a sense of urgency has a large influence on the feasibility of a project. In the case of the Room for the River program, this was achieved through an external factor, namely the highwaters of 1993 and 1995. Second, the serious consideration of the needs and wishes of stakeholders led to reduced resistance as people felt they were taken seriously. Third, the Noordwaard received a substantial amount of resources to complete the project. This enabled the program management to make local investments and give additional support to regional governments.

The project in the Noordwaard primarily enabled innovation through the double objective of improving both flood safety and spatial quality. The spatial design component required different flood safety measures to achieve both goals. As spatial quality is also embedded in the flood-resilient landscapes this too should stimulate implementing novel flood safety measures focussed on also improving spatial quality. Incorporating feedback from local inhabitants and exploring alternative solutions further enabled innovation. The flood-resilient landscapes approach further extends this by aiming for system-level innovation in response to climate change. Rather than focussing primarily on technical changes, it advocates for a fundamental shift in how landscapes are managed by focussing on long-term needs and possibly involving different forms of governance.

The participatory was an important aspect of the orchestrating capacity in the Noordwaard project as respondents state it made stakeholders feel heard and it allowed for design choices to be explained and discussed. This led to increased support among stakeholders. In the Zwolle project, no participation takes or will take place. For future projects applying the flood-resilient landscapes approach, the importance of participation for the orchestrating capacity should not be ignored. On the one hand, this gives it the opportunity to develop a stakeholder involvement process similar to Noordwaard or better. However, if not managed well, stakeholders could become a source of resistance. In both cases strategic alignment is stated as an enabler for orchestrating capacity. Formulating shared goals at the start of the project in both cases led to smoother cooperation and the development of integral solutions. Furthermore, respondents for both cases state the importance of mediating across scales and sectors is an important enabler due to the cross-sectoral approach which is unavoidable in any spatial flood risk management approach. Collaborative sessions like design sessions aid in mediating across scales and sectors by bringing the different organisations together. This gives people the time to understand each other's problems.

4.3.2. Forward-looking decisions

In both case studies, respondents consider the decisions make forward-looking, although the projects have a partly different approach. Both projects have a broad scope in which flood safety and spatial quality are the most important factors. For the Noordwaard, a double objective of achieving both flood safety and spatial quality was set. However, respondents state mostly short-term challenges are addressed, with the exception of flood safety measures. The flood-resilient landscapes approach has a broad forward-looking problem statement. It considers a wide variety of long-term challenges and considers them explicitly through the use of narratives for the future.

In both case studies interview respondents state that robustness is achieved through a multi-layered spatial flood safety approach. In the Noordwaard, preliminary designs are tested using the planning kit, in addition to thorough testing of the final design. Based on these tests, the design can be considered robust. If a design was to be implemented in the Zwolle case, this too would be tested using hydraulic models, as is required in the Netherlands.

The two projects have a different approach to flexibility. For the Noordwaard, space is left open to enable possible future interventions if necessary. However, no future options are explicitly explored. In the flood-resilient landscapes approach, flexibility plays a larger role through the use of adaptation pathways. This gives decision-makers insight into the consequences of selecting interventions, enabling them to avoid undesirable path-dependencies.

For the Noordwaard, no long-term vision for the future is made. Instead, similar to the forward-looking problem, the forward-looking justification is limited to flood safety issues. For the Zwolle case respondents state that the long-term vision plays a major role as the design process is guided by three alternative visions for the future. Due to the explicit consideration of what the future may look like, all decisions have a forward-looking justification.

4.3.3. Influence of transformative governance capacities on forward-looking decisions

In both case studies, knowledge of future developments and challenges is the main reason why stewarding capacity is perceived as important for a forward-looking problem and a forward-looking justification. For robustness and flexibility, the stewarding capacity is regarded as important, because technical knowledge is necessary to create a robust and flexible area. There are no major differences between the two case studies with regard to the influence of stewarding capacity on forward-looking decisions.

Because in both case studies an approach which differs from traditional practices is applied, both experience additional resistance. As a result, the unlocking capacity is perceived to be important in both cases. Apart from this similarity, it is not possible to adequately compare the two cases, because the Zwolle case study as an innovation project will not face resistance which is characteristic of a project that is to be implemented.

Both respondents from the Noordwaard and Zwolle case study state innovating capacity is an important factor in achieving forward-looking decisions, because innovation is required to develop and implement an innovative project design. In the Noordwaard project, innovating capacity is also considered important in the development of robust and flexible physical solutions. For the Zwolle project, this will depend on the type of solutions which will predominantly be implemented. For spatial measures, innovation is considered important and valued highly for robustness and flexibility.

In both case studies a large spread in the ranking of the influence of orchestrating capacity on a forward-looking problem can be identified. In the Noordwaard project, this is caused by the different stakeholder interactions that are considered by the interview respondents. In both projects, the cooperation between the few actors active in the problem definition phase is considered an important factor in realising a forward-looking problem definition. The interaction between the project organisation and local stakeholders was an important contributor to robustness and to a lesser degree flexibility. In the Zwolle project this is still an unknown.

5. Discussion

This chapter reflects upon the key findings of this research. In addition, a reflection on the methods and approach is elaborated on.

5.1. Reflection on key findings

Stewarding capacity can be considered a key factor in achieving future flood resilience, because it is necessary to understand the system and how it will develop over time adequately address future challenges. Otherwise, making forward-looking decisions and achieving flood resilience is not possible. The importance of unlocking capacity is mostly expressed as the willingness of people and organisations to change standard practice. This can be stimulated with investments and stakeholder management. However, this is no guarantee for a transition to be successful. A major driver for the realisation of Room for the River and therefore the project in the Noordwaard is the highwaters of 1993 and 1995. A (near) national disaster created a sense of urgency among the public and institutions to take action. Such a shock event might be required for the Dutch government to invest in projects accelerating a transition towards climate-resilient flood risk management. This is in line with literature as major flood disasters have acted as drivers for changing flood risk management policies (Mauch, 2009) and extreme weather events in general direct the attention of politics to long-term problems (Pot, 2020). However, the presence of transformative climate governance capacities improves the response to shock events like a highwater. The identification of unsustainable practices and a vision on improved standards in flood risk management enables the preparation for a paradigm shift when a shock event does occur. From the interviews it becomes apparent that innovating capacity is required to develop and improve spatial flood risk management approaches and spread these innovations. In literature this is comparable to the pre-development and take-off stage of a transition in which in novelties are created and shared (Rotmans et al., 2000). Because both study cases are part of these stages of a transition, the necessity for innovating capacity as stated by the interview respondents are in line with literature. For the orchestrating capacity, creating and pursuing shared goals is recognised as important in a multi-disciplinary project like a spatial approach to flood risk management. This increases support for the final product and leads to integral solutions in which solutions to multiple challenges are addressed. Literature too states that formulating shared goals lead to increased support (Krywkow, 2009; Pahl-Wostl et al., 2007).

In the Noordwaard project, the forward-looking problem was limited to flood safety issues while for the flood-resilient landscapes project this is an inherent part of the design process. Robustness is regarded by the interview respondents of both projects as 'normal' in any flood risk management project in the Netherlands. This stems from the technocratic-scientific approach that was dominant in the last century (Lintsen, 2002). As a result, any project will only be approved if it is robust. The use of a spatial flood risk management approach in itself contributes to flexibility. In addition, interview respondents for the flood-resilient landscapes project state flexibility is achieved through the use of adaptation pathways. This is in line with adaptation pathways literature (e.g. Haasnoot et al., 2013; Hanger-Kopp et al., 2022; Werners et al., 2021). In the Noordwaard project, flexibility was limited to avoiding path-dependencies and lock-ins. This too contributes to flexibility according to literature (Haasnoot et al., 2013). Similar to the forward-looking problem, the flood-resilient landscapes project uses the forward-looking justification as a starting point in its methodology. Similar to the responses to robustness, respondents of both projects consider the use of (extreme) scenarios for the future standard practice in the Netherlands for any flood risk management project..

Based on the results of the interviews it can be concluded that transformative climate governance capacities have a significant influence on forward-looking decisions. However, apart from this relationship, transformative climate governance capacities also influence each other. From the results of the evaluation of the Noordwaard case study, it becomes apparent that the orchestrating capacity influences the unlocking capacity. Investing in collaboration with stakeholders resulted in reduced resistance against changes in the Noordwaard, which is expected based on literature (Krywkow, 2009; Pahl-Wostl et al., 2007). Similarly, orchestrating capacity is mentioned as an important factor to break open resistance to change. Next to this, orchestrating capacity improves innovating capacity and stewarding capacity through knowledge sharing and cooperation in innovation. This can be expected based on social learning theory which states social learning leads to the acquisition of knowledge and restructuring of existing knowledge (Baird et al., 2014). In addition to transformative climate governance capacities influencing each other, criteria for forward-looking decisions can also influence transformative climate governance capacities. An example of this is the influence of a forward-looking problem on innovating capacity during a project. A forward-looking problem is important to achieve innovation later in the project, as the methodology used in a project determines to what degree innovation is possible (F9). Based on these findings, the evaluation framework could be expanded by adding additional relationship indicators between and within the process and output.

The flood-resilient landscapes project in Zwolle is an innovation project. The goal of the project is to learn about how to improve the methodology. As a result, not all important aspects are included, because they are not in the scope of the project. Therefore, some key aspects such as stakeholder involvement are not included in the process on purpose. On the one hand, this means the focus on orchestrating capacity will be significantly improved compared to the current way of working, but it also causes uncertainty as no exact process is formed and potential hurdles are not discovered and taken into account yet. Next to this, the difference in project progress can lead to different responses. For example, the unlocking capacity is perceived differently between the two projects. In the Noordwaard, the project is finished and throughout the project the resistance was perceived as low while for the flood-resilient landscapes project one can only speculate how much resistance there would be if the methodology would be implemented. This speculation leads to a more negative prospect of the amount of resistance the project would face, resulting in the perceived need for unlocking capacity.

the influence of the process and output on the ultimate outcome in both case studies cannot be studied yet, because the ultimate outcome is still partly unknown. Therefore, in the interviews, the influence of the process and output on the ultimate outcome were not discussed. Despite this, multiple indicators for flood resilience can already be identified. First of all, stewarding capacity is important in achieving all three abilities for flood resilience. Recognising future challenges is the essential first step to addressing the abilities for flood resilience. Furthermore, the other three capacities for transformative climate governance can also be linked to the ability to transform and adapt. This is because the transformative climate governance and the ability have a comparable focus. The innovating capacity can be recognised as a contributor to the ability to transform and adapt, because part of the ability to transform and adapt is to “adopt new approaches and perspectives” (Hegger et al., 2016, p. 4). The unlocking capacity and orchestrating capacity too are contributors to the ability to transform and adapt by facilitating the right governance context for change. Similar to the stewarding capacity, a forward-looking problem is required to recognising the need for changes to timely implement adequate measures. The robustness criterion for forward-looking decisions can be related to the capacity to resist in the operationalisation of flood resilience by Hegger et al. (2016). In addition, some interview respondents have considered robustness as multi-layered flood safety. If this interpretation is used, robustness can also be linked to the ability to absorb and recover. This is because spatial measures are aimed at absorbing the impact of floods in case they do occur.

5.2. Reflection on methods and approach

The evaluation framework for flood resilience is based on assumptions derived from literature. The overall design of the framework with two different indicators for flood resilience is satisfactory. On a more detailed level, improvements can be made to the evaluation framework. First of all, the influence of transformative climate governance capacities on each other can be added. During the interviews it became apparent that relationships within the process exist. A literature research could be conducted to explore which relationships between the capacities can be expected and these could be tested by doing a case study evaluating these relationships. In addition, the importance of capacities could differ over time. The addition of a time component in the evaluation framework could lead to a more detailed evaluation. The same is the case for forward-looking decisions. The components of a forward-looking decision appear to have an influence on each other and too can be added to the framework. A last improvement can be made by indicating the degree to which a component or subcomponent has an influence. Currently, merely the presence of an influence is indicated without an indication of which relationship is more prevalent. This addition could give insight into what parts of the process and outcome should be prioritised to effectively and efficiently contribute to the ultimate outcome.

The use of the evaluation framework for flood resilience can be applied to both completed and ongoing projects. The main reason why parts of the Zwolle case study could not be evaluated is because it is an innovation project. Some parts which are typical of any spatial flood risk management project are not conducted in the Zwolle project. However, some information for the evaluation might be limited or missing if the project is still in the early stages. A full evaluation is expected to be possible once the design phase is completed.

In this research, two data collection methods were applied. The use of multiple data sources made it possible to confirm the findings of one data collection method with another. This improved the internal validity of the research (Yin, 2014). Furthermore, the use of long semi-structured interviews as a method of gathering data resulted in a rich and detailed data set, including the reasoning of the opinions of respondents. In addition, where necessary, additional information could be asked for where necessary, which led to more relevant, nuanced and detailed information. As an extra validation step, the interpretations of the interviews used in the thesis were shared with the interview respondents for feedback. As a result, the data and its interpretations more accurately represented the opinions of the interview respondents.

The selection of interview respondents was based on expertise and the position within the project. To achieve a saturated data set it is necessary to involve interview respondents such that the full project is covered in terms of specialties, organisations represented and different phases in the project. For the Noordwaard study case, the saturation could be improved by interviewing a local inhabitant, living in the Noordwaard at the time of the project. This gives additional insight into the participatory process from a new perspective. In addition, a spatial design specialist could be interviewed to further improve saturation. In the Zwolle study case, all relevant specialities and each phase of the project was included. A slight improvement could possibly be made by interviewing a person from the involved architectural firm. For the Zwolle case it is not possible to interview a local inhabitant, because no participation process is conducted in this project and no changes are made to the study area.

The evaluation method applied in this research can be extended by organising a focus group with the interview respondents after the results are processed. By presenting the results to the focus group and giving room for discussion, the interview respondents themselves can formulate conclusions instead of the researcher. In addition, the respondents are given additional insight from each other. As a consequence, respondents might change the scores given, narrowing the bandwidth of the data points in each influence graph. This leads to more accurate results.

The orchestrating capacity includes a wide variety of different relationships with stakeholders, government agencies and NGOs. As a result, respondents gave responses on many different types of cooperation. Because all four transformative climate governance capacities were given equal attention in this research, the depth to which each type of relationship is researched is limited given the many components the orchestrating capacity consists of. Moreover, it can be disputed whether all four capacities for transformative climate governance should receive equal attention when applying the evaluation framework for flood resilience. Based on the results of this research it can be argued that, depending on the context of a project, the four capacities are not equally important. For example, the extensive participatory process and emphasis in cooperation in the Noordwaard project causes the orchestrating capacity to be more important for the project as a whole, while the innovating capacity only has an influence on a small part of the project.

As this research is focused on the Dutch water management context, the conclusions cannot be extended without reviewing the differences in the governance structure of the country. Moreover, cultural differences could have a major impact on the presence and effects of transformative climate governance capacities.

6. Conclusions and Recommendations

In the first section of this chapter, conclusions are stated for each research question. This is followed by the second section in which recommendations are made for practice and further research.

6.1. Conclusions

This research aimed to evaluate and formulate recommendations for improving the process and output of spatial flood risk management approaches with regard to flood resilience. To achieve this aim, four research questions were formulated that are answered in this section.

RQ1: According to literature, how to evaluate the extent to which spatial flood risk management approaches contribute to flood resilience?

Flood resilience can only be measured after a long time period, because it is an ultimate outcome of a project. Therefore, indicators for flood resilience were analysed instead. This was done through the evaluation of the process and output of a project. Through an extensive literature review, indicators for process and immediate outcomes were researched, leading to the use of two concepts: forward-looking decisions and capacities for transformative climate governance. Forward-looking decisions by Pot et al. (2018) were evaluated to analyse the output of a project. The evaluation of forward-looking decisions included the problem definition, the implemented design and the overall vision justifying design choices. Furthermore, the governance context of a project was evaluated to get insight into the process of a project. This was done using capacities for transformative climate governance proposed by Hölscher et al. (2019). Along the four capacities (stewarding capacity, unlocking capacity, innovating capacity and orchestrating capacity) it was evaluated whether the governance in projects stimulated systemic change in climate adaptation.

RQ2: In the selected spatial approaches, how are transformative climate governance capacities and forward-looking decisions reflected in spatial flood risk management approaches?

The Noordwaard project stimulated innovative spatial flood safety measures by having a double objective in the problem definition. This combines flood safety with spatial quality, leading to spatial solutions addressing both objectives. In the flood-resilient landscapes project in Zwolle a system-based approach is applied to achieve flood safety while improving the quality of living in the area. A strong aspect in the depoldering of the Noordwaard was the orchestrating capacity. Not only was there good cooperation between governmental bodies and NGOs, but the participation process was also considered a major factor in the success of the project. In the Zwolle project local stakeholders are not involved. As the flood-resilient landscapes approach is not fully developed it is not yet clear how strongly the four capacities will be present in such projects. When evaluating forward-looking decisions it becomes apparent that the flood-resilient landscapes project researches and designs for objectives and challenges further in the future and both designs achieve robustness through a multi-layered safety approach. Flexibility is achieved in the Noordwaard by having a strategic outlook into the future and leaving space for additional measures. In Zwolle, adaptation pathways are designed to achieve a high level of flexibility for the upcoming 100 years. The forward-looking justification of the Noordwaard was limited to flood safety in the short and medium term while improving spatial quality. The flood-resilient landscapes project in Zwolle applies different visions for the future as a starting point. As a consequence, the forward-looking justification is a major focus of the methodology.

RQ3: To what extent do transformative climate governance capacities influence forward-looking decisions?

Stewarding capacity is perceived as having a large influence on all four criteria for a forward-looking decision. Knowledge is necessary to understand the problem and to create a robust and flexible design. Respondents state that the unlocking capacity is mostly important to obtain endorsement in politics which explains the perceived high influence of the unlocking capacity on a forward-looking problem. Furthermore, the unlocking capacity is important to be able to apply non-standard solutions contributing to robustness and flexibility. The influence of innovating capacity on forward-looking decisions is contested. The main factor in determining the influence is whether innovation is necessary in a certain project. Innovation is not a requirement, but can aid substantially in achieving forward-looking decisions. Orchestrating capacity has limited influence on a forward-looking problem, because the quality of cooperation has limited influence on how forward-looking a problem statement is. Orchestrating capacity has a significant to very large influence on both robustness and flexibility. For a forward-looking justification, orchestrating capacity also has a significant influence, albeit to a lesser degree compared to the other forward-looking decision criteria. The influence is mostly attributed to forming shared goals.

RQ4: What can be learned from this research to improve spatial flood risk management approaches to enhance flood resilience?

All four capacities for transformative climate governance are important to realise a transition towards a flood risk management strategy which incorporates flood resilience. The development and extensive sharing of knowledge, which is part of the stewarding capacity, is crucial in developing flood-resilient designs. In the first place, knowledge of the study area and how it could change over time needs to be collected to get an understanding of the challenges at hand. Next to this, knowledge is important to come to well-considered decisions. In the Noordwaard project, the planning kit (Dutch: Blokkendoos) is used. By supplying quantitative information on the effects of different measures, the decision-making process is improved. Another example is the use of adaptation pathways in the Zwolle project. By researching the implications of decisions, potential path-dependencies can be avoided.

Early investments in addressing the unlocking capacity are important to successfully complete a project. In the Noordwaard case, preparations are undertaken and investments are made to increase the chance of the successful completion of the project. For example, the development of the planning kit and the investment in the participatory process led to better communication and reduced resistance. This not only increased the chance of successful project completion, but it also avoided legal costs in later phases of the project. In addition, speculating about possible sources of resistance is important to recognise what measures can be taken to reduce or avoid resistance, but the prospect of having to deal with resistance should not be a reason to cancel a project altogether. In the Zwolle case the expected resistance is high while in the Noordwaard case resistance was considered low due to the approach to dealing with possible sources of resistance. This shows that resistance is something that needs to be addressed, but if considered well it should not be a reason to cancel projects. This also applies to projects which apply the flood-resilient landscapes approach.

When applying a spatial flood risk management approach, a well-organised participatory process is crucial. In the Noordwaard case, the participatory process applied is identified as a major contributor to its success. The serious consideration of the needs and wishes of stakeholders led to reduced resistance as people felt they were taken seriously. In the Zwolle case study no participatory process has taken place, but all interview respondents acknowledge the possibility of stakeholders being a possible source of resistance against the project. A future flood-resilient landscapes project could use the process applied in the Noordwaard project as a basis for creating a good participatory process.

Good collaboration between the participating stakeholders in the project leads to more integral solutions. Working together with people from different sectors makes it possible to share knowledge and get an understanding of each other's challenges. As a result, collaboration can give rise to solutions which address problems in multiple sectors which would otherwise not be considered. Moreover, understanding the problems in other sectors reduces the chance of an intervention negatively impacting others.

6.2. Recommendations for practice

In order for the Netherlands to become more flood resilient, spatial measures for flood risk management need to be considered. Current practice is mainly focussed on preventing floods while the capacity to absorb and recover can only be achieved through spatial measures. This requires a governance context which is open to non-standard solutions. This can be achieved by investing in creating awareness about the possibility of spatial measures and by improving and increasing cooperation between different sectors.

The participatory process is a major contributor to the successful implementation of a project applying a spatial approach to flood risk management. To realise spatial measures for flood safety, local stakeholders will be impacted. This is both a risk and an opportunity. If not managed well, local stakeholders can build up high resistance against change. However, a well-organised participatory process mitigates this. Therefore, the participatory process is an important factor in developing the unlocking capacity. Moreover, participation stimulates innovation through the sharing of local knowledge from stakeholders, leading to an increased innovating capacity. Therefore, it is recommended that in a spatial flood risk management project resources are invested into the participatory process to involve local stakeholders. This can be done by having one or more dedicated stakeholder managers, depending on the scale of the project, which is the contact person for the stakeholders. It is preferable to have the stakeholder manager be the same person during the entire project as building trust between the stakeholder manager and stakeholders takes time.

6.3. Recommendations for future research

To further develop the evaluation framework for flood resilience, additional research should be done to explore relationships between transformative climate governance capacities. The same is the case for the components of forward-looking decisions. In addition, more detailed research on the degree of influence in the evaluation framework can be conducted. This gives valuable insight into what parts of the process and output should be prioritised to effectively and efficiently contribute to flood resilience. Furthermore, the importance of the transformative climate governance capacities changes over time.

To get insight into when each governance capacity is important, the influence of the capacities in different phases of a project should be explored. This can give further information on how to effectively contribute to flood resilience.

Orchestrating capacity includes a wide variety of different relationships with stakeholders, government agencies and NGOs. As a result, different aspects of the orchestrating capacity can have varying impacts. By doing more research on the dynamics between stakeholders in spatial flood risk management approaches a better understanding of the orchestrating capacity and its impact can be uncovered.

The scope of the interviews in this research was on the process and output of a project. The ultimate outcome is not discussed. As a result, the influence of the process and output on the ultimate outcomes in spatial flood risk management approaches remains theoretical. To validate this part of the evaluation framework, more longitudinal research on this relationship should be conducted in the future when the ultimate outcomes become apparent to get insight into the influence of the process and output on the ultimate outcomes.

To further investigate what process indicators and outputs contribute to flood resilience, additional research should be done to understand whether the influence process and output are also relevant and present in other contexts. This research topic can be expanded to other types of projects which are part of a transition and it can be expanded to cases, both in the Netherlands and in other countries.

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Appendix A: Interview protocol

This Appendix presents the interview protocol used during the interviews. In the first part, questions on transformative climate governance capacities are shown. The second part presents the interview questions used to discuss the criteria for forward-looking decisions. Support questions for the third part on the influence of transformative climate governance capacities on forward-looking decisions are listed.

Interview part 1: transformative climate governance capacities

Table 9: Interview questions used for part 1 of the interview.

Capacity	Enablers	Interview questions
Stewarding capacity	Generating knowledge about system dynamics	- In hoeverre is/wordt er kennis opgedaan over het systeem/gebied. En hoe dit mogelijk kan veranderen op de lange termijn? (bijvoorbeeld op ecologisch, economisch en sociaal vlak) - In hoeverre wordt opgedane kennis vastgehouden binnen het project en de organisatie? Op welke manier(en)?
	Monitoring and continuous learning	- In welke mate zijn veranderingen in het gebied gemonitord? En geldt dit ook voor de veranderingen die plaatsvinden onder belanghebbenden?
	Strengthening self-organisation	- In hoeverre is de organisatiestructuur flexibel? In hoeverre stimuleert of belemmert het het reageren op veranderingen?
Innovating capacity	Enabling novelty creation	- Was er binnen het project ruimte voor innovatie? Zo ja, op welke manier(en)?
	Increasing visibility of novelty	- Is er gewerkt aan het creëren van draagvlak van innovatie?
	Anchoring novelty in context	- Welke strategie of strategieën worden/zijn er toegepast om de innovatie te implementeren? - Is er binnen de organisatie aan gewerkt deze strategie vaker toe te passen?
Unlocking capacity	Revealing drivers of unsustainable path-dependencies and mal-adaptation	- In welke mate is er informatie/kennis aanwezig om pad-afhankelijkheden te herkennen en te doorbreken? - In welke mate zijn er systemen om pad-afhankelijkheden te herkennen en te doorbreken?
	Breaking open resistance to change	- In hoeverre is er geprobeerd weerstand tegen verandering te doorbreken? Hoe is dit gedaan?
	Undermining vested interests and incentive structures	- Wat hebben jullie gedaan om belemmeringen te omzeilen en gevestigde belangen te ondermijnen?

Table 9 continued.

Orchestrating capacity	Strategic alignment	- Wat was jou visie voor dit project? Hoe verhoudt dat zich tot die van anderen? - Hoe is er omgegaan met de verschillende visies/doelen van actoren? - Is er gewerkt aan het formuleren van gezamenlijke doelen? Waarom (niet)?
	Mediating across scales and sectors	- In hoeverre is er goed samengewerkt met andere sectoren? En andere overheidslagen? En in verschillende fases van het project? - Ontstonden er conflicten tussen partijen? Hoe is hier mee omgegaan?
	Creating opportunity contexts	- Welke rol spelen meekoppelkansen in dit project? - Is er gewerkt aan het bewust herkennen en gebruik maken van meekoppelkansen? Zo ja, hoe?

Interview part 2: forward-looking decisions

Table 10: Interview questions used for part 2 of the interview.

FLD criterion	Interviewvragen
Forward-looking problem	Is de probleemstelling (deels) gebaseerd op toekomstige uitdagingen en behoeftes? Hoe compleet is de probleemstelling ten opzichte van de aanwezige toekomstige uitdagingen? (welk jaartal? Is dit ver genoeg?) Binnen welke kaders is de probleemstelling geformuleerd? Welke uitgangspunten? Hoe compleet is dit naar jou mening?
Robustness	Zijn er tests uitgevoerd om een of meerdere oplossingen te toetsen? Blijft de oplossing functioneel wanneer het getoetst wordt aan een extreem scenario? Gaan jullie oplossingen toetsen? Hoe?
Flexibility	Kan de oplossing indien nodig aangepast worden in geval van veranderende omstandigheden? Kan de oplossing indien nodig worden aangevuld met andere maatregelen? Wordt het gebied gemonitord? Zo ja, wat is het doel hiervan? Is er nagedacht over een iteratief beslisproces voor de aanpassing van de oplossing? Denk hierbij bijvoorbeeld aan het toepassen van adaptatiepaden.
Forward-looking justification	Is het besluit gekoppeld aan doelen en/of een visie voor de toekomst? Is er gebruik gemaakt van scenario's van de toekomst?

Interview part 3: Influence of transformative climate governance capacities on forward-looking decisions

In the last part of the interview, the influence of transformative climate governance capacities on forward-looking decisions is discussed using stickers and four slider scales. This in itself should spark discussion. If not, several support questions are used to get insight into the thought process. These are presented below.

- Waarom plak je de sticker op die plek?
- Zijn er bepaalde eigenschappen van het project waarom dit verband er in deze mate wel of niet is?
- Op welke positieve en/of negatieve manier(en) heeft dit verband zich geuit in het project?

Appendix B: Code tree

This appendix presents the code tree used in the data analysis of the interviews.

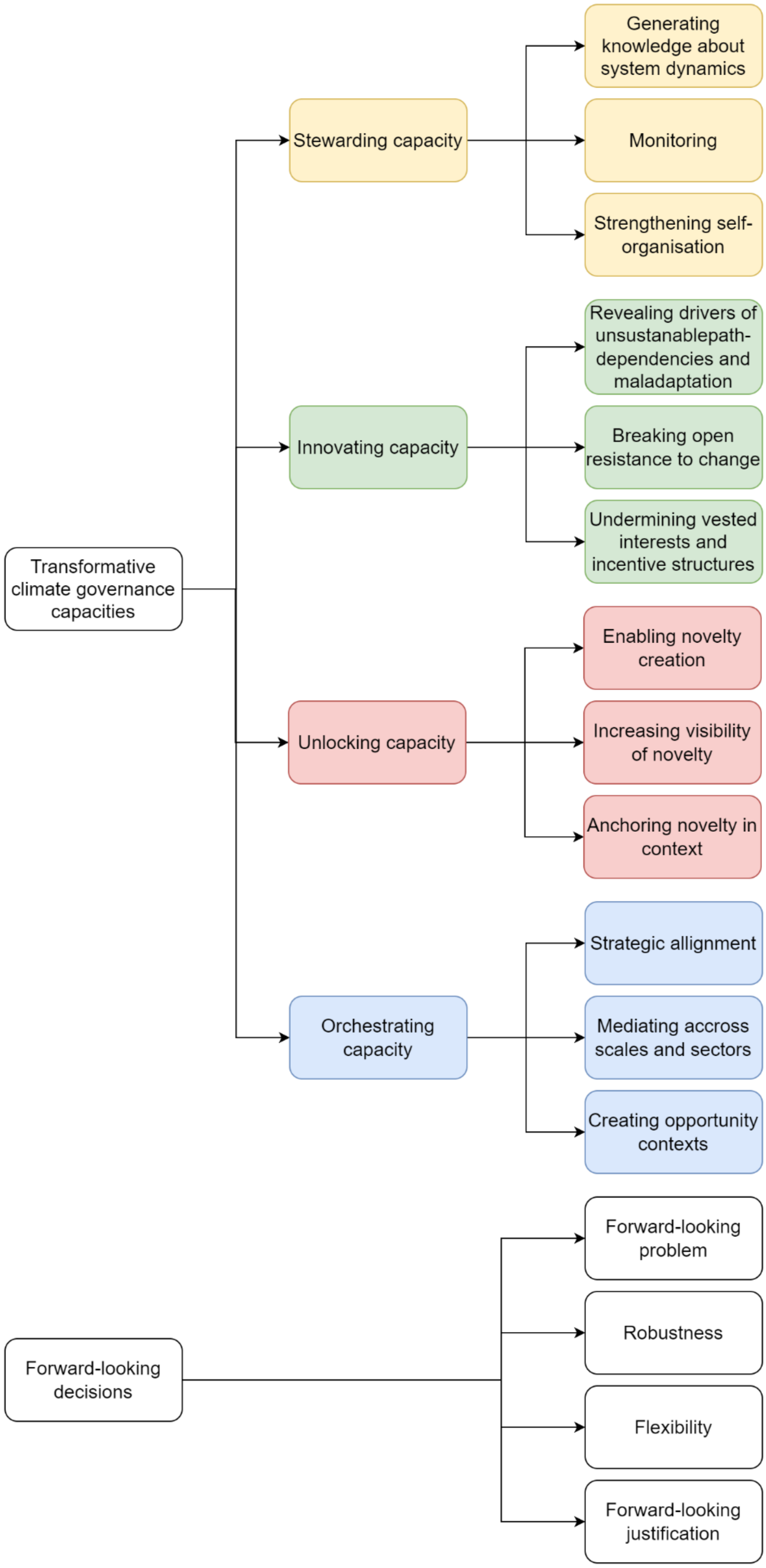

Figure 10: Code tree applied in the data analysis of the interviews.