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The implementation of green/blue infrastructure for flood risk management

Which factors hinder or support the implementation of green/blue infrastructure in flood risk management in the Netherlands

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Summary

In the past centuries, climate change has been on the rise. Burning fossil fuels like oil, coal, and gas is the primary driver of climate change. When fossil fuels are burned, greenhouse gasses are released, which thicken the atmosphere causing the earth to warm up. One of the effects of climate change is the increase in annual discharge in North-Western Europe, which in turn causes increased flood hazards. River floods are among the most damaging climate events. An example is the floods in the summer of 2021 in parts of Belgium, Luxembourg, and the Netherlands, which caused 240 people to lose their lives. These floods were the result of heavy rainfall.

When a country must deal with flood risk, several strategies could be used to reduce this risk. One of these strategies is keeping floods away from urban areas. This can be done through technical measures or spatial measures. Technical measures are traditional human-engineered measures such as dikes and dams and can be referred to as grey infrastructure. Spatial measures consist of more interventions like giving rivers more space by relocating dikes or retention zones. The implementation of green/blue infrastructure to complement grey infrastructure in flood risk management is a more adaptive and sustainable approach to flood risk management as it increases flood resilience through ecological interventions, prioritising biophysical dynamics' functioning and does not require the overuse of natural resources.

However, the Netherlands heavily relies on grey infrastructure, like dikes, in flood risk management. Because of the increase in annual discharge and flood risk, the dikes that protect the Netherlands will have to be strengthened every few years. This is not a sustainable approach to flood risk management as it requires the overuse of natural resources and ongoing maintenance costs. A more adaptive approach to flood risk management is needed. Implementing green/blue infrastructure in flood risk management could be the solution. Green/blue infrastructure has a lot of benefits over grey infrastructure, like increasing biodiversity and carbon sequestration, moderating temperatures, and increasing water infiltration. Despite these benefits, the Netherlands still relies on grey infrastructure, and the widespread implementation of green/blue infrastructure in flood risk management is limited. To find out what factors have caused this, the following research question was put together:

“Which factors hinder or support the implementation of green/blue infrastructure for floods risk management in the Netherlands?”

To answer the research question, the policy arrangement approach was adopted. This approach can help identify barriers that occur in a policy arrangement, such as difficulties in modifying the existing rules, procedures, and practices that may hinder policy changes. It uses four dimensions, actors, rules, resources, and discourses, to analyse policy processes.

This research is a single case study. The case that is studied is the project The Green River Well. This flood risk management project aims to incorporate both green/blue infrastructure and grey infrastructure. The data for this research was collected through semi-structured interviews with four of the five policymakers (actors) involved in the project. This project's policy-making process was analysed using the four dimensions of the policy arrangement approach to determine which factors hinder or support the implementation of green/blue infrastructure in flood risk management.

Based on the results of this research, the following conclusions were drawn:
Most of the factors that hinder the implementation of green/blue infrastructure in the Netherlands have to do with the hydro-engineering discourse being so heavily institutionalised. The main actors in the project The Green River Well are the Ministry of I&W and Water Authority Limburg. These actors have a flood protection task and must strengthen the dikes as their policy says so (because of the institutionalisation of the hydro-engineering discourse). This is a factor that hinders the implementation of green/blue infrastructure. The interest of the Municipality Bergen, Rijkswaterstaat and Province Limburg can be considered factors supporting green/blue infrastructure implementation. These actors attain bargaining positions through their possessions of resources, which gives them influence in the policy-making process despite not being the main actors. The project team of The Green River Well has a lot of knowledge of ecology and biodiversity. In combination with the project team’s positive attitude, this has supported the addition of green/blue infrastructure in the project plans. If project teams have little knowledge of ecology and biodiversity and no positive attitude, this could hinder the implementation of green/blue infrastructure. Because the hydro-engineering discourse is so heavily institutionalised in the Netherlands, the available finances for projects like The Green River Well are only meant for strengthening dikes (grey infrastructure). Some laws prevent the addition of green to projects like The Green River Well but do not prohibit nature from growing freely, limiting the implementation

of green/blue infrastructure to some extent. New discourses on sustainability and integrated approaches seem to be emerging. This shows in the Dutch Government initiating a program that finances the improvement of water quality and nature in flood risk management projects. This program supports the implementation of green/blue infrastructure in the Netherlands. The fact that the government initiates a program to compensate for the adverse effects of dikes might indicate that the dominance of the hydro-engineering discourse in flood risk management in the Netherlands is coming to an end.

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Chapter I Introduction

1.1 Climate Change & Flood Risk

Average air and ocean temperatures are increasing, snow and ice are melting globally, and sea level is rising (I. P. O. C., 2007). The fact that climate change is real cannot be denied anymore. One of the leading causes of climate change is the increase in greenhouse gasses (Fawzy et al., 2020; Hardy, 2003; Hegerl et al., 2019). Anthropogenic sources of greenhouse gasses like carbon dioxide are derived from the (over)use of natural resources in activities like cement manufacturing and fossil fuel combustion (Cassia et al., 2018). In the past centuries, the influence of greenhouse gasses on global warming has been consistent (Hegerl et al., 2019). The atmospheric concentration of carbon dioxide, the main greenhouse gas, over the past 650.000 years went from 180ppm to 300ppm and already significantly exceeded the natural range in 2005 (I. P. O. C., 2007). From 1995 to 2006, eleven of the twelve years of surface temperature rank among the warmest years in the instrumental record since 1850 (I. P. O. C., 2007). More recently, 2020 was the second warmest year for the combined land and ocean temperatures in the 141-year record (Lindsey & Dahlman, 2020).

In the past decades, natural disasters have been on the rise (Thomas, 2017). Recent occurrences of extreme events and climate-related disasters are troubling (Fawzy et al., 2020; Thomas, 2017). Whether the increase of all-natural disasters is caused by climate change is widely discussed. However, Klijn et al. (2012) conclude that climate change does cause an increase in flood hazards. As an example of increasing extreme events, in 2011, Thailand had to deal with a degree of flooding it had not seen before, whilst Russia had to deal with an unprecedented heatwave in 2010 (Thomas, 2017). One of the effects of climate change is sea-level rise, which is threatening cities worldwide (Lindsey, 2019; Nicholls, 2011). In that regard, the Intergovernmental Panel on Climate Change (IPCC) released a report in 2011 stating that the rising sea levels will make coastal cities more vulnerable and that the increase in ‘extreme weather events’ will cost nations billions (Haigh & Amaratunga, 2012). The effects of climate change also cause concern on a smaller scale. Recent climate change scenarios predict a 10% increase in the annual discharge North of the Alps until 2050 (Glaser & Stahl, 2004). Whilst an increase in annual discharge North of the Alps is predicted, hydrological studies (both quantitative and qualitative) indicate that there is no continental-wide flood occurrence trend for the whole of Europe (Barredo, 2009; Haylock & Goodess, 2004; Moberg et al., 2006; Paprotny et al., 2018). This is because of variations in catchments around Europe; in North-Western Europe, an increase has been observed, whilst in other parts of Europe, no trends have been observed (Hall et al., 2014; Paprotny et al., 2018). Increases in annual discharge and catchments in North-Western Europe would also mean increased runoff in major rivers. The Netherlands is home to many of these major rivers and will therefore see the effects of this in the form of increased water levels and increased levels of river flood risk.

Damages and casualties caused by extreme floods have increased in the past 50 years (Schanze, 2006). In Europe, river floods are among the most damaging climate events; without adaptations, climate change could triple the direct damages from river floods during the 21st century (European Environment Agency, 2021). In the summer of 2021, parts of Belgium, Luxembourg and The Netherlands faced heavy downpours, which caused 240 people to lose their lives (Van Fleteren, 2021). These floods resulted from heavy rainfall (Van Fleteren, 2021). According to the European Environment Agency (2021), annual river floods have increased in North-Western parts of Europe whilst annual river floods have decreased in Southern and Norther-Eastern parts of Europe because of climate change. A press release by Christian Aid (2021) also blames climate change for these floods. They also state that heavy rainfall, as seen in the summer of 2021, will occur 1,8 to 9 times more often due to climate change (Christian Aid, 2021).

1.2 Problem statement

Due to increasing risks and uncertainty, governments are called to think about new strategies to cope with increasingly heavy rainfall and flood risk for the years to come. Several possible approaches exist when a city or country must deal with floods or flood risk. Oosterberg et al. (2005) make a clear distinction between three main strategies to cope with floods: (1) keep floods away from urban areas, (2) prepare urban areas for floods, and (3) keep urban areas away from floods. These strategies come with different sets of measures. Whilst strategies 2 and 3 are more focused on warning, adjusting, and relocating urban areas, measure 1 focuses on technical and spatial measures to keep floods away from the urban areas (Oosterberg, van Drimmelen & van der Vlist, 2005). Technical measures consist of building dikes, spillways, and dredging, whilst spatial measures consist of giving rivers more space through the lay-back of dikes and retention areas (Oosterberg, van Drimmelen & van der Vlist, 2005). These measures are often referred to as ‘grey infrastructure’. Wetlands International (2020) define grey infrastructure as: “traditional human-engineered measures that perform infrastructure functions such as water and wastewater treatment plants or protective infrastructures such as dikes and seawalls”. According to Mens (2005), the effectiveness of flood risk management strategies depends on the combination of two distinct principles, resilience and resistance. Resistance stands for flood defence to reduce the probability of a flood (or hazard reduction), and resilience means minimising the consequences of flooding through spatial planning, evacuation, and warning (or vulnerability reduction).

The dominant approach to flood risk management in the Netherlands still relies on the implementation of grey infrastructure (hazard reduction through technical measures/resistance) when it comes to decisions to be taken and investments to be made in flood risk management (Rijkswaterstaat, 2021; Van Buuren et al., 2018). Without dikes, 59% of the Netherlands would be underwater (Milieudefensie, 2022). According to Vojinovic (2015), coping with flood risk by implementing technical measures is the result of the way floods are perceived. Floods and other natural disasters are defined by Burton and Kate (1963) as: “Those elements in the physical environment, harmful to man and caused by forces extraneous to him" (P.413). Vojinovic (2015) argues that this view of floods has led to the preference for physical treatment rather than social treatment and has led to ineffective solutions, but also: “conditions for ever-increasing risks and greater disasters” (P.1). Woodward et al. (2014) state that: “Assuming a worst-case climate change scenario and constructing a flood defense based on this assumption is likely to be suboptimum as it requires significant up-front expenditure and may well constitute an overdesign should the worst-case scenario not be realised” (P.77). If dikes are not significantly expended up-front in the coming years, where increasingly extreme rainfall is expected, then relying on grey infrastructure would mean that dikes would have to be repeatedly strengthened every few years, which would require ongoing maintenance costs (Klijn et al., 2012; Nakamura et al., 2020) and the overuse of natural resources (Vejinovic, 2015). Overusing natural resources, repeatedly strengthening, and ongoing maintenance costs for grey infrastructure are not sustainable. Moreover, with increasing flood resistance through strengthening dikes comes increased risks and consequences when a flooding happens (Vejinovic, 2015). If no other measures are taken, and the dikes are not continuously strengthened and maintained, they will eventually break, and large parts of the Netherlands will be affected.

An adaptive strategy, that is robust to climate change uncertainties, that is sustainable, and that combines resistance with resilience is needed in flood risk management (Woodward, Kapelan & Gouldby, 2014). The Brundtland Commission defined sustainable development as “development that meets the needs of the present without comprising the ability of future generations to meet their own needs” (Waheed, Khan & Veitch, 2009, P.442). Solely relying on grey infrastructure in flood risk management will reduce risks in the short term but increase risks in the long term. This is, therefore, not a sustainable way of flood risk management. A more adaptive flood risk management strategy is needed to complement the existing grey infrastructure for flood protection (Nakamura et al., 2020; Zuniga-Teran et al., 2020). An adaptive approach is anticipatory instead of responsive, recognising and considering future uncertainties (Klijn et al., 2015). One that meets the present needs for flood protection and does not compromise the needs of future generations.

Such a strategy could be using green/blue infrastructure in flood risk management to complement the existing grey infrastructure. Green/blue infrastructure is defined by Wetlands International (2020) as: "planned interconnected networks of natural and semi-natural areas, including water bodies and green and open spaces, that provide different ecosystem services". Collins (2002) refers to green/blue infrastructure as: "Recreating the structural elements of a naturally functioning ecosystem" (P.67). Green/blue infrastructure aims to: "increase flood resilience through ecological interventions that prioritise the functioning of biophysical dynamics" (Battemarco et al., 2022, P. 2; Benedict & McMahon, 2012). Green/blue infrastructure can increase (urban) resilience (Perini & Sabbion, 2016) because it is able to reduce the consequences of a flood happening and enhance the recovery capacity of a society when a flooding does happen (Klijn, Asselman & Mosselman, 2019). Complementing grey infrastructure with green/blue infrastructure combines resistance with resilience and would make for a more effective flood risk management strategy (Mens, 2005). Next to that, green/blue infrastructure does not require the overuse of natural resources, making it more sustainable (Maes & Jacobs, 2017).

Recreating floodplains, wetlands, and restoring rivers are examples of green/blue infrastructure in (river) flood risk management. During floods, floodplains and wetlands inundate in a naturally functioning river system (Peipoch et al., 2015). The construction of dikes could prevent floodplains and wetlands from inundating and disturbs the naturally functioning ecosystem. By recreating floodplains and wetlands, damages and causalities are reduced because land is created that is meant to flood. Green/blue infrastructure has also been highly praised as a more socially, economically, and environmentally sustainable option for flood risk management than traditional grey infrastructure options (Law, Diemont & Toland, 2017). Because of these benefits, green/blue infrastructure has been increasingly advocated in flood risk management (Carter et al., 2018).

1.3 Research aim and research question

So, increasing flood risk calls for more adaptive approaches in flood risk management, especially in the Netherlands. According to Morrison et al. (2018), adaptive approaches in flood risk management seek to accommodate rather than control environmental systems and embrace uncertainty. Adaptive approaches in flood risk management are about accepting future floods and the uncertainty of future floods. This is an important feature because of uncertainty about future rainfall and floods caused by climate change. A more adaptive approach could be the implementation of green/blue infrastructure. According to Klijn et al. (2019), green/blue infrastructure can reduce the consequences and enhance the recovery capacity of a society when a flooding happens. These are aspects more linked to accommodating environmental systems (like floods) and are factors that make green/blue infrastructure more adaptive. However, the Netherlands still relies on grey infrastructure regarding flood risk management. Regarding this, it would be helpful to see which factors hinder or support the implementation of green/blue infrastructure in flood risk management and what solutions there might be to tackle the hindering of nature-based solutions. Therefore, the main research question for this research will be: *Which factors hinder or support the implementation of green/blue infrastructure for flood risk management in the Netherlands?* To answer this research question, a case study was selected. The project The Green River Well is the case that will be studied in this research. The Green River Well is a flood risk management project in the Netherlands. Negotiations for the project plans are currently still ongoing. Current project plans aim to manage the flood risk by implementing green/blue infrastructure next to grey infrastructure. Studying the factors that hinder(ed) or support(ed) the implementation of green/blue infrastructure in this project could help answer the research question. The research methodology chapter will explain why this case was chosen and what the project entails.

1.4 Scientific relevance

An increase in the effects of climate change like floods and heavy rainfall on a more regular basis has caused much research on flood risk management. The European Environment Agency (2017) claims that evidence shows that investment in green solutions, such as landscape conservation and restoration, can provide improved infrastructure solutions and is more cost-efficient. Ferreira et al. (2021, P.1.) define green/blue infrastructure as: “a strategically planned network of natural and semi-natural areas that are designed and managed to deliver a wide range of ecosystem services''. Green/blue infrastructure could provide solutions for many types of floods, like sea-level rise floods, groundwater floods, and river floods. Therefore, this research focuses on river flooding and green/blue infrastructure in river flood risk management. Examples of green/blue infrastructure in river flood risk management could be the recreation of floodplains, constructed wetlands, or restored rivers with meadows that allow the river to meander freely. A burgeoning literature emphasises the (co) benefits of green/blue infrastructure next to being more adaptive and sustainable, compared to more traditional ways, like grey infrastructure.

The (co) benefits that green/blue infrastructure can provide are an increase in biodiversity, an increase in carbon sequestration, recreational possibilities (Berg et al., 2014; European Environment Agency, 2017), an increase in water infiltration and moderating temperatures through evaporative cooling (Carter et al., 2018). By recreating natural processes in flood risk management, habitats are enriched, biodiversity is increased and naturally functioning ecosystems are restored (Benedict & McMahon, 2002; Berg et al., 2014; Zuniga-Teran et al., 2020). An increase in biodiversity, mainly plants and vegetation, will also cause more carbon to be sequestrated (Kavehei et al., 2018; Yang et al., 2019). An increase in carbon sequestration mitigates the greenhouse effects that cause climate change. By combining green/blue infrastructure, more vegetation (like bushes, trees, and even forests) is realised, providing shading and reducing ground surface temperatures (Liu et al., 2021; Saaroni et al., 2018). Reducing ground surface temperatures helps with mitigating climate change. Another way in which vegetation cools the surface area is through evaporative cooling by evapotranspiration (Shen et al., 2015; Tan et al., 2018). Plants transpire water through their leaves, which then move to the atmosphere whilst picking up heat in the process (Shen et al., 2015; Tan et al., 2018). Through this process, plants provide a cooling effect. Compared to grey infrastructure, green infrastructure can also facilitate increased water infiltration and rain harvesting (Pamungkas & Purwitaningsih, 2019).

Despite these benefits, the widespread implementation of green/blue infrastructure in flood risk management is limited (Tayouga & Gagné, 2016). The Netherlands still mainly relies on grey infrastructure through civil engineering (Klijn et al., 2012; Rijkswaterstaat, 2021; Van Buuren et al., 2018), as was mentioned in the introduction. Sarabi et al. (2020) identified a set of barriers to implementing nature-based solutions like green/blue infrastructure. However, they mention that the barriers they identified do not occur in all cases and that they can differ depending on the context. Chapter 2.4 will go further in-depth on the barriers that Sarabi et al. (2020) identified. The barriers to implementing green/blue infrastructure in flood risk management in the Netherlands have not yet been identified; this research aims to do so.

1.5 Societal relevance

As previously mentioned, natural disasters have been on the rise. Whilst there are many forms of natural disasters, this research will focus on river flooding. Klijn et al. (2012) have concluded that climate change and sea-level rise are direct causes of increased flood risk. In the Netherlands, 26% of the total land area is below sea level, whilst 29% of the total land area is subject to river flooding when rivers overflow their banks en masse (Knoop, 2022). Floods cause damage to people and the environment all around the globe (Carter, White & Richards, 2009). The flooding in Malaysia in December of 2021, where over 30.000 people were displaced after the heaviest flooding Malaysia had faced in years, is an example of this (Reporter, 2021). Among all natural disasters, floods are the most damaging. More than half of the victims of natural disasters are related to flooding (Douben, 2006). Over the 30 years, from 1980 to 2009, the magnitude and frequency of extreme floods increased globally, with the most substantial increase in Europe and the United States (Berghuijs et al., 2017; Najibi & Devineni, 2018). The floods in parts of The Netherlands, Belgium, and Luxembourg in the summer of 2021 exemplify this (Van Fleteren, 2021). Heavy rainfall caused the river Maas to overflow its banks in the summer of 2021, leaving estimated damages of 350-600 million (Tu Delft, 2021).

The current (river) flood risk management policy in the Netherlands mainly relies on the implementation of grey infrastructure, like dikes and dams. Klijn et al. (2012) researched whether this policy needed revision under the current global change. They found that the current flood risk management policy can be sustained for centuries if the protective ability of dikes is continuously assessed, and if needed, dikes are continually strengthened (Klijn et al., 2012, P.183). In addition, Klijn et al. (2012) also conclude that the current flood risk management policy is not suited for protecting against flooding and dike breaches in places where substantial economic losses or a large number of fatalities might occur (P. 191). The floods in the summer of 2021 show that the sole use of grey infrastructure is insufficient to cope with floods. With flood hazards increasing, solely relying on grey infrastructure is not an (economically) sustainable way of flood risk management as it would require continuous maintenance costs and the overuse of natural resources (Vejinovic, 2015). This research emphasises the importance of implementing green/blue infrastructure into the flood risk management policy to complement the existing grey infrastructure and better cope with increasing risks.

Next to the protective benefits of complementing grey infrastructure with green/blue infrastructure, this research also shows the importance of the sustainable benefits of green/blue infrastructure. Horbel et al. (2022, P.230) argue that: “Humans’ overconsumption of natural resources shows increasingly extreme effects on the natural environment, such as climate change”. Nature-based solutions like green/blue infrastructure recreate natural processes and do not require the overuse of natural resources compared to grey infrastructure; this makes green/blue infrastructure more sustainable (Maes & Jacobs, 2017). Investing in more sustainable ways of flood risk management is desirable with rising concerns about climate change and sustainability.

Chapter II Theoretical Framework

As mentioned in the introduction, this research will identify what factors hinder or support the implementation of green/blue infrastructure in flood risk management. To analyse this, I will be using the policy arrangement approach (PAA). Later in this chapter, the PAA will be further elaborated on.

First, the main theories will be given regarding climate change, flood risk management, green/blue infrastructure, and barriers to implementation. The conceptual model will be presented and explained at the end of this chapter.

2.1 Climate change

The United Nations (2022) defines climate change as: “Long-term shifts in temperature and weather patterns”. Humans' burning of fossil fuels (natural resources) like oil, coal, and gas has been the main driver of this process in the past centuries (United Nations, 2022). Burning fossil fuels releases greenhouse gasses, like carbon dioxide, which form a ‘blanket’ around the earth, causing it to warm up; this is called the greenhouse effect (Met Office, 2022). In pre-industrial times (1750-1850), the global atmospheric concentration of carbon dioxide had a value of around 280ppm; this has since increased to 379ppm[3] in 2005 (Change, I. P. O. C., 2007). Over the years, the ‘blanket’ around the earth has gotten thicker, resulting in a global surface temperature increase of (average) 0.76℃ from 1850-1899 to 2001-2005 (Change, I. P. O. C., 2007). Some effects of increasing surface temperature are the increase in heavy rainfall and/or longer-lasting rainfall events and increasing snowmelt (Change, I. P. O. C., 2007; Huang et al., 2020; IPCC Work Group I., 2013; Ohba & Sugimoto, 2019).

Heavy and/or long-lasting rainfall is globally the main factor that causes river floods (Douben, 2006). Next to rainfall, snowmelt is another factor that can cause river floods (Blöschl et al., 2015). More frequent (heavy) rainfall events cause runoff and river discharge to increase, increasing flood risk. This could significantly impact society through causalities and damages (Huang et al., 2020). Increasing surface temperatures can affect snow dynamics in cold regions and result in more rainfall extremes, which could make snowmelt-dominated catchments more susceptible to extreme rainfall and thereby alter the regional flood seasonality and magnitudes, increasing the probability of a flood happening (Jiang, Bevacqua & Zscheischler, 2022). So, rising surface temperatures because of climate change cause increased flood risk. Although the literature suggests that climate change causes increased flood risk, it is uncertain to what extent it is increased (Mumtaz, 2021).

Flood risk can be defined as a combination of the probability of a flood happening (hazard), the population and capital in flood risk areas (exposure), and the consequences if it occurs (vulnerability) (Oosterberg et al., 2005). Climate change is not the only reason for increased flood risk. Additional causes for increased flood risk are urbanisation, deforestation, and construction dikes. In the case of high water, a dike built downstream results in more significant water accumulation upstream, increasing flood risk (Tol & Langen, 2000). Urbanisation, the process of rural settlements changing into urban settlements, increases runoff and peak flow, which causes increased flood risk (Nigussie & Altunkaynak, 2019; Xiang, Tong & Wang, 2013). Clark (1987) found that as forest cover increases, runoff decreases. Trees and their roots have a water absorbing capacity which makes them capable of absorbing excess surface water, decreasing runoff (Laurance, 2007). So, deforestation increases flood risk (Clark, 1987; Laurance, 2007).

When discussing flood risk, it is essential to make the distinction between floods and flooding as these are often mixed up. The definitions of floods and floodings that will be used in this research are as follows:

- A flood is defined as a temporary condition of surface water (river, lake, sea) in which the water level and/or discharge exceeds a certain value, thereby escaping from its normal confines. However, this does not necessarily result in flooding (Munich-Re, 1997).
- Flooding is defined as the overflowing or failing of the normal confines of, e.g., a river, stream, lake, sea, or accumulation of water as a result of heavy precipitation through lack or exceeding of the discharge capacity of drains, both affecting areas which are typically not submerged (Douben & Ratnayake, 2005).

2.2 Flood risk management

Economic, human, and social losses of floods and floodings are minimalised using flood risk management. Flood risk management deals with issues and tasks ranging from predicting flood hazards to the consequences of floods and instruments and measures for flood risk reduction (Schanze, 2006). Schanze (2006, P.4) defines flood risk management as: “holistic and continuous societal analysis, assessment and reduction of flood risk”, where holistic refers to as comprehensive as possible. The management components of flood risk management can be structured into three main tasks (Schanze, 2006, P.6):

- Risk analysis
- Risk assessment
- Risk reduction

Information on previous, present, and future flood risk is provided through risk analysis. The perception and evaluation of the flood risk are then dealt with through risk assessment. Risk reduction deals with interventions that can reduce the risk. Schanze (2006) produced a basic framework for flood risk management, linking the tasks to the decision-making and development process, see figure 1.

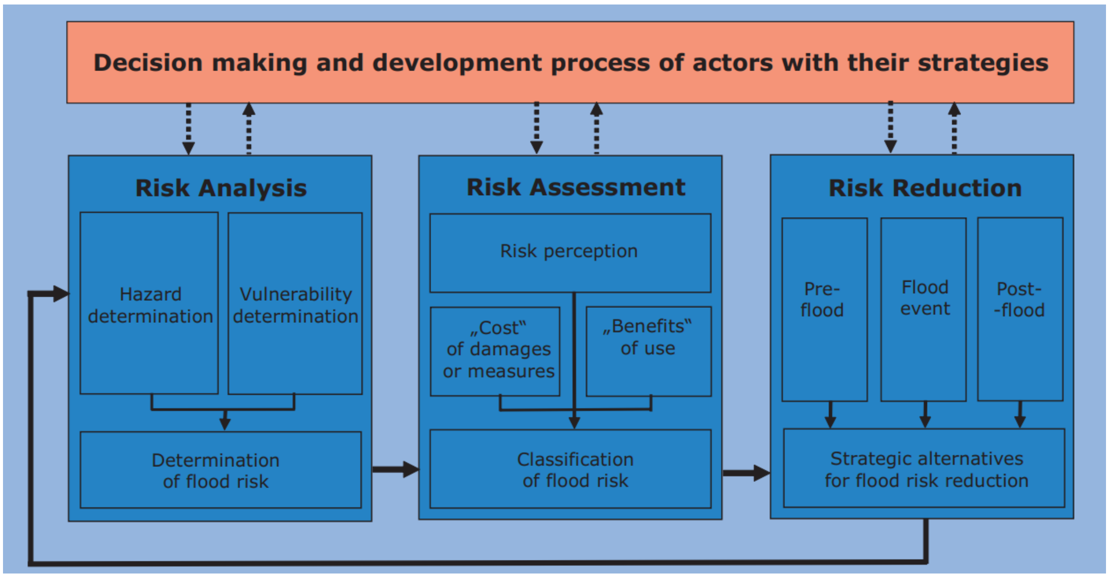

Figure 1. The basic framework of flood risk management (Schanze, 2006).

At the top of the framework is the decision-making and development process of actors and their strategies. Decisions and actions are performed based on the information decision-makers gain from the tasks (risk analysis, assessment, and reduction) (Schanze, 2006). Decisions and actions can differ depending on an actor's strategy for flood risk management. Oosterberg et al. (2005) identify three main strategies for flood risk management based on their definition of food risk (hazard*exposure*vulnerability):

- Hazard reduction (keep floods away from people): In this strategy, technical measures, such as dikes, spillways, and dredging, are prominent (Oosterberg et al., 2005, P. 24). These measures are used to reduce river floods. A strong water management organisation is required for this strategy, with secure financing and powers and a clear mandate to make sure the interest of flood risk management succeeds over land uses like flood plains and depressions in crucial areas (Oosterberg et al., 2005, P.24). Next to these technical measures, spatial measures are also common in this strategy. Spatial measures consist of retention areas, the lay-back of dikes, and river bypasses (Oosterberg et al., 2005, P.24).

- Exposure reduction (keep people away from floods): In this strategy, considerations of flood risk influence the choice of location for urban expansion through strong constraints for urbanisation (Oosterberg et al., 2005, P. 26). If areas are at risk of flooding no new urban areas will be built there. This strategy requires strong spatial planning and a dominant position of water managers in discussions on land use (Oosterberg et al., 2005, P. 27).
- Vulnerability reduction (prepare urban areas for floods): In this strategy, the view that urbanisation can proceed if people take precautions, like adjusting their homes, is dominant. This calls for individual and local responsibility (Oosterberg et al., 2005, P. 24). Important for this strategy are public acceptance of occasional flooding of their property, willingness to prepare, and discipline when floods occur (Oosterberg et al., 2005, P. 24).

The hazard reduction strategy, which relies on technical measures like dikes and spillways (grey infrastructure) and spatial measures, is widely viewed as the backbone of flood risk management (Oosterberg et al., 2005). Morrison et al. (2017, P.291) state that: "The standard approach to flood risk management (FRM) amongst developed nations has often been the adoption of resistance-based strategies (Zevenbergen and Gersonius, 2007; Shrubsole, 2013) – attempting to control flood threats with infrastructure". The institutionalisation of hydro-engineering (flood management through technical measures like dikes and dams) in flood risk management in the Netherlands is an example of this (Kaufman & Wiering, 2020). Hall (1986) defines institutions as "the formal rules, compliance procedures, and standard operating practices that structure the relationship between individuals in various units in the polity and economy" (P.19). The institutionalisation of hydro-engineering in the Netherlands shows in the fact that: "Dutch national and regional flood management policies are traditionally aimed at reducing the probability of flooding through the construction and maintenance of dikes" (Neuvel & van den Brink, 2009, P.4). Next to that, Dutch dikes must comply with a set of design standards that are legally established in the Dutch Flood Defences Act (Neuvel & van den Brink, 2009). This shows that the Dutch flood risk management strategy mainly relies on hazard reduction through technical measures.

Mens (2005) recognises that the effectiveness of flood risk management strategies depends on the combination of two distinct principles, resilience and resistance. Resistance stands for flood defence, like dikes and dams, to reduce the probability of a flood happening (or hazard reduction), and resilience stands for reducing the consequences of flooding through spatial planning, evacuation, and warning (or vulnerability reduction). Urban resilience is defined by Perini and Sabbion (2016) as: "The ability of an urban system to adapt (maintain or rapidly return to previous functions) when facing a disturbance" (P.3). Traditional grey infrastructure can be adequate (in for example reducing flood risk) but are often mono-functional and non-adaptive (Perini & Sabbion, 2016). By introducing grey infrastructure in flood risk management, the probability of flooding is reduced. Grey infrastructure can therefore help reach resistance to flooding. Nonetheless, grey infrastructure in flood risk management does not enhance a society's recovery capacity when a flooding does happen and does not reduce the consequences of a flooding, making it unsuitable for reaching flood resilience (Klijn, Asselman & Mosselman, 2019). However, as Mens (2015) recognises, the effectiveness of a flood risk management strategy depends on the combination of resistance and resilience. According to Mens's (2015) theory, relying solely on grey infrastructure would not be the optimal flood risk management strategy. Introducing green and blue infrastructure alongside traditional grey infrastructure can enhance (urban) resilience (Perini & Sabbion, 2016). It would be a more effective strategy as it combines resistance with resilience/hazard reduction with vulnerability reduction.

2.3 Green/blue infrastructure

Green/blue infrastructure aims to: "increase flood resilience through ecological interventions that prioritise the functioning of biophysical dynamics in close relationship with the built environment and local population" (Battemarco et al., 2022, P. 2; Benedict & McMahon, 2012). In green/blue infrastructure, blue refers to water elements like rivers or ponds, whilst green refers to natural elements like forests, trees, or fields. Applications of green/blue infrastructure range from buildings and lots to entire cities and rural areas (Foster et al., 2011). Examples of green/blue infrastructure are green roofs, rain gardens, recreated floodplains, constructed wetlands, or restored rivers with meadows that allow the river to meander freely. As mentioned before, this research focuses on river flooding, so the most relevant types of green/blue infrastructure are floodplains, constructed wetlands and restored rivers.

Green/blue infrastructure can increase (urban) resilience (Perini & Sabbion, 2016). The reason for this is the ability of green/blue infrastructure to reduce the consequences of a flood happening and enhance the recovery capacity of a society when a flooding does happen (Klijn, Asselman & Mosselman, 2019). Green/blue areas, like floodplains or wetlands, are designed to inundate during a flood, which causes the consequences to be minimal when these areas inundate. Next to that, when floodplains or wetlands inundate, river water levels drop, which decreases flood risk downstream.

Green/blue infrastructure falls under the concept of nature-based solutions (NBS), which are innovative solutions inspired by nature that mimic natural processes (Sarabi et al., 2020). IUCN (2022) defines nature-based solutions as: "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits". Nature-based solutions can provide solutions for water purification, improving air quality and decreasing temperature and reducing flood risk (Sarabi et al., 2020). Green/blue infrastructure can therefore be classified as a nature-based solution for reducing flood risk and increasing flood resilience.

As mentioned in chapter 1.5, green/blue infrastructure can provide multiple complementary benefits over grey infrastructure (Alves et al., 2019). One of these benefits is that green/blue infrastructure can help with climate mitigation by acting as a carbon sink (Foster, Lowe & Winkelman, 2011). Also, in comparison to grey infrastructure, green/blue infrastructure can support biodiversity by providing more suitable habitats for various species (Filazzola, Shrestha, & MacIvor, 2019). Next to these benefits, green/blue infrastructure is also advocated as being more adaptive (Perini & Sabbion, 2016; Voskamp & van den Ven, 2015). Emami (2020, P.230) defines a set of strategies for adaptive flood management:

- Adaptability (changing threat to opportunity);
- Avoiding costly irreversible mistakes;
- Extensive risk recognition;
- Focus on long-term management rather than construction;
- Resilience;
- Harmony with the environment.

Introducing green/blue infrastructure in flood risk management allows using the threat of floods to attain the co-benefits of green/blue infrastructure. Compared to grey infrastructure, green/blue infrastructure focuses more on long-term management than construction and is more in harmony with the environment as natural processes are recreated (Kabisch et al., 2016). As mentioned before, green/blue infrastructure can enhance (urban) resilience (Perini & Sabbion, 2016). Morrison et al. (2017, P.292) argue that: “Improving resilience to flood events and building the capacity to adapt to changing flood conditions, requires a combination of both resistance- and adaptive-based approaches”. Or in other words that grey infrastructure (resistance-based) is complemented with green/blue infrastructure (adaptive-based).

Kurstjens et al. (2020, P.8) acknowledge that floodplains and wetlands are an essential aspect of naturally functioning river systems but conclude that floodplains and wetlands are an important ‘missing link’ in Dutch river systems. As a result, Kurstjens et al. (2020) researched and selected promising areas for implementing floodplains and wetlands. The selection of the most promising areas for floodplains and wetlands along the branches of the Rhine have been mapped; see figure 2. The figure shows that there are plenty of possible locations for the implementation of green/blue infrastructure in the form of floodplains and wetlands in the Netherlands.

Figure 2. Promising areas for floodplains and wetlands (Kurstjens et al., 2020).

2.4 Barriers to implementation

Nature-based solutions like green/blue infrastructure can complement grey infrastructure to create a more effective flood risk management strategy that combines resistance with resilience. However, barriers have caused the adoption and implementation of nature-based solutions like green/blue infrastructure to be limited (Kabisch et al., 2016; Meng et al., 2022; Sarabi et al., 2020). Kabisch et al. (2016, P.7) raised a broad range of potential barriers to implementing nature-based solutions from an expert workshop. These potential barriers were then clustered into five categories:

- *Fear of the unknowns:*
  This barrier regards the uncertainties and risks of implementing nature-based solutions.
- *The disconnect between short-term actions and long-term goals*
  The short-termism of many cities administrations can clash with the long-term planning that implementing and maintaining nature-based solutions requires.
- *The discontinuity between short-term actions and long-term plans*
  The focus is often on the design and early-stage implementation of nature-based solutions. However, nature-based solutions require long-term plans.
- *Sectoral silos*
  This barrier occurs when knowledge is trapped in ‘sectoral silos’ or ‘sectoral language’. Nature-based solutions often require collaboration of different fields which is hindered by sectoral silos.
- *The paradigm of growth*
  In many cities the focus remains on economic growth through the increase of built-up area. Less attention is given to green spaces and the benefits of nature-based solutions.

Kabisch et al. (2016) note that understanding these barriers and the interconnected factors that reinforce them is essential in finding opportunities to address them. Sarabi et al. (2020) later diversified and increased this existing set of barriers. Based on an extensive literature review and expert interviews, Sarabi et al. (2020) generated a set of fifteen possible barriers to implementing nature-based solutions based on several European cities. The barriers presented by Sarabi et al. (2020) were used by Solheim et al. (2021) to describe and classify the barriers experienced in using nature-based solutions in rural and mountain landscapes. The set of barriers that Sarabi et al. (2020) generated, and the causes of these barriers are as follows:

1. *Lack of political will and long-term commitment*

    Politicians often prefer projects that generate short-term outcomes, mainly for re-election purposes. In this regard, nature-based solutions often produce benefits in the long term; this can cause politicians to avoid nature-based solutions. However, commitment and political leadership are necessary for the implementation of nature-based solutions.

2. *Lack of sense of urgency among policy-makers*

    A low sense of urgency to implement nature-based solutions among political decision-makers can be caused by policy-makers not being aware of the full potential of nature-based solutions.

3. *Lack of public awareness and support*

    The development of nature-based solutions can be impeded by limited public awareness of nature-based solutions or the negative perception of a community towards nature-based solutions. Engagement of the community appears to be crucial in developing nature-based solutions.

4. *Risk aversion and resistance to change*

    Nature-based solutions can have uncertain long-term outcomes, which can cause fear of failure among city planners and engineers. To avoid the risk of failure, city planners and engineers might prefer more traditional grey solutions, as grey solutions tend to have rather certain outcomes.

5. *Silo mentality*

    Different departments and institutions can be stuck in their silos, which means that they operate based on distinct visions, legal structures, or goals, that might prefer grey infrastructure over nature-based solutions.

6. *Misalignments between short-term plans and long-term plans*

    In many municipalities and cities short-termism has become integrated in the administrative culture. This short-termism can clash with the long-term planning required for adopting, implementing, and realising nature-based solutions.

7. *Lack of supportive policy and legal frameworks*

    It is possible that regulations and policies do not support the development of ecosystem-based approaches like nature-based solutions. Implementing nature-based solutions can also be hampered by conflicting national, regional, and local policies.

8. *Lack of design standards and guidelines for maintenance and monitoring*

Guidelines for implementing and maintaining nature-based solutions tailored to local conditions can be missing. This can cause uncertainties in designing, implementing, and maintaining nature-based solutions in the best possible way and can hamper the implementation of nature-based solutions.

9. *Lack of skilled knowledge brokers and training programs*

   Professionals, like planners and engineers, might lack the knowledge of designing, implementing, and maintaining nature-based solutions. Also, actors that can translate knowledge on nature-based solutions to different levels in the field can be missing. The reason for this could be that training programs are primarily focused on traditional (grey) solutions.

10. *Functionality and performance uncertainties*

    A lack of information on nature-based solutions can cause uncertainties about the benefits of nature-based solutions. Because nature-based solutions are a relatively new approach, there is limited availability of studies of nature-based solutions in practice and nature-based solutions in different climate scenarios.

11. *Perceived high cost*

    The implementation and maintenance of nature-based solutions can be perceived as being more costly than more traditional (grey) approaches, which is then a barrier to the implementation. Perceived high costs often occur among private owners.

12. *Lack of available financial resources*

    Municipal revenues of cities can be directed towards the maintenance and development of traditional grey infrastructure, which means that there might be no financial opportunities for developing new approaches like nature-based solutions.

13. *Lack of financial incentives*

    When it is not straightforward for citizens and entrepreneurs what nature-based solutions can offer (financially), they might not be encouraged to develop nature-based solutions together.

14. *Property ownership complexities*

    Land and real estate in urban areas often belong to private owners. These private owners can prioritise financial benefits over sustainability goals, causing them to adapt grey solutions of nature-based solutions.

15. *Space constraints*

    Space constraints for nature-based solutions often occur in dense urban areas. Examples of space constraints are type of soil (unsuitable for vegetation), too steep roof slopes, and electricity lines (constraint for planting trees).

In this research, these barriers are considered to be the barriers to implementing nature-based solutions. Sarabi et al. (2020, P.8) mention that these barriers do not necessarily occur in all cases and that each city faces unique barriers in implementing different nature-based solutions. So, for implementing green/blue infrastructure in flood risk management in the Netherlands, other barriers than the previously mentioned could occur.

2.5 Policy Arrangement Approach

The policy arrangement approach was adopted to identify the barriers to implementing green/blue infrastructure in the Netherlands. Several components make the policy arrangement approach suitable for this research and are the reason that this approach was chosen.

Firstly, because flood risk management in the Netherlands is heavily institutionalised (Brockhoff et al., 2022; Kaufmann et al., 2016; Kaufman & Wiering, 2020), an institutional type of policy analysis is needed. The institutionalisation of flood risk management in the Netherlands shows in the large amount of policy and legislation regarding flood risk management (Kaufman & Wiering, 2020). Because an institutional policy analysis is needed, models like interpretive policy analysis, policy networks, and normative theory are excluded. Veenman, Liefferink & Arts (2009) adopted the policy arrangement approach to explain and describe the de-institutionalisation of forestry in the Netherlands. Veenman et al. (2009) witnessed forest policy's institutionalisation (and de-institutionalisation) in the Netherlands, causing them to adopt the PAA. Secondly, an important aspect of the policy arrangement approach is that it includes the concept of ‘power’, meaning that the possibility of ‘interest politics’ is not excluded (Veenman, Liefferink & Arts, 2009). This concept is missing in other approaches/frameworks like the Advocacy Coalitions Framework or ACF (Sabatier, 1999) and the Institutional Analysis and Development framework or IAD (Jentoft et al., 1998). Thirdly, there are several theories capable of describing parts of arrangements and identifying barriers created by these arrangements. Such theories are network theory, describing the actors involved, their relationships, and the groups they belong to (Marsh & Rhodes, 1992). Discourse analysis, which describes the way topics (like flood risk management) are discussed and defined (Foucault, 1971). And also, Configuration theory, which is used to describe organisational structures and their effectiveness (Mintzberg, 1983). The policy arrangement approach combines these theories, making it capable of describing all situation aspects at once. This makes for a broader view of the barriers to implementing green/blue infrastructure in flood risk management.

The policy arrangement approach offers an inclusive and coherent interpretative framework for analysing and understanding policy arrangements (Arts & Leroy, 2006). By analysing and describing policy arrangements, barriers that occur because of these arrangements can be brought to light. A policy arrangement is defined as the way in which a policy domain, like flood risk management, is shaped in terms of substance and organisation (Wiering & Arts, 2006). When these two aspects are looked further into, the policy arrangement approach distinguishes four analytical dimensions: actors, resources, rules of the game, and discourses (Arts & Leroy, 2006). Whereas actors, resources, and (some) rules of the game refer to the organisational aspects and (other) rules and discourses refer to substantive aspects (Veenman, Liefferink & Arts, 2009). These four dimensions are interrelated, meaning that a change in one of the dimensions often tends to impact one or more dimensions. For example, if new discourses emerge, this could lead to new rules of the game or new actors in decision-making. Arts & Leroy (2006) use a tetrahedron to show the interconnectedness of these four dimensions. Figure 3 shows the tetrahedron used by Arts & Leroy (2006).

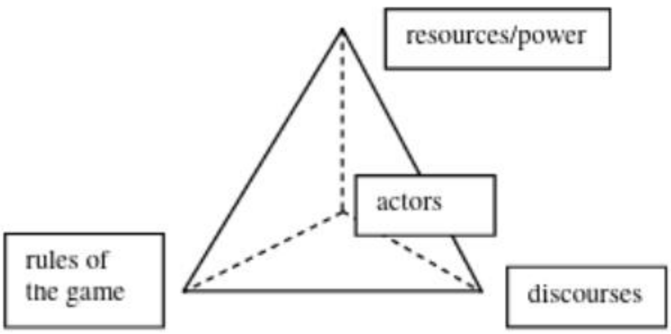

Figure 3. Tetrahedron of the four dimensions (Arts & Leroy, 2006).

The next part of this chapter will go further in-depth on the four dimensions used to analyse a policy arrangement. It will also look at the ways of analysing the dimensions themselves.

Actors

This dimension refers to the policy coalitions, which have shared beliefs on the different discourses regarding the topic and the actors that operate inside them. These coalitions will use their resources and power to achieve their goals. Arts & Tatenhove (2006) argue that this might cause some policy coalitions and actors to support the main discourses, whilst others may oppose these main discourses. When analysing this dimension, it is important to start by identifying the most important actors and power relations. Having done this, one can begin to group the different actors by their views on the policy domain at stake (Arts & Leroy, 2006).

Actors in flood risk management might be municipalities, provinces, water authorities, etc. As Arts & Tatenhove (2006) mentioned, these actors/layers can have different views on discourses regarding flood risk management in the Netherlands. Some might favour green/blue infrastructure because they are aware of the benefits that could come along with green/blue infrastructure. Other actors might not be aware of these benefits and could therefore be against implementing green/blue infrastructure.

Resources

This dimension focuses on the changes in distribution and addition of different resources such as money, information, knowledge, and expertise. Arts, van Tatenhove & Leroy (2006) view resources as the ability to assign money, skills, and knowledge. Different actors have different availability of resources which is often related to the actor's power. In this dimension, power relations between actors are again being identified (Arts & Leroy, 2006). Arts, van Tatenhove & Leroy (2000) argue that the 'constitution of power' is divided unequally. Therefore, different actors will not have the same availability of resources as others which causes dependencies between actors. Liefferink (2006) argues that if one brings these dependencies to the surface, it will become clear that because of shared control over specific resources, some actors are "driven into each other's arms" (P.54). Arts & Leroy (2006) mention that in one policy arrangement money might be the central stake, whilst in another, it is expertise or knowledge. In the policy arrangement of flood risk management in the Netherlands, it is important to find out what resource is most important and how these resources are divided under the different organisations involved. If actors with a positive view of green/blue infrastructure can assign resources, this could help implement green/blue infrastructure.

Rules

This dimension refers to the rules and regulations inside a policy arrangement (Arts & Leroy, 2006). These rules and regulations delineate a policy domain. The rules and regulations define the possibilities and constraints for policy agents to act within the domain (Arts, van Tatenhove & Leroy, 2006). Two types of rules exist, formal and informal rules. Formal rules are rules that are written in laws or legal texts. This means that these are the rules that actors must follow by law. Informal rules are not written down in laws but refer to the political culture, which colours the way in which policies are shaped (Arts, van Tatenhove & Leroy, 2000). Informal rules and regulations can consist of, for example, awareness of the importance of green/blue infrastructure or transparency of policy-makers in flood risk management. Rules and regulations of policy-making can change over time, and therefore this dimension is considered to be dynamic. The rules and regulations inside the policy domain of flood risk management in the Netherlands could hinder the implementation of green/blue infrastructure. For example, laws that require the use of grey infrastructure in flood risk management could hinder the implementation of green/blue infrastructure. Therefore, identifying formal and informal rules and regulations could bring to light barriers to implementing green/blue infrastructure.

Discourses

For Foucault, discourses are about: “what can be said and thought, but also about who can speak, when, and with what authority” (Ball, 1990, P.2). Arts, van Tatenhove & Leroy (2000) argue that the definition of environmental problems is socially and politically constructed. Therefore, it is important to understand the current discourses because these define whether green/blue infrastructure is currently seen as a necessity or not. Kaufman & Wiering (2022) give a clear overview of the main discourses on flood risk management over the past few decades in the Netherlands.

In the Middle Ages, the first discourse surfaced in the Netherlands, the hydro-engineering discourse (Kaufman & Wiering, 2022). The hydro-engineering discourse emphasised that nature should and could be controlled by mankind through engineering. This resulted in the first dams and dikes being built (Kaufman & Wiering, 2022). Regional water taxes were implemented to finance the engineering projects. This caused stakeholders’ expectations to rise, so water managers had to keep improving their hydro-engineering expertise, driving society to accept and rely on them more and more (Kaufman & Wiering, 2022). In these times, the hydro-engineering discourse started being institutionalised. Then in 1953, the Netherlands faced massive flooding that caused many fatalities. This led to safety standards for the primary flood defences being semi-formalised and the flood defence strategy becoming dominant in the Netherlands (Kaufman & Wiering, 2022).

In the 1970s, an environmental discourse on flood risk management emerged. This discourse had an increased acknowledgement of the environment and saw water as a 'friend' (Kaufman & Wiering, 2022). Next to the environmental discourse, an integrated management discourse arose. This discourse envisioned an approach to water management that included the collaboration of multiple stakeholders. The environmental water discourse criticised the hydro-engineering projects for their ecological and societal consequences (relocating villages) (Kaufman & Wiering, 2022). The environmental discourses saw support from the growing global environmental discourses. However, after the floods of 1993 and 1995, the government decided to strengthen the hydro-engineering arrangement in the form of the Delta Works (Kaufman & Wiering, 2022). This was because the hydro-engineering experts could provide rapid solutions for the 'fight against the water'. Later, after evaluating the primary flood defences (which had to be done according to the Flood Defence from 1996), the defences did not match safety standards. Therefore, a program was made to improve and strengthen the primary flood defences, the HWBP (hoogwaterbeschermingsprogramma) or FPP (flood protection plan). Another response to the floodings of 1993 and 1995 was the project 'Room for the River. This project aimed to widen the rivers, which indicated a more ecosystem-based approach. The three main discourses in this program are merged: hydro-engineering, environmental and integrated management. However, the emergence of new discourses on flood risk management in the Netherlands, Kaufman & Wiering (2022) conclude that there are no 'critical turns' that could lead to change in the current flood risk management approach of the Netherlands, which is based on hydro-engineering.

2.6 Conceptual model

When looking at flood risk management in the Netherlands, multiple factors can affect the implementation of green/blue infrastructure. As mentioned before, the factors or dimensions used in the PAA are discourses, resources, actors, and rules. In this research, these factors will be looked further into to determine whether they positively or negatively affect implementing green/blue infrastructure. The factors, discourses, resources, etc., are interrelated, meaning that if one changes, the others also change (Liefferink, 2006). This is why the factors are connected to implementing green/blue infrastructure in the conceptual model. In practice, changes in any of the four dimensions can determine a different extent of green/blue infrastructure implementation. And the other way around, changes in the extent of the implementation of green/blue infrastructure could also change the four dimensions.

The factors displayed in the conceptual model consist of multiple components; rules, for example, can consist of formal and informal rules.

Actors

For the actors dimensions, I will be focusing on the government actors. These actors are involved in the policy-making around flood risk management and have a direct impact on the implementation of green/blue infrastructure. Two main aspects of these actors will have to be identified to assess whether these actors might hinder or support the implementation of green/blue infrastructure. Firstly, all the actors involved must be identified. These different actors will then be grouped by their views on green/blue infrastructure. Secondly, the power relations between the actors will be determined. This is important because some actors might have the power to hinder or support the implementation of green/blue infrastructure.

Rules

Regarding the rules and regulations of the policy arrangement, I will be looking at both the formal rules that might impact the implementation of green/blue infrastructure and the informal rules that provide the way in which policies are shaped. For the formal rules, I will look at the laws and legislation that the policy-makers are obliged to comply with. Formal rules could directly impact the implementation of green/blue infrastructure by, for example, only allowing grey infrastructure. I will also try to identify the informal rules. An isolated, expert-based political culture (informal rules) that mainly focuses on the use of grey infrastructure could be a barrier to implementing green/blue infrastructure. It is therefore important to also look at the informal rules of flood risk management.

Resources

In the resources dimension, I will mainly focus on two sets of resources: financial abilities and knowledge/expertise. For the financial abilities, I will look at the financial resources of the actors involved and the ability to distribute these financial resources. Some actors might have significantly more financial resources than others, which might impact the implementation of green/blue infrastructure. If, for example, an actor that sees the benefits of green/blue infrastructure has significant financial resources, then this could increase the chance that green/blue infrastructure is implemented. Next to the financial resources, I will also be looking at the knowledge and expertise of the different actors. If an important actor has no knowledge of green/blue infrastructure but only of grey infrastructure, then this might hinder the implementation of green/blue infrastructure. An actor might have the financial capabilities to implement some type of infrastructure but might not have the ability to acknowledge the benefits of this type of infrastructure. Or, if an actor has great knowledge of biodiversity, then this might support the implementation of biodiversity in the project.

Discourses

For the discourse dimension, I will be looking at whether the actors involved think the main discourses in flood risk management have changed over the years and if this has impacted flood risk management. Changes in the main discourses on flood risk management might influence the implementation of green/blue infrastructure as the actors' perspectives could be changed. To help with identifying the main discourses, the most important features of these discourses have been summarised:

- Hydro-engineering: Controlling nature through engineering expertise and flood defence by dikes and dams.
- Environmental: Acknowledgement of environmental values, water as a 'friend' and not as an 'enemy', and criticism of outcome (ecological and societal consequences) of hydro-engineering interventions.
- Integrated management: Comprehensive approach to water management, the collaboration of stakeholders, and criticism on water-sector dominated governance approach.

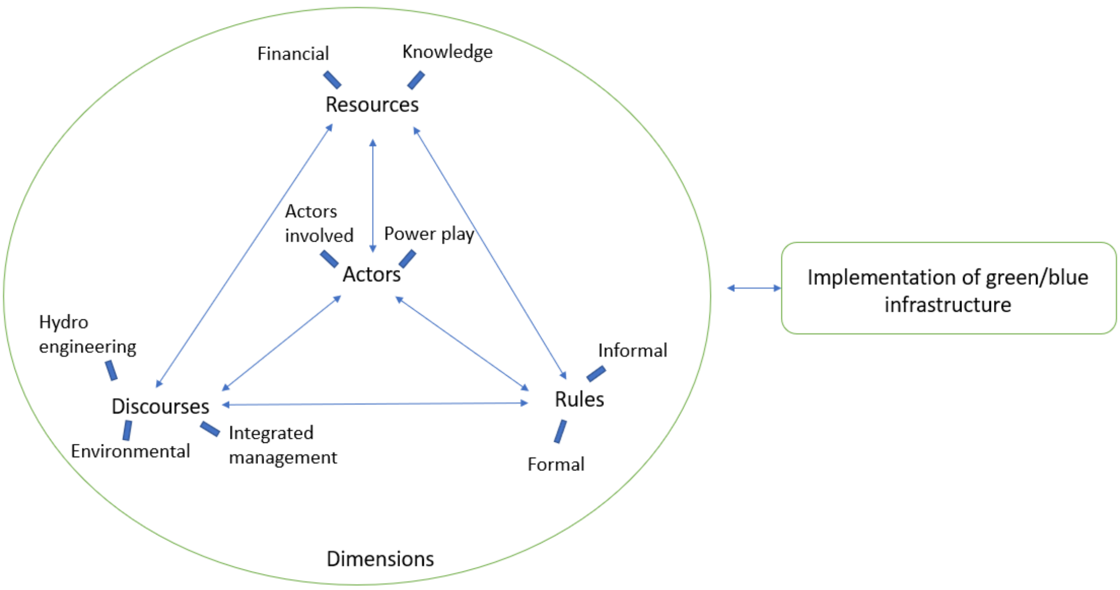

Figure 4. Conceptual model.

The arrows connecting the four dimensions represent the interconnectedness of the dimensions. If one of the dimensions changes, the others do too. Next to that, a change in the dimensions can also change to what extent green/blue infrastructure is implemented, and also the other way round. For example, if green/blue infrastructure is implemented more, then that will likely increase the knowledge of green/blue infrastructure.

Chapter III Methodology

3.1 Case selection

For this research, I chose to do qualitative research. Black (1994) argues that: “A qualitative approach - interviews, observation of activities, interpretation of written material - is most revealing when the variables of greatest concern are unclear” (P. 425). In my research, I try to identify the different factors that hinder or support the implementation of green/blue infrastructure; because it is unclear what factors these are, qualitative research would be most revealing. Qualitative research also helps us understand the nature, strengths, and interactions of variables (Black, 1994); this is important because, as mentioned before, all the factors are interconnected in the conceptual model.
The research approach will be a case study.

3.1.1 The Green River Well

The case study that was selected for this research is the flood risk management project, The Green River Well. Initially, this project only consisted of a dike strengthening task and a dike relocation task ordered by the government. However, during the decision-making and development process of the project, multiple other developments were integrated into the project. Examples of these developments are a green river, nature-inclusive agriculture, and stream recovery; these can be considered green aspects of the project. The factors that hindered or supported these green aspects (or other green aspects that were not integrated) will be examined, which will help to answer the research question. Through doing a case study, a wide range of perspectives can be captured. Concrete plans have been made at the time of this research, but the decision-making and development process is still ongoing (to possibly integrate more/other aspects).

3.2 Data collection

For the data collection of this research, two types of data sources are used: semi-structured interviews and literature review. The primary data for this research is collected through five semi-structured interviews with policymakers and actors directly involved in the project, The Green River Well. Respondents are selected based on two main criteria. The first criteria is that the respondent has to be part of one of the five actors involved in the project, The Green River Well (Municipality Bergen, Province Limburg, etc.). Second, respondents must be (heavily) invested in the project The Green River Well by, for example, being part of the project team.

For this research, I chose to do semi-structured interviews instead of unstructured or completely structured interviews. The semi-structured style consists of key questions constructed in an interview guide to get a broad perspective of the topic, but that also keeps the interviewer and the respondent in line with the topic. In the interviews, the aim is to keep the interviewees in line with the interview guide as much as possible to attain the information needed to answer the research question. Because of the semi-structured interview style, there is room for the respondents to speak freely throughout the interviews. The semi-structured kind of interview allows us to discover and elaborate upon the information that the respondent finds important. For each of the respondents, an interview guide was made; these can be found in the appendix. All the interviews were conducted through Microsoft Teams. Consent to record the interview was asked in all cases. The duration of the interviews varied from 20 minutes up to 1 hour; this had to do with the fact that some interviewees had more own input than others. In total, five semi-structured interviews were conducted. The project team of The Green River Well consists of five actors; four of these actors were interviewed. Table (1) below gives an overview of the different interviewees.

Interviewee	Actor	Function	Interview Guide	Date
Eric Kuiper	Municipality Bergen	Counsellor Spatial Planning	Appendix I	13-5-2022
Annelies Heidekamp	Ministry of Infrastructure and Water Management	Senior Policy Officer	Appendix II	3-6-2022
Wim van Hengel	Rijkswaterstaat (I)	Senior Advisor Water Management	Appendix III	7-6-2022
Keesjan van den Herik	(Contracted by) Water Authority Limburg	Independent Advisor, Project Manager	Appendix IV	14-6-2022
Rosalie Oomen	Rijkswaterstaat (II)	Trainee	Appendix V	10-6-2022

Table 1. Overview of interviewees.

To reach the actors involved in the project, invitation emails were sent to the municipality of Bergen, where the project takes place, the Province of Limburg, Rijkswaterstaat, the Ministry of Infrastructure and Water Management and Water Authorities Limburg. This invitation email can be found in the appendixes (Appendix VI). The only actor (involved in the project) that wasn't interviewed is the Province of Limburg. Multiple invitation emails were sent, but no response was given.

I decided not to interview local residents and private interest groups for the data collection. The actors involved in the project represent the local residents; because of this, these actors can give some view into the thoughts of the local residents. Also, local residents do not have a direct vote in policy making and can only possibly influence the implementation of green/blue infrastructure through the actors involved in the project.

The secondary data for this research is collected through a literature review. The data collected from the literature review describes the theoretical framework and the discourses dimension of the policy arrangement approach. The literature review is used for the discourses dimension so that the history of the dominant discourses in flood risk management in the Netherlands can be described. This is important for this research as these discourses might still have an impact on flood risk management as of today. Kaufmann & Wiering (2022) give a clear overview of the history of discourses in flood risk management in the Netherlands; their description of discourses is used in this research. The description of discourses is expanded by the data collected from the semi-structured interviews, based on the respondents' views on the current discourses in flood risk management.

3.3 Data analysis

A combination of deductive and inductive coding was applied to analyse the data. At first, the deductive approach was applied. The coding scheme used in this approach was structured by the four dimensions of the policy arrangement approach. The codes were determined by operationalising the conceptual model. Starting the coding with a deductive approach helped with structuring the findings in the results chapter by order of the four dimensions. The coding scheme used for the deductive approach is depicted in table 2. The data was coded in Atlas.ti.

Code group	Codes
Actors	Actor involved
	Power relation
Resources	Financial
	Knowledge/expertise
Rules	Formal rule
	Informal rule
Discourses	Hydro-engineering discourse
	Environmental discourse
	Integrated-management discourse

Table 2. Overview of codes.

Because not all findings could be coded using the deductive approach, codes were added to the coding scheme inductively. This was done through open coding, in which all the transcripts were again read from beginning to end, and along the way, fragments of the text were given codes. During this process, codes were given to all fragments (that had not yet been coded) that could help answer the research question. This allowed for the hindering or supporting factors to also emerge from the data itself. Using the inductive approach of coding (open coding) resulted in a total of 41 codes. These were then, where possible, divided into four code groups based on the four dimensions of the policy arrangement approach. Using these approaches to coding, parts of the transcripts were summarised and highlighted to identify possible factors that hinder or support green/blue infrastructure.

Chapter IV Results

In this chapter, the results following the conducted semi-structured interviews and the literature study will be presented. This will be done in order of the four dimensions of the policy arrangement approach. First, the results of the actors dimension; secondly, the rules dimension; thirdly, the resources dimension and finally, the discourses dimension.

4.1 The project

Next, a general description of the project, The Green River Well, will be given. This will make the results section a lot clearer because one already has an idea of the main aspects of the project. Whilst green aspects were added to the project, the main aspects of the project, The Green River Well, are still dike strengthening and dike relocation. By relocating the dikes, more space is given to the river. This helps with lowering the water level. As mentioned in the introduction, Belgium, Luxembourg, and parts of The Netherlands faced heavy floods, which caused 240 people to lose their lives (Van Fleteren, 2021). The floods of 2021 were an extra cause to see if multiple plans could be carried out at once. (Waterschap Limburg, 2022).

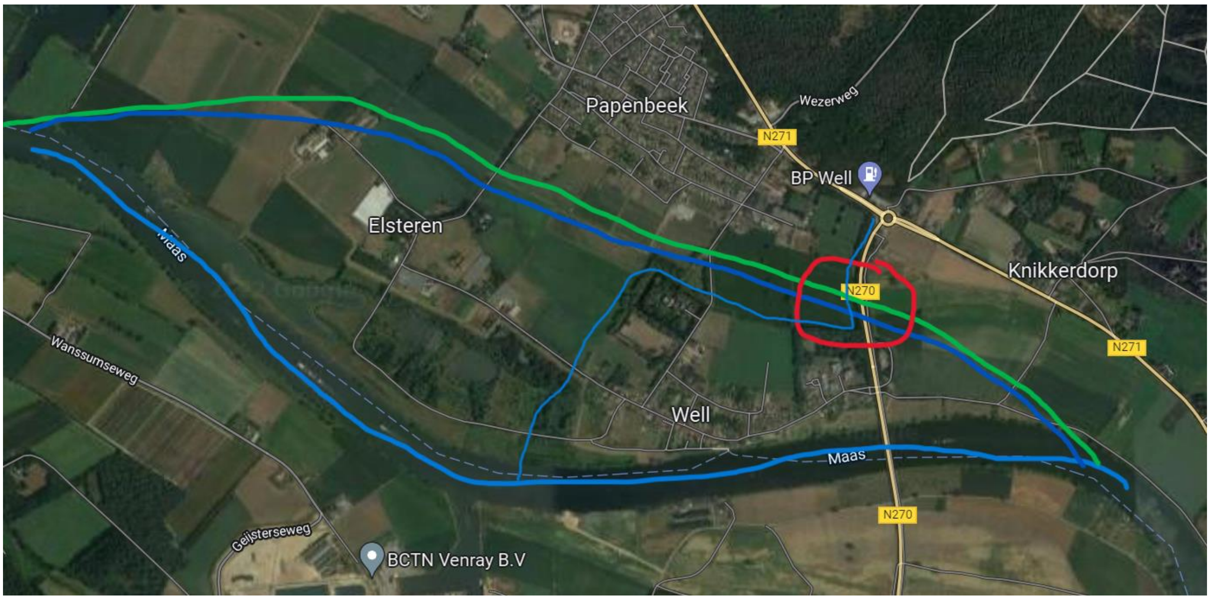

Figure 5. The plans for the Green River Well (Google Maps, 2022).

Dike Strengthening

Well's existing embankments, constructed after the highwaters in 1993 and 1995, do not match today's legal norms. To protect the inhabitants of Well against high water levels in the future, higher and stronger dikes and embankments will be built. These new higher and stronger dikes won't take away space from the river Maas but will protect the surrounding houses and businesses. In fact, space will be given back to the river Maas. As a result, the homes and businesses surrounding the river are better protected, more water can flow through the river Maas, and the Maas as a whole becomes safer (Waterschap Limburg, 2022).

The green river

The green river is the name for the dried-up secondary channel next to the Maas. This part of the river can be seen in figure 5 as the green/blue line. In the past, this bit of land used to flood during high water. However, the construction of the road, the N270 (which is the yellow line in figure 3), prevented this from happening. An aspect of the project The Green River Well is to make an under passage in the N270 for the river. As a result of this under passage, the dried-up part of the river or 'green river' can inundate (easier), reducing the water level. So, the green river acts as a flood plain during high water. The green river is the main green/blue aspect of the project. When the green river is not flooded (so 99% of the time), this area will be used for nature-inclusive agriculture. In 20 years, the soil of the green river should be healthy whilst staying balanced. Nature-inclusive agriculture stands separate from using fertiliser, antibiotics, or pesticides by using the qualities of the environment.

Stream recovery

The stream that flows through the green river will be recovered. In the recovery of the stream, multiple weather extremes have been considered. The stream will be widened, making it more resilient to heavy rainfall and drought, which also benefits the water levels. The stream will also be given a more natural character. As a result, the stream will offer space to water plants and animals that belonged there originally.

4.2 Actors

As mentioned in the theoretical framework, the first step in analysing the actors dimension in the case of the Green River Well is to define the main actors involved in the project's policy-making process. To make this process easier, all the actors involved in the project need to be identified. In the interview with the municipality of Bergen, the interviewee mentioned the following actors to be involved in the policy-making process of the project:

- Rijkswaterstaat
- Ministry of Infrastructure and Water Management / Ministry of I&W (Ministerie van Infrastructuur en Waterstaat)
- Province of Limburg
- Municipality Limburg
- Water Authorities Limburg (Waterschap Limburg)

Slomp (2012) also gives a clear overview of the different organisations responsible for flood risk management in The Netherlands, see figure 6.

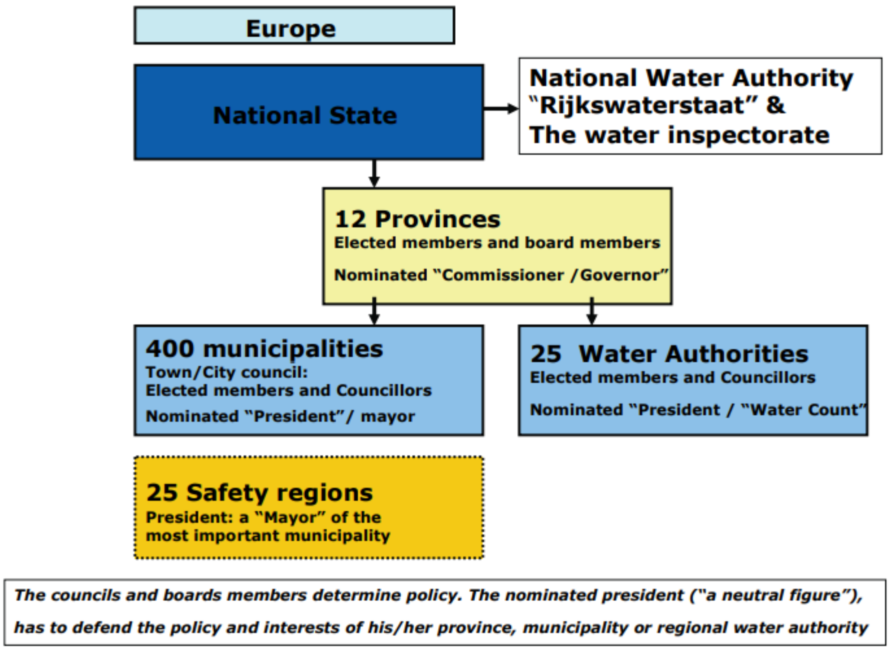

Figure 6. Organisations in the Netherlands (Slomp, 2012).

So, in the Netherlands, four governmental layers are responsible for water management. Besides the three main layers, municipalities, provinces and the national government, another more autonomous layer is the regional waterboards (as seen in figure 6) (Wiering & Crabbé, 2006). Operating inside the national layer but with regional departments is the Directorate-General for Public Works and Water Management (Rijkswaterstaat), which is another important policy actor (Wiering & Crabbé, 2006).

Inside the municipalities, provinces, and water authorities, two functions are involved in projects like The Green River Well, directors and civil servants. Directors are elected through municipal elections. These directors determine policy and make sure that the policy is implemented. Civil servants then prepare and implement this policy. So, in the project The Green River Well, the directors determine policy, which is then prepared and implemented by the civil servants. The interviewee from Water Authority Limburg states, “The province of Limburg is a very agricultural and a somewhat old-fashioned province that does not have much with nature and nature development” (personal communication, 14-06-2022). The interviewee from Water Authority Limburg argues that this translates into the policy made by directors as these are chosen by the province and municipalities.

Now that the actors involved in the project are known, the main actors must be identified. The interviewee from Rijkswaterstaat (I) mentioned that there are two main actors. These are the Water Authority Limburg and the Ministry of I&W. Water Authority Limburg is leading the project because they got the task to strengthen the dikes. This is also the Water Authority’s general task: ensuring the dikes are safe and keeping the water away from the people (Waterschap Limburg, 2022). Water Authority Limburg is also responsible for putting together and contracting the project team. Next to the Water Authority Limburg, the Ministry of I&W is a main actor in this project. This is because the Ministry of I&W is bringing in most of the finances; the resources chapter will go more in-depth on this.

The task of strengthening the dikes comes from a program called the HWBP (Hoogwaterbeschermingsprogramma) or flood protection program (FPP). The interviewee from the Municipality of Bergen stated that the FPP is legally required to be implemented in the project The Green River Well. In the rules and regulations chapter, the FPP will be further explained. The actors that are responsible for the implementation of this program are Rijkswaterstaat and Water Authorities Limburg. Because of this, these actors have more influence/power in the project because the FPP (or strengthening the dikes) needs to be implemented by law, unlike the addition of green to the project. This means that some of the desires other actors might have for this project will not get executed because it doesn’t go hand in hand with implementing the FPP.

Despite the leading role of the Water Authority and the Ministry of I&W being the biggest financer, most interviewees state that the different actors are all treated equally. The interviewee from Water Authority Limburg describes the cooperation process as follows: *“It is not because you have a lesser interest that you are always subservient to the greater interest” (personal communication, 14-06-2022).* The interviewee from the Ministry of I&W

confirms this in her interview: *"I think we try to take each other's tasks very seriously and also try to understand what everybody's position is in the project" (personal communication, 03-06-2022)*.

In the project, the project team works towards a particular image of the future. The image of the project's future is where all the interests and desires of the different actors are captured. Making this image is an essential part of the project as this is where the main lines of the project are defined. To create such an image of the future of the project, all the different actors come together around a table with a map of the target area, which is shown in figure 7.

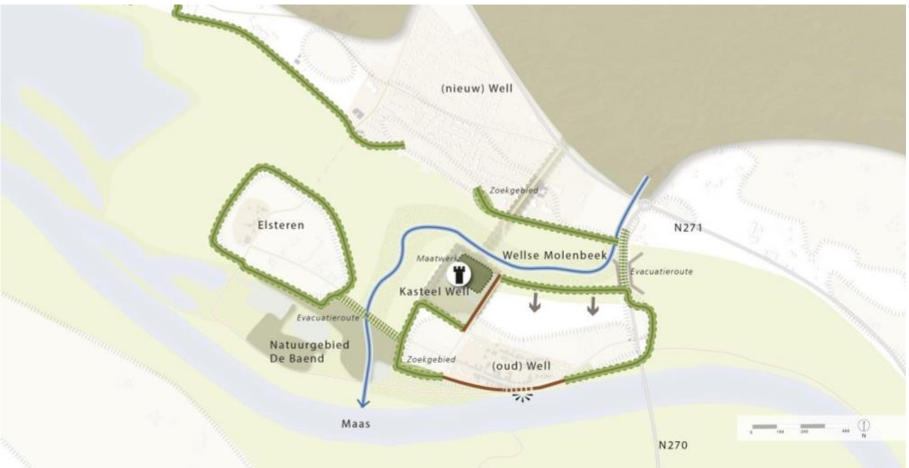

Figure 7. Dike trajectory Well: Results design sessions (Waterschap Limburg, 2020)

All the actors then start listing their interests and desires, and after that, the actors try and include all these interests and desires into the project. The interests and desires of the actors are, in brief, the following (as mentioned by the interviewee from Rijkswaterstaat):

- The Ministry of I&W: Flood protection and limiting costs.
- Water Authority: Dike strengthening and stream recovery.
- Rijkswaterstaat: Gaining back riverbed by moving dikes outwards and promoting the interests of the river itself.
- Municipality of Bergen: creating a hedges landscape, nature-inclusive agriculture, the safety of inhabitants and recreation.
- Province of Limburg: quality of the landscape.

What is interesting in these different interests and desires is that no actor at the table has in their policy to add green to the project or to maximise biodiversity. The interviewee from Rijkswaterstaat (I) mentions that, in theory, the Ministry of I&W is responsible for adding green to the project. Still, from the Ministry, only somebody from the branch flood protection is at the table and not somebody from the branch nature objectives. The interviewee from Rijkswaterstaat (I) mentions that there were also no ecologists involved in making the image of the future. The reason for this is that realisation of nature purposes and ecological goals is, according to the policy, not part of the destination of the project.

So, from a policy point of view, maximising biodiversity and the addition of green to the project is not a task at hand. However, maximising biodiversity and adding green to the project could still be considered an aim by the project team. The interviewee from Water Authority Limburg argues that this mainly depends on the nature of the project team. If the different actors involved in the project see the importance of adding green and increasing biodiversity or have a heart for nature, likely, green aspects will still be added to the project, despite it not being in the policy. This does require a positive attitude towards the project by all the actors involved. All the interviewees state that the actors involved in The Green River Well have had this positive attitude. At the start of the project, the municipality of Bergen and (to a lesser extent) the province of Limburg also wanted to negotiate about the design of the green river, instead of just strengthening and relocating the dikes. The Ministry of I&W and Rijkswaterstaat initially did not want to think along for the realisation of this because this was not a task at hand. It was when Rijkswaterstaat recognised that it would be fair if they did think along that the Ministry of I&W also changed their minds. Because of positive attitudes, all the actors together start thinking about the design of the green river. Important to mention here is that the river is green because 99% of the time, there is no water in the river. During these times, the riverbed is full of tall grass; therefore, the term green river is used instead of blue river. The interviewee from Water Authority Limburg states that if the project team aims to maximise biodiversity and add green to the project, this must be explicitly mentioned and elaborated upon in the project plans. Projects like The Green River Well could take 10 to 15 years to complete. In these years, the project team can change. It is possible that the changed project team is mainly interested in civil engineering. If maximising biodiversity and adding green to the project are not explicitly mentioned in the project plans, the new project team could have no regard for these aims.

4.3 Rules

During the project, there are several laws and policies that need to be obeyed by the different actors. Multiple interviewees mention the ‘policy rules major rivers’ (Beleidsregels Grote Rivieren) to be one of these policies. Specifically, this policy is mentioned because it influences the implementation of green infrastructure. The policy rules on major rivers contain several clauses that need to be considered. For example, Clause 5 states that for the following river-bound activities in the part of the river that applies to the current-carrying regime, permission is given:

A. The construction or modification of hydraulic engineering structures.
B. The realisation of facilities for better and safer handling of recreational vessels.
C. The construction or modification of hydroelectric power plants.

………

F. The realisation or improvement of nature.

(Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022)

So, point F of article 5 would indicate that permission will be given for the improvement of nature in the current-carrying part of the river. One might think that this would mean that nature can grow freely and that this part of the river is full of plants and bushes. However, there is another clause that has a direct effect on Clause 5, this being Clause 7 of the policy rules major rivers. Clause 7 states that: Permission is only given if:

a. the activity is situated and implemented in such a way that the safe functioning of water management is guaranteed.
b. there is no actual impediment to increasing the discharge capacity, and
c. the activity is situated and implemented in such a way that water level rise or the reduction in storage capacity is as small as possible.

(Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2022)

Clause 7 also comes into effect for parts of the river that have a water-storing function. The interviewee from Rijkswaterstaat (I) mentions that Clause 7 has a significant impact on the realisation of nature on the riverbed. When the interviewee from Rijkswaterstaat (I) is asked what effect planting a few trees in the riverbed would have, the interviewee answers: "*That causes the water to be pushed up against those trees, causing the water level to rise*" (personal communication, 07-06-2022). So, if the actors would want to plant those trees in the riverbed, probably no permit will be given because those trees would cause water levels to rise. The interviewee from the municipality of Bergen depicts how strict Clause 7 can be. The interviewee states that wanting to place as little as a basketball hoop in the riverbed could get turned down. Because once again, in the situation of high water, the water would be pushed up against the basketball hoop causing the water level to rise. Slomp (2012) gives a clear overview of what is meant with the riverbed, see figure 8.

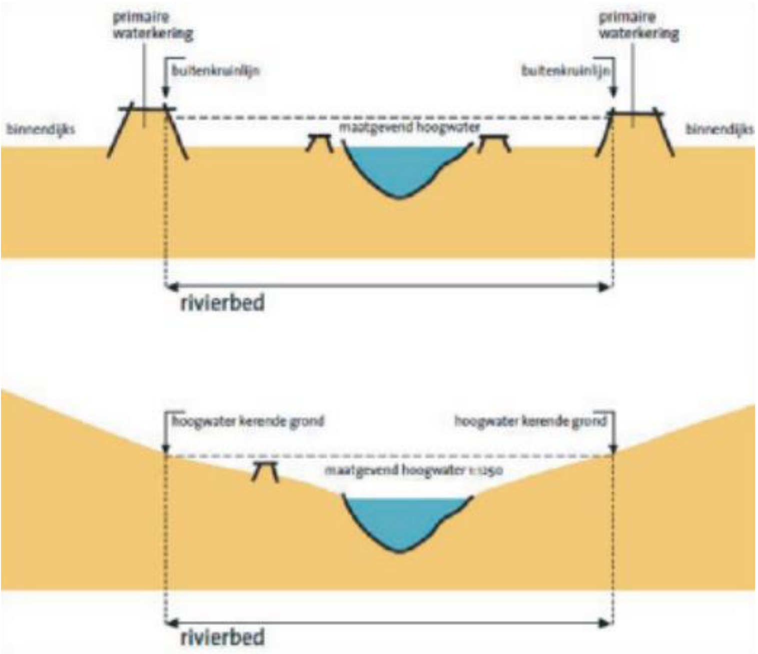

Figure 8. Overview of the size of the riverbed (Slomp, 2012).

The interviewee from the Ministry of I&W gives an insight as to why this Clause is so strict: “*Look when it ultimately comes down to water safety versus nature. These are two variables that sometimes simply cannot go together. Then you can still do your best with the layout, but a large primeval forest does not go together with water safety. It is just very important to look at what is possible where and what is not possible and to find space for each other there*” (personal communication, 03-06-2022). So, there is no space for nature when water safety is at hand. The interviewee from Water Authority Limburg mentions that whilst the project cannot add green to this part of the river because of the policy rules major rivers; there will still be some vegetation development. This is because, in the parts of the river that are dry 99% of the time, the vegetation that naturally develops is allowed to develop.

In the interview with Rijkswaterstaat (I), the interviewee mentions that sometimes there is space for nature in the project plans when water safety is at hand: “*You also see in other projects that parts of the water level reduction you realise are also filled with greenery to achieve ecological goals. And that is also possible in the granting of permits”* (personal communication, 07-06-2022). In some other projects, part of the water level reduction gained through, for example, relocating dikes, is given back for realising green aspects. If, for example, the water level is reduced by 16cm by relocating a dike, 4cm of this reduction could be used to add green to the project. This would result in a project that sees a 12cm reduction whilst also having green aspects.

As mentioned in the actors part of this chapter, the HWBP (Hoogwaterbeschermingsprogramma) or, in English, the FPP (flood protection program) is a program that aims to strengthen over 1.500KM of dikes in the coming 30 years in the Netherlands. The dike strengthening aspect of the green river in Well is part of the FPP. In the project, The Green River Well, 5.7-kilometre dike will be strengthened. Figure 9 shows the dikes that will be strengthened (marked in red).

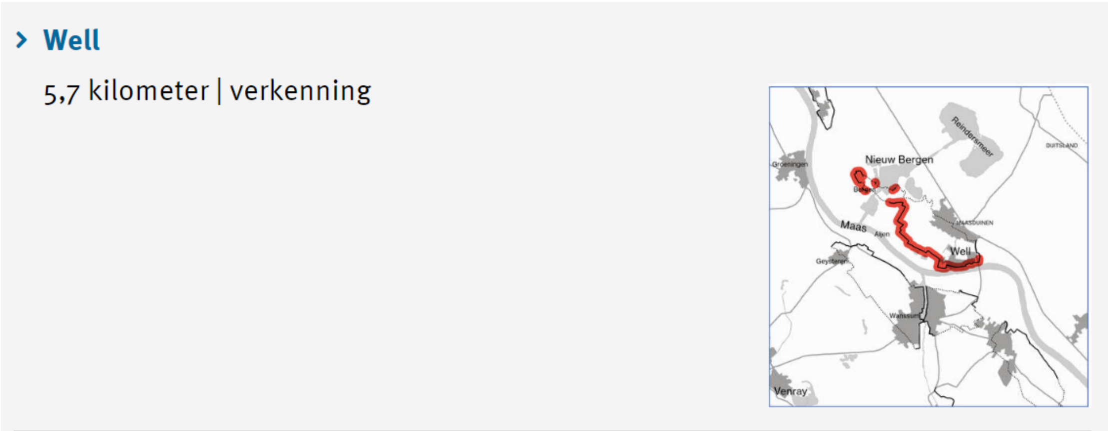

Figure 9. FPP project Well (Rijkswaterstaat, 2020).

Because strengthening the dikes is part of the FPP, Rijkswaterstaat and Water Authority Limburg are legally required to reinforce the dikes in Well. Only giving the river more space by relocating the dikes is therefore not an option.

When the interviewees were asked about the existence of any informal rules that could hinder or support the implementation of green/blue infrastructure, none of the interviewees could think of any.

4.4 Resources

Budgets

The project, The Green River Well, is mainly financed by the Ministry of I&W and the FPP (so, Rijkswaterstaat and Water Authority Limburg). The other actors, municipality Bergen and province Limburg, also have budgets for this project. However, the budgets of the municipality and the province are very small compared to the budgets of the Ministry and the FPP. The interviewee of Rijkswaterstaat (I) gives an example of what these budgets might look like: Ministry & FPP - 50.000.000, Province - 1.000.000 and municipality - 500.000.

The budget from the Ministry of I&W and the FPP has as destination water safety, meaning that this money must be used for strengthening and relocating dikes, not for the destination greenery. In the interview with Rijkswaterstaat (I), the interviewee comes with an anecdote to explain this thinking in means of destinations for budgets: "*If you do something for flood protection, then people who spend that money in The Hague for flood protection must be able to justify why they spend that money and what they achieve with it. If they spend that money and then get the question of: "Yes, what have you done for it?", and they say: "Yes, we have planted ten trees", then the question is asked:" what does that mean for high water safety?", "yes nothing", so that is not possible. So, if you want to develop something ecologically, you can only do so to a very limited extent from the high-water safety budget. So, if you bring another destination into the project, you must immediately look for a source of financing for it"* (personal communication, 07-06-2022). The interviewee from the Ministry of I&W confirms this: "*If there is no government task for greenery, then we must have a serious conversation on the implementation of green infrastructure"* (personal communication, 03-06-2022).

Another factor that influences the addition of green into a project like the Green River Well is that the budget mainly comes from the Ministry of I&W and FPP; the money they have is public money. When money that has as destination high water safety is used for adding more green, other projects in the Netherlands, similar to the Green River Well, might also want to use that money for adding green. Therefore, the interviewee from the Ministry of I&W states that it is essential to always look at the bigger picture.

Knowledge/expertise

Generally, Rijkswaterstaat and Water Authority Limburg have the most knowledge on flood risk management. The Water Authority Limburg has the knowledge to see where and when dikes need to be strengthened and how to strengthen them. This knowledge is rooted in the hydraulic paradigm. As was mentioned in the theoretical framework, the hydro-engineering discourse has been heavily institutionalised in the Netherlands since 1953. Because of this, mainly Water Authorities need to keep improving their knowledge and expertise on their hydro-engineering expertise because they are responsible for the dikes.

The different actors also get a lot of help from others; the interviewee from the Ministry of I&W mentions that she has her own lawyers, land recruitment specialists and specialists from Rijkswaterstaat. Rijkswaterstaat as an actor also has its own specialists to help in projects like the Green River Well.

The interviewees from Rijkswaterstaat (I) and Water Authority Limburg both mention that there is no certified ecologist part of the project team. However, whilst there is no actual ecologist part of the project team, there is a lot of knowledge on ecology present in the project team. The interviewee from Water Authority Limburg mentions that there are multiple people who are part of the project team that know almost every species of plant and bird that are common in the Province of Limburg.

Power relations

The Ministry of I&W is the biggest financier of the project. If other actors want to implement something into the project, they first need to seek permission from the Ministry of I&W. The Ministry of I&W will then see if the addition to the project fits within the budget. The Ministry of I&W being the biggest financer of the project gives it a powerful position. However, all the actors involved in the project are needed to come to a successful ending. It is important that in projects like these, a consensus is always reached and that all actors are satisfied. The interviewee from Rijkswaterstaat (I) mentions that if one of the actors quits, that would be a major problem. Because of land possession and licenses, all the actors involved are needed. The province of Limburg is responsible for setting the standards for construction permits of large infrastructural projects like dikes (Slomp, 2012). Suppose, for example, the municipality of Bergen decides to pull the plug. In that case, the project cannot be completed because the municipality of Bergen owns the land where the project should take place. Usually, the province of Limburg owns the land, but the municipality has bought a big part of the land for the Green River Well (Gemeente Bergen, 2022). The municipality of Bergen is also responsible for providing building permits (Slomp, 2012). Land possession and providing the construction permits, therefore, give the municipality of Bergen and the province of Limburg a good bargaining position.

PAGW

The PAGW (Programmatische Aanpak Grote Wateren), or Programmatic Approach Large Waters, is an investment program by the Ministry of I&W and Agriculture, Nature, and Food quality (making it a government task). This program aims to improve the ecological water quality and strengthen nature (Ministerie van Landbouw, Natuur en Voedselkwaliteit, 2022). The program was set up because the water quality and nature in the Netherlands are in bad shape. The reason for this, according to the Ministry of Agriculture, Nature, and Food quality (2022), are the water management networks like dikes, dams, and polders. Another reason water quality and nature are in bad shape is the intensive use of the waters. The PAGW works together with regional governments, companies, social partners, and nature organisations to combine this government task with regional tasks. By doing so, the PAGW aims to create this strong and resilient nature and excellent ecological water quality.

A trainee at Rijkswaterstaat is currently looking at the possibility of incorporating PAGW goals into the project The Green River Well. If this is possible, then that would mean that the project The Green River Well could get additional financing to improve the ecological water quality and strengthen the nature. The interviewee from Rijkswaterstaat (II), who is looking at these possibilities, states that this has not resulted in anything yet because it is quite hard to get involved in such projects. The interviewee from Rijkswaterstaat (II) also states that: *"The project Well can also say: "we don't want you to get involved because things will only get more complicated", chances are the project can then easily continue as it is now. But if they want more money, they can get it from the PAGW"* (personal communication, 10-06-2022). If the project The Green River Well does decide to involve the PAGW, then the extra money the project receives must be spent on adding nature. The PAGW will also monitor if the money is being spent on the right purposes.

4.5 Discourses

The history of discourses on flood risk management in the Netherlands has already been discussed in the theoretical framework. This part of the results chapter will go further in-depth on the current discourses on flood risk management in the Netherlands.

A change that the interviewee from Rijkswaterstaat (I) noticed is that there has been more room for an integrated approach in flood risk management projects in the past years. As mentioned in the theoretical framework, in the 1970s, an integrated management discourse arose that included the collaboration of multiple stakeholders. However, the integrated approach that the interviewee from Rijkswaterstaat (I) mentions is not integrated in the way of bringing in multiple stakeholders but integrated in the way of looking at developing multiple things at the same time. The interviewee from Rijkswaterstaat (I) states that: "*In the past, dike strengthening projects were solely dike strengthening projects. Now there is also being looked at the floodplains and broadly at how you can develop things together"* (personal communication, 07-06-2022). Integrating multiple developments into the same project is more sustainable because less transport is needed, it causes less hindrance, and extracted soil can be reused in other places (Waterschap Limburg, 2020).

The project The Green River Well clearly shows this more integrated approach. Instead of just strengthening and relocating the dikes, more developments are integrated into the project, like stream recovery.

The interviewee from the Ministry of I&W states that she has witnessed increasing regard for sustainability. Climate neutrality and circularity are terms that are used more and more. These developments indicate the emergence of a sustainability discourse. The interviewee from Water Authority Limburg confirms this. He states that because of the increasing regard for sustainability, with projects like these, the carbon footprint must be heavily reduced. The interviewee from Water Authority Limburg also states that there is a biodiversity crisis, but that this crisis is much less recognised than the climate crisis. Therefore, maximising biodiversity in projects like the Green River Well is not a task that is set at the beginning of the project but reducing the carbon footprint is.

Chapter V Conclusion

In this chapter of the research, the conclusion, discussion and reflection will be discussed. First, the conclusions of this research will be presented in 5.1. Secondly, the discussion is presented in 5.2. And finally, the reflection is presented in 5.3.

5.1 Conclusion

In the introduction of this research, the main research question was formulated, which stated: “Which factors hinder or support the implementation of green/blue infrastructure for flood risk management in the Netherlands?”. As mentioned before, the policy arrangement approach was used to identify the factors that hinder (or barriers) or support green infrastructure. The policy arrangement approach consists of four dimensions: actors, rules, resources, and discourses. These dimensions order the results section of this research to give a clear overview of the data. The conclusion section is not ordered by the four dimensions, so the interconnectedness of the four dimensions is clearly emphasised.

In the project the Green River Well, there are five actors involved in the policy-making process; these are Rijkswaterstaat, the Ministry of Infrastructure and Water Management (Ministry of I&W), Province of Limburg, Municipality Bergen and Water Authority Limburg. The main actors in this project are the Ministry of I&W and Water Authority Limburg. Water Authority Limburg has the general task of strengthening the dikes, which can be considered the project’s main aspect and is why the Water Authority has a leading role. The Ministry of I&W is the biggest financier of the project, which makes the Ministry of I&W a powerful actor. These actors have a flood protection task, so they must strengthen the dikes. Adding nature or greenery to the project The Green River Well is not part of this task. Therefore, their finances must be spent on flood protection, like strengthening the dikes or relocating the dikes and not, or in very little proportions, on adding green. This can be considered a factor that hinders the implementation of green infrastructure.

The interests and desires of Rijkswaterstaat, Municipality Bergen and Province Limburg can be considered factors that support the implementation of green/blue infrastructure. Although Rijkswaterstaat must carry out the FPP (Flood Protection Program) in cooperation with Water Authority Limburg, it also has an interest in promoting the interests of the river itself and relocating dikes to give the river more space. The main interest of the province is the quality of the landscape, which also supports the addition of green to the project. The municipality supports the addition of green to the project through their interest and desire to create a hedges landscape and adding nature-inclusive agriculture.

The project The Green River Well originally only had a dike strengthening and dike relocation task. The interviews show that mainly because of the positive attitude of the actors involved (the project team), green/blue developments have also been integrated into the project. The project team's positive attitude is therefore considered a supporting factor for green/blue infrastructure. Examples of green developments that have been integrated are the stream recovery that is being realised and the creation of the ‘green river’. The different actors involved in the project all have their policies. My interviews show that none of these policies of the different actors states that green aspects should be added or that biodiversity should be increased in these projects. So, from a policy point of view, adding green or maximising biodiversity is not a task for projects like The Green River Well. However, if the project team itself sees the importance of adding green or maximising biodiversity, they can make this an aim for the project without it being in their policy. Therefore, the implementation of green/blue infrastructure currently heavily depends on the views and thoughts of the project team itself. This shows that the hydro-engineering discourse is still the dominant discourse in flood risk management in the Netherlands because flood risk management policy only states that grey infrastructure should be implemented. The theory chapter discusses how around 1953, the hydro-engineering discourse started being institutionalised. The fact that at this time, flood risk management policy mainly supports grey infrastructure and not green/blue infrastructure shows that the hydro-engineering discourse is still heavily institutionalised to this day.

In the rules dimension of the policy arrangement of the Green River Well, one set of rules influences the policy-making process of the Green River Well, the ‘policy rules major rivers’ (Beleidsregels Grote Rivieren). These policy rules contain several clauses that hinder the implementation of green infrastructure. Because of this set of policy rules, most likely, no permission will be given to adding green, like planting trees, to the project. However, it does not prohibit nature from growing freely on the riverbed. Therefore, it only limits the implementation of green/blue infrastructure to a certain extent.

In the project, The Green River Well, the Flood Protection Program (HWBP) must be carried out by law. The goal of the FPP is to strengthen the dikes, not relocate them. Relocating dikes gives the river more space, which is considered a more natural way of flood risk management in the theoretical framework. Therefore, the FPP can be viewed as a factor that hinders the implementation of green/blue infrastructure. The fact that dikes must be strengthened by law perfectly depicts the institutionalisation of the hydro-engineering discourse. The task of carrying out the FPP is in the hands of the Water Authority Limburg and Rijkswaterstaat, which shows the connection between the rules, discourses and actors dimensions.

The dominance of the hydro-engineering discourse also shows in the financing of projects like The Green River Well. The main resource that has an influence on the implementation of green in the project the Green River Well is financing. As mentioned before, the Ministry of I&W and the FPP are the main financiers of the project. The money they have for this project is reserved for the destination flood protection due to the institutionalisation of the hydro-engineering discourse. Therefore, this money cannot, or in very little proportions, be spent on adding green or nature to the project. Financing is, therefore, a factor that hinders the implementation of green infrastructure. This factor can be reduced in strength by the municipality of Bergen and the province of Limburg. The province of Limburg and the municipality of Bergen acquire a bargaining position through their ownership of the land where the project takes place. Suppose the municipality and the province do not agree on the different aspects of the project, like strengthening the dikes or relocating the dikes. In that case, the project cannot be executed. This gives the municipality and the province leverage in implementing, for example, nature-inclusive agriculture or landscape development in the project. These can be considered green aspects of this project. The ownership of the land by the province and municipality and their interests and desires to add these green aspects can therefore be seen as a factor that supports the implementation of green infrastructure.

The knowledge inside the project team is another factor that influences the implementation of green/blue infrastructure in flood risk management. In the project The Green River Well, there is a lot of knowledge of ecology present. This supports the implementation of green/blue infrastructure. The interviewee from Water Authority Limburg mentions that in other projects, the project team can mainly have knowledge of civil engineering, which is likely to hinder the implementation of green/blue infrastructure.

The interviewee from Rijkswaterstaat (I) mentions that dike strengthening projects in the past just focussed on strengthening dikes and did not look at integrating other developments, like green developments. This hinders the implementation of green/blue infrastructure and shows the dominance of the hydro-engineering discourse. The interviewee from Rijkswaterstaat (I) also mentions that recently there has been more room for integrated approaches in flood risk management projects. Next to just dike strengthening, other (green) developments are now integrated into the projects. The stream recovery that has been integrated into the project The Green River Well is an example of this. This more integrated approach can therefore support the implementation of green/blue infrastructure in flood risk management.

Two interviewees mention increasing regard for sustainability in flood risk management, indicating that a sustainability discourse could be on the rise. This shows in the fact that projects like The Green River Well must drastically reduce their carbon footprint. The emergence of a sustainability discourse could support the implementation of green/blue infrastructure in flood risk management because this type of infrastructure is more sustainable than the more traditional grey infrastructure.

Although hydro-engineering is still the dominant discourse in flood risk management in the Netherlands, the interviews show that new discourses on sustainability and integrated approaches are emerging. The emergence of the program PAGW could be the result of this sustainability discourse. This is a program that the Dutch government itself has initiated, and that finances the improvement of water quality and nature. The government states that this program was initiated because water quality and nature are in poor condition. They mention dikes as one of the reasons for this poor condition. The fact that the government itself initiates a program to compensate for the negative effects of dikes might indicate that the dominance of the hydro-engineering discourse in flood risk management in the Netherlands is coming to an end.

5.2 Discussion

In this part of the conclusion, the results will be discussed. First, the results of this research will be compared to the existing theories derived from the literature. Secondly, the recommendations for further research will be given based on the results of this research.

Interpretation of findings

Section 5.1 presents the findings on the factors that hinder or support the implementation of green/blue infrastructure in flood risk management in the Netherlands. As mentioned in the theoretical section of this research, green/blue infrastructure falls under the concept of nature-based solutions. Sarabi et al. (2020) have identified a set of fifteen barriers to nature-based solutions. The following section will compare the barriers to nature-based solutions identified by Sarabi et al. (2020) with the barriers for green/blue infrastructure identified in this research.

1. *Lack of political will and long-term commitment*

The barrier lack of political will and long-term commitment was not identified in the case of The Green River Well. The reason for lack of will and long-term commitment is often because political decision-makers prefer interventions with short-term results for re-election purposes. Directors of the municipality, province, and water authorities are the only functions (relevant to this case) inside these actors that are elected. Directors determine policy, so if a director is unwilling to commit to implementing green/blue infrastructure, that would be a barrier to the implementation. However, no directors were interviewed, so it cannot be said for sure that this is a barrier (or not) to the implementation of green/blue infrastructure.

2. *Lack of sense of urgency among policy-makers*

The results of this research show that depending on the directors of the municipality, provinces, and water authorities and the project teams of projects like The Green River Well, this could be a barrier to the implementation of green/blue infrastructure. In the project The Green River Well, this is not a barrier because the project team acknowledge that adding green aspects to the project is important to preserve nature and biodiversity. However, the respondents also mention that there are other projects where the actors involved do not see the benefits of adding green aspects and therefore lack the urgency to implement these green aspects. On some occasions, a lack of urgency is a barrier to implementing green/blue infrastructure in the Netherlands.

3. *Lack of public awareness and support*

In the province of Limburg, where the project, The Green River Well, is located, a lack of public awareness and support is a barrier to the implementation of green/blue infrastructure. The interviewee from water authority Limburg mentioned that the province of Limburg is not too keen on nature development, which translates to the policy made by directors as these are chosen by the province. The reason for this way of thinking could be that the province of Limburg is somewhat old-fashioned, according to the interviewee of Water Authority Limburg, and that the province, therefore, prefers more traditional ways of flood risk management.

4. Risk aversion and resistance to change

The results of this research show that risk aversion and resistance to change is not a barrier to the implementation of green/blue infrastructure in river flood risk management in the Netherlands. The different respondents mention that if the substantiation of the importance of green additions is sufficient, then the actors are willing to change their minds. In this respect, it is the legal frameworks that do not allow the changes and not the thoughts of the actors themselves. For example, even if the actors wanted to only implement green/blue infrastructure to complement existing dikes (grey infrastructure) instead of also strengthening the dikes, then that would not be possible legally because the dikes have to be strengthened by law.

5. Silo mentality

Policymakers that stick to their ‘silos’ is considered a barrier to nature-based solutions by Sarabi et al. (2020). It is also identified as a barrier to green/blue infrastructure in flood risk management. Multiple respondents mention that actors sticking to their silos has hindered the addition of green aspects to the project, The Green River Well. Actors like the Water Authority Limburg and the Ministry of I&W can get stuck in their silos because they operate based on legal frameworks that require the implementation of grey infrastructure like dikes.

6. Misalignments between short-term plans and long-term plans

The short-termism of municipal administrations is a barrier to nature-based solutions because nature-based solutions require long-term planning. The results of this research show that this is not a barrier to the implementation of green/blue infrastructure in river flood risk management in the Netherlands. Actors are aware that flood risk management projects like The Green River Well can take 10-15 years to complete and have access to schedules that help with the long-term planning aspects of these projects. The reason that misalignments between short-term and long-term plans is a barrier of nature-based solutions but not for green/blue infrastructure in river flood risk management could be that flood risk management projects generally require long-term planning because these are often major projects. This makes implementing green/blue infrastructure easier as long-term planning knowledge is already present.

7. Lack of supportive policy and legal frameworks

The results of this research show that lack of supportive policy is not a barrier to the implementation of green/blue infrastructure in river flood risk management because so much policy has been written that some sort of supportive policy can always be found. On the other hand, the lack of legal frameworks is a barrier to the implementation of green/blue infrastructure in flood risk management. Legal frameworks in the Netherlands tend to still require the implementation of grey infrastructure in flood risk management, which hinders the implementation of green/blue infrastructure. The reason for this is the institutionalisation of the hydro-engineering discourse in flood risk management in the Netherlands. This also causes the financial resources to be limited because these are aimed at grey infrastructure.

8. Lack of design standards and guidelines for maintenance and monitoring

Uncertainties on the best way to design, maintain and implement nature-based solutions can be a barrier to implementation. None of the respondents of this research mentioned a lack of design standards and guidelines for green/blue infrastructure. The reason for this could be that green/blue infrastructure like floodplains and wetlands occur naturally and therefore require less design standards and guidelines than nature-based solutions like green roofs or urban gardens, which do not occur naturally.

9. Lack of skilled knowledge brokers and training programs

The barrier lack of skilled knowledge and training programs is not perceived in the case of The Green River Well. The interviewee from the Ministry of I&W stated that there was plenty of knowledge available on implementing natural aspects into the project, The Green River Well. However, the interviewee from the Ministry of I&W also states that this depends on the composition of the project team and that it could occur that there is little knowledge inside project teams on implementing natural aspects.

10. Functionality and performance uncertainties

Uncertainties of functionality and performance uncertainties can be a barrier to the implementation of nature-based solutions. If actors in flood risk management do not see the benefits of green/blue infrastructure, then that could cause them to stick to their silos (preferring grey infrastructure). In the project, The Green River Well, performance and functionality uncertainties has been a barrier to a certain extent. At the beginning of the project, actors like the Ministry of I&W and Water Authority Limburg stuck to their silos and did not want to think along on adding green aspects to the project. Only later, when they were convinced of the benefits of adding green aspects, they started thinking outside their silos. This resulted in the creation of the tunnel that will open up the green river.

11. Perceived high cost

Perceptions of high costs can be a barrier to the implementation of nature-based solutions. However, during this research, none of the respondents mentioned perceiving green/blue infrastructure as being costly (or more costly than grey infrastructure). An explanation for this could be that perceived high costs of nature-based solutions often occur among private owners. In the case of The Green River Well, the land is owned by the Municipality of Bergen and is therefore not privately owned.

12. Lack of available financial resources

The results of this research show that this barrier to nature-based solutions is also a barrier to the implementation of green/blue infrastructure in flood risk management in the Netherlands. In the project, The Green River Well, the Ministry of I&W is by far the biggest financer. The finances that are made available by the Ministry of I&W need to be used for strengthening and relocating dikes by law. This creates a barrier to the implementation of green/blue infrastructure like floodplains or wetlands. The institutionalisation of the hydro-engineering discourse has caused the available finances for flood risk management to be mainly destined for the maintenance and construction of grey infrastructure.

13. Lack of financial incentives

The lack of financial incentives is not perceived as a barrier to the implementation of green/blue infrastructure in flood risk management in the Netherlands. Sarabi et al. (2020) mention that this barrier often occurs among private owners when they are not aware of the (financial) benefits nature-based solutions can bring them, resulting from a lack of business models for successful implementation. Examples of financial incentives to encourage nature-based solutions among private owners could be tax reduction or cost-sharing. The reason that the barrier lack of financial incentives was not perceived for green/blue infrastructure in the Netherlands could be that the flood risk management sector is not privately owned. Therefore, actors in flood risk management do not prefer to implement certain types of measures for financial incentives like tax reduction.

14. Property ownership complexities

The results of this research show that property ownership complexities are not a barrier to the implementation of green/blue infrastructure in flood risk management in the Netherlands. Nature-based solutions are often implemented in cities, where the majority of land and real estate belongs to private owners. Sarabi et al. (2020) argue that private owners are likely to prefer financial benefits over sustainability goals. As mentioned before, the land and areas that are relevant for river flood risk management are often owned by the municipalities and provinces. In the case of the project, The Green River Well, the municipality of Bergen owns the land. Therefore, property ownership complexities are not a barrier to the implementation of green/blue infrastructure.

15. Space constraints

Lack of suitable locations for nature-based solutions could occur when for example, the slopes of roofs are too steep for green roofs, the ground soil is not beneficial for vegetation, or if there is no space for floodplains or wetlands. Research by Kurstjens et al. (2020) suggests that there are plenty of suitable locations for floodplains and wetlands in the Netherlands. The results of this research are in line with the findings of Kurstjens et al. (2020), as none of the respondents mentioned space constraints to be a barrier to the implementation of green/blue infrastructure in flood risk management. Nature-based solutions like green roofs and rain gardens are often implemented in dense urban areas, the latter causing space constraints. Green/blue infrastructure in flood risk management can also be implemented in rural areas, which takes away space constraints.

As mentioned before, nature-based solutions come in an extensive range of types and forms. The main reason for the difference between nature-based solutions in general and green/blue infrastructure in river flood risk management is that they address different problems. Whilst nature-based solutions can also offer solutions for river flood risk in the form of green/blue infrastructure, they are often aimed at solving challenges in urban areas like air pollution, heatwaves and biodiversity loss. Sarabi et al. (2020) mention that nature-based solutions in the urban context is the most common context for the literature they reviewed. Nature-based solutions in the urban context often regard solutions that can be privately owned, like green roofs or rain gardens. Because of this, many barriers Sarabi et al. (2020) identify are related to the private ownership of nature-based solutions. Nature-based solutions for river flood risk do not take place in an urban context (or not as often), and if they are implemented, they are implemented by government actors (and not privately owned) as these are the actors that manage flood risk in the Netherlands, which explains the difference in identified barriers.

Recommendations

There are a few recommendations for the future that I would like to make that could help with making the Netherlands more resilient to floods in the future. The first recommendation for further research that I would like to make is to further research the factors that hinder or support the implementation of green/blue infrastructure in the Netherlands. In this research, one case was studied, the project The Green River Well. However, there are many more flood risk management projects in the Netherlands. More of these projects could be researched to get a broader and more reliable view of the factors that hinder or support green/blue infrastructure in flood risk management. A clear and reliable overview of the hindering and supporting factors could help with addressing these hindering factors.

The second recommendation I would like to make is to study the case, The Green River Well when the project is finished. At the time of this research, the project The Green River Well is not yet carried out. Discussions on the project plans are still ongoing. Further research is to study whether the green/blue infrastructure that has been incorporated in the project plans made so far will actually be carried out in the future. This might bring to light other factors that hinder or support the implementation of green/blue infrastructure in flood risk management that this research has not yet shown. Next to that, I would also recommend involving the directors of the municipalities, provinces, and water authorities in the research. In this research, no directors were interviewed because the civil servants were the only actors to respond. However, these directors are critical actors in flood risk management as they represent the municipalities, provinces, and water authorities and steer the policy.

In the introduction of this research, the argument is made that increasing flood risk calls for more adaptive approaches to flood risk management. Green/blue infrastructure, like recreating floodplains and wetlands, is a more adaptive approach to flood risk management. The theoretical framework of this research shows that floodplains and wetlands are a ‘missing link’ in Dutch river systems. My third recommendation would therefore be for the Dutch government to construct a program that works on implementing floodplains and wetlands in Dutch river flood risk management, involving multiple actors like water authorities, Rijkswaterstaat, municipalities, etc. The difference between such a program and the PAGW is that the PAGW focuses on financing green additions in already existing projects. A new program could be aimed at funding new projects for implementing floodplains and wetlands in flood risk management. The current Flood Protection Program could be used as an example for constructing a new program for floodplains and wetlands.

5.3 Reflection

This final section will reflect on the conducted research, the limitations of the study, and the hindrances and positive moments that occurred throughout the research. At the start of this research, I had little knowledge of flood risk management in the Netherlands. The floods that occurred in the summer of 2021 made me realise that adequate flood risk management is very important. My interest in sustainability brought me to the topic of green/blue infrastructure in flood risk management, which is how this research originated. Throughout this research, I learned a lot about all the different aspects of flood risk management. I found out that managing flood risk is very complex due to the number of actors involved and the large amount of policies and legislation.

The choices made for this research's methods and theoretical framework have both strengths and weaknesses. Adopting the policy arrangement approach gave the opportunity to describe all the dimensions of the policy arrangement to get a clear overview of the different barriers that occur within these arrangements. However, understanding and explaining the policy arrangement approach was a process that took a lot of time as I found the words used to explain the policy arrangement approach by other researchers quite abstract.

As for the methods used in this research, it can be said that choosing to do semi-structured interviews as the primary source of data collection was the right choice. Throughout these interviews, a large amount of data was collected, and a clear overview of the processes in flood risk management was obtained. However, the main limitation of this research is that only one case (or flood risk management project) was studied. Flood risk management in the Netherlands consists of many projects. Studying all these projects would give more reliable research results. Although only one case has been studied, it is believed that the research results' validity is solid. The reason for this is that all the actors involved (apart from one) in the policy-making process of the project, The Green River Well, have been interviewed using interview guides to get the right required data.

In the process of conducting the interviews, I learned a lot about how to conduct these interviews to get the most and most relevant information. That is why the interview guide was revised after almost every interview to get more reliable and relevant info. I realised I was steering the respondents with some of my questions. For example, after the first interview with the municipality of Bergen, some questions from the interview guide were revised and adapted. This is because I established that I was forcing some answers with the question I was asking, making the data less valid. An example of a question that was revised:

- Before adaptation: In the process of working together, can differences in preferences for either green or grey infrastructure be distinguished between the different parties?
- After adaptation: What are the different interests and desires of the actors involved in the project The Green River Well?

A possible limiting factor of this research is that the project The Green River Well has been a very positive project since the start, as mentioned by the interviewees. The interviewees state that this has helped with adding green to the project. Studying the factors that hindered or supported the implementation of green/blue infrastructure in the project The Green River Well could paint a wrong picture of the actual factors that hinder or support the implementation of green/blue infrastructure in the Netherlands. In other flood risk management projects that do not have such a positive attitude, there could be other factors that hinder or support the implementation of green/blue infrastructure. The positive attitude in the project The Green River Well and the fact that only the project the Green River Well was studied makes it challenging to generalise the conclusions of this research to flood risk management in the Netherlands. Despite this, this research still gives a general indication of the factors that hinder and support green/blue infrastructure in flood risk management in the Netherlands.

Another limiting factor of the results of this research is that one of the actors involved in the project, The Green River Well, was not interviewed. This being the province of Limburg. Although the other actors could give some description of the interests and desires of this actor in the project, it would have been better if this actor had also been interviewed. The reason that this actor was not interviewed is that the actor did not respond to any of the invitation emails. Next to that, no directors of the municipality of Bergen, province of Limburg, and Water Authority Limburg were interviewed. The directors of these actors determine policy, which is then prepared and implemented by the civil servants. The directors of these different actors ultimately decide what policy is made. Because no directors were interviewed, the thoughts behind their decisions could not be identified. Therefore, some barriers to the implementation of green/blue infrastructure in flood risk management possibly have not been identified, as these could have been subject to the thoughts and interests of the directors.

Another limiting factor of this research is that limited data were collected from the interview with the municipality of Bergen. The respondent of the municipality of Bergen has been invested/involved in the project since the beginning and had a lot to say on the process so far. Because the interview lasted 1 hour and 20 minutes, the file became too big to record both visuals and sound. Sadly, only the visuals were recorded. After finding this out, I emailed the interviewee to ask if he could email a summary of the most important things discussed. Therefore, I still had some data from the interview with the municipality of Bergen. In the interviews after that, I made sure to double record the interviews and not exceed the 1-hour mark.

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Appendixes

Appendix I Interview guide Eric Kuiper (13-05-2022)

	Ik ben Mees van den Broek, ik studeer aan de radboud universiteit en ik schrijf mijn bachelorscriptie over de factoren die groene infrastructuur in overstromingsrisicobeheer steunen of juist hinderen. Er zitten namelijk vele voordelen aan groene infrastructuur en als duidelijk is welke factoren dit hinderen of steunen kan groene infrastructuur in de toekomst vaker geïmplementeerd worden. 30-45 minuten opnemen? vragen?
Introductie	Kunt u allereerst is vertellen wat uw werk inhoudt en hoe u betrokken bent bij het project de Groene Rivier Well? (Could u first off tell me what your job entails and how u are involved in the project the Green River Well?)
	Kunt u een kleine samenvatting geven van het project de Groene Rivier Well? (Could u give a small summary of the project the Green River Well?)
	Wat is uw visie op groene infrastructuur? (What is your vision on green infrastructure?)
	Een project als deze vergt natuurlijk veel samenwerking, welke partijen zijn er allemaal bij dit project betrokken? En zijn dit dan waterbouwkundigen of zijn er ook ecologen bij betrokken? (A project like this requires a lot of collaboration, could u maybe picture what such a collaboration between different parties looks like?) (Are this mainly civil engineers or are there also ecologist involved?)
Actors	Is er een partij die tijdens het project het laatste woord heeft? En hoe kom je tot een laatste beslissing? (In the project different parties work together, is there a single party that has the final say in decisions?) (How do you get to a final decision?)
	Is er in het samenwerkingsproces een onderscheid te maken in partijen die vooral groene infrastructuur ondersteunen (bijvoorbeeld meer ruimte voor de rivier) en partijen die vooral grijze infrastructuur ondersteunen (dijken of dijkversterking)?

	Ontstaan er dan ook wel eens conflicten tussen de verschillende partijen? (In the process of working together, can differences in preferences for either green or grey infrastructure be distinguished between the different parties?) (Do conflicts between the different actors ever occur?)
Resources	Zijn er onder de betrokken partijen duidelijke verschillen in kennis en beschikbare middelen (bijvoorbeeld geld)? (Are there between parties obvious differences in knowledge and available resources like money?)
	Hoe en door wie worden zulke groene projecten gefinancierd? (How are such projects financed?)
	En zijn er binnen het project bepaalde partijen die meer of minder financiele macht hebben dan de rest? (And are there in the project certain parties that have more or less power than others?
	Kan het machtsverschil tussen verschillende partijen de implementatie van groene infrastructuur hinderen? (Can the power differences between the actors hinder the implementation of green/blue infrastructure?)
Rules and regulations	Zijn er formele regels die de implementatie van groene infrastructuur kunnen hinderen? (Are there formal rules to which you as policymakers need to keep in mind?)
	En zijn er misschien ook informele regels die de implementatie van groene infrastructuur kunnen hinderen? (And are there also any informal rules of which men excepts you to keep them in mind whilst working on the project the Green River Well?)
Discources	Komt het voor dat partijen elkaar van mening doen veranderen in het onderhandelingsproces? Kunnen onderhandelingen er ook voor zorgen dat sommigen partijen bewuster worden van het belang van groene infrastructuur? (Does it occur that parties change each other's mind during the negotiation process, for example by making them more environmentally conscious?) (Can negotiations also cause actors to become more aware of benefits of green/blue infrastructure?)
	Denkt u dat de manier waarop overstromingenrisico's worden beperkt in Nederland in de laatste jaren aan het veranderen is? Zo ja waarom?

	(Do u think that the way flood risk is managed in the Netherlands has changed over the last few years? if so, why?
	Als u terugkijkt naar het verrichte werk rondom de het project zijn er dan specifiek factoren geweest die de implementatie van het project hebben ondersteund? (If you look back at the work that has been done so far regarding the project, are that thing in this process that you would say of: that could have been done better?)
	En zijn er specifiek situaties geweest die ervoor gezorgd hebben dat het project juist in de goede richting ging? (Have there been any specific situations that have positively affected the project?)
	Dat waren al mijn vragen, ik wil u hartelijk bedanken voor het interview en wens u nog een fijne dag. (Those were all of my questions, I would like to thank you for the interview and have a nice day.)

Appendix II Interviewguide Annelies Heidekamp (3-6-2022)

	Ik ben Mees van den Broek, ik studeer aan de radboud universiteit en ik schrijf mijn bachelorscriptie over de factoren die groene infrastructuur in overstromingsrisicobeheer steunen of juist hinderen. Er zitten namelijk vele voordelen aan groene infrastructuur en als duidelijk is welke factoren dit hinderen of steunen kan groene infrastructuur in de toekomst vaker geïmplementeerd worden. 30-45 minuten opnemen? vragen?
Introductie	Kunt u allereerst is vertellen wat uw werk inhoudt en hoe u betrokken bent bij het project de Groene Rivier Well? (Could u first off tell me what your job entails and how u are involved in the project the Green River Well?)
	Kunt u een kleine samenvatting geven van het project de Groene Rivier Well? (Could u give a small summary of the project the Green River Well?)
	Wat is uw visie op groene infrastructuur in overstromingsrisico beheer? (What is your vision on green infrastructure in flood risk management?)
	Een project als deze vergt natuurlijk veel samenwerking, welke partijen zijn er allemaal bij dit project betrokken? En zijn dit dan waterbouwkundigen of zijn er ook ecologen bij betrokken? (A project like this requires a lot of collaboration, could u maybe picture what such a collaboration between different parties looks like?) (And are these hydraulic engineers or are there also ecologists involved?)
Actors	Is er een partij die tijdens het project het laatste woord heeft? En hoe kom je tot een laatste beslissing? (In the project different parties work together, is there a single party that has the final say in decisions?) (And how do you get to your final decision?)
	Is er in het samenwerkingsproces een onderscheid te maken in partijen die vooral groene infrastructuur ondersteunen (bijvoorbeeld meer ruimte voor de rivier) en partijen die vooral grijze infrastructuur ondersteunen (dijken of dijkversterking)? Ontstaan er dan ook wel eens conflicten tussen de verschillende partijen?

	(In the process of working together, can differences in preferences for either green or grey infrastructure be distinguished between the different parties?) (Do conflicts ever occur between the different parties?)
Resources	Zijn er onder de betrokken partijen duidelijke verschillen in beschikbare middelen, zoals geld? En zijn er door deze verschillen ook partijen die meer macht hebben? Kan het machtsverschil tussen verschillende partijen de implementatie van groene infrastructuur hinderen? (Are there between parties obvious differences in knowledge and available resources like money?) (Are there because of these differences also parties that have more power?) (Can de power difference hinder the implementation of green/blue infrastructure)
	Kan het verschil in kennis en expertise onder de verschillende partijen ervoor zorgen dat de implementatie van groene infrastructuur wordt gehinderd? (Could the difference in knowledge and expertise of the parties hinder the implementation of green/blue infrastructure?)
Rules and regulations	Zijn er formele regels die de implementatie van groene infrastructuur kunnen hinderen? (Are there formal rules to which you as policymakers need to keep in mind?)
Discources	Komt het voor dat partijen elkaar van mening doen veranderen in het onderhandelingsproces? (Does it occur that parties change each other’s mind during the negotiation process, for example by making them more environmentally conscious?)
	Denkt u dat de manier waarop overstromingenrisico’s worden beperkt in Nederland in de laatste jaren aan het veranderen is? Zo ja waarom? (Do u think that the way flood risk is managed in the Netherlands has changed over the last few years? if so, why?
	Als u terugkijkt naar het verrichte werk rondom de het project zijn er dan specifiek factoren geweest die de implementatie van het project hebben ondersteund? (If you look back at the work that has been done so far regarding the project, are that thing in this process that you would say of: that could have been done better?)
	En zijn er specifiek situaties geweest die ervoor gezorgd hebben dat het project juist in de goede richting ging?

	(Have there been any specific situations that have positively affected the project?)
	Dat waren al mijn vragen, ik wil u hartelijk bedanken voor het interview en wens u nog een fijne dag.

Appendix III Interviewguide Wim van Hengel (7-6-2022)

	Ik ben Mees van den Broek, ik studeer aan de radboud universiteit en ik schrijf mijn bachelorscriptie over de factoren die groene infrastructuur in overstromingsrisicobeheer steunen of juist hinderen. Er zitten namelijk vele voordelen aan groene infrastructuur en als duidelijk is welke factoren dit hinderen of steunen kan groene infrastructuur in de toekomst vaker geïmplementeerd worden. 30-45 minuten opnemen? vragen?
Introductie	Kunt u allereerst is vertellen wat uw werk inhoudt en hoe u betrokken bent bij het project de Groene Rivier Well? Wat is dan precies de rol van rijkswaterstaat in zo'n project? (Could u first off tell me what your job entails and how u are involved in the project the Green River Well?) (What exactly is the role of Rijkswaterstaat in a project like this?)
	Er zijn natuurlijk veel partijen betrokken bij het het project, hebben deze partijen ook allemaal verschillende rollen en belangen? Zijn er ook ecologen betrokken bij het project? (There are ofcourse many different parties involved in such a project, do these parties all different roles and desires?) (Are there also ecologists involved in the project?)
Actors	Zijn er partijen, of een partij die als het waren het project leidt? (In the project different parties work together, is there a single party that leads the project?)
	Bij een project als deze wordt naar een bepaald wensbeeld toegewerkt toch? Hoe komt zo'n wensbeeld tot stand? Zijn er partijen die bij het vormen van zo'n wensbeeld graag meer groen in het beeld zouden zien dan anderen? (Does a project like this work towards a certain image of the future?) (How does such an image of the future come to existence?) (Are there parties that have in interest in adding green in this process?)
Resources	Zijn er onder de betrokken partijen duidelijke verschillen in beschikbare middelen, zoals geld?

	Zo ja, welke partijen hebben dan meer of minder budget? Hebben partijen met meer budget dan ook meer inspraak? Zijn er betrokken partijen te onderscheiden die meer kennis en expertise hebben op bepaalde vlakken dan anderen? (Are there between the different parties involved obvious differences in resources like money?) (If yes, which parties have more ore less budget than others?) (Do the parties with more budget also have more power?) (Are there parties involved that have more knowledge or expertise in certain fields?)
Rules and regulations	Zijn er wetten die de implementatie van groene infrastructuur kunnen hinderen? Zo ja, welke zijn dat dan? Voorbeeld? (Are there formal rules to which you as policymakers need to keep in mind?) (If yes, which ones are these?)
Discources	Denkt u dat de manier waarop overstromingenrisico's worden beperkt in Nederland in de laatste jaren aan het veranderen is? Zo ja waarom? (Do u think that the way flood risk is managed in the Netherlands has changed over the last few years? if so, why?
	Als u terugkijkt naar het verrichte werk rondom de het project zijn er dan specifiek factoren geweest die de implementatie van het project hebben ondersteund? (If you look back at the work that has been done so far regarding the project, are that thing in this process that you would say of: that could have been done better?)
	En zijn er specifiek situaties geweest die ervoor gezorgd hebben dat het project juist in de goede richting ging? (Have there been any specific situations that have positively affected the project?)
	Dat waren al mijn vragen, ik wil u hartelijk bedanken voor het interview en wens u nog een fijne dag.

Appendix IV Interviewguide Keesjan van den Herik (14-6-2022)

	Ik ben Mees van den Broek, ik studeer aan de radboud universiteit en ik schrijf mijn bachelorscriptie over de factoren die groene infrastructuur in overstromingsrisicobeheer steunen of juist hinderen. Er zitten namelijk vele voordelen aan groene infrastructuur en als duidelijk is welke factoren dit hinderen of steunen kan groene infrastructuur in de toekomst vaker geïmplementeerd worden. 30-45 minuten opnemen? vragen?
Introductie	Kunt u zichzelf als eerste misschien even kort introduceren? En hoe bent u betrokken bij het project de Groen Rivier Well? Wat is dan precies de rol van het waterschap in zo’n project? Worden vanuit het waterschap ook wel eens andere vormen van overstromingsrisicobeheer overwogen naast het aanleggen van dijken of dijkversterkingen? (Can u shortly introduce yourself) (How are u involved in the project The Green River Well) (What exactly is the role of Water Authority Limburg in this project?) (Are next to dikes and dams other forms of flood risk management also considered on behalf of Water Authority?)
	Was het bij het project de Groene Rivier Well vanaf het begin al de bedoeling om meerdere plannen in een keer uit te voeren? In een project als de Groene rivier Well zijn natuurlijk veel meer partijen betrokken, zijn er grote verschillen tussen de belangen van deze partijen? Is er ook een partij aanwezig binnen het project die het belang heeft om van het project een groen project te maken? Of om bijvoorbeeld de biodiversiteit te vergroten of iets dergelijks? Zijn er ook ecologen betrokken bij het project? Wat zou er moeten gebeuren om binnen een project als de groene rivier wel vergroting van de biodiversiteit of toevoeging van groen te realiseren? (Was it planned from the start to integrate multiple developments at once?) (Are there big differences in the interests and desires of the parties involved?) (Is there also a party involved that has an interest in adding nature to such a project?)

	(Are there also ecologists involved in the project?)
Actors	Zijn er partijen, of een partij die als het ware het project leidt? (Are there parties or a party that leads the project?)
	Wordt er tijdens een project als deze naar een bepaald wensbeeld toegewerkt? Hoe komt zo'n wensbeeld tot stand? Wat was de toevoeging van het waterschap aan dit wensbeeld? (Does a project like this work towards a certain image of the future?) (How does such an image of the future come to existence?) (Are there parties that have in interest in adding green in this process?)
Resources	Zijn er onder de betrokken partijen duidelijke verschillen in beschikbare middelen, zoals geld? Zo ja, welke partijen hebben dan meer of minder budget? Hebben partijen met meer budget dan ook meer inspraak? Is er ook budget beschikbaar voor het toevoegen van groen of het vergroten van de biodiversiteit bij een project als deze? Zijn er betrokken partijen te onderscheiden die meer kennis en expertise hebben op bepaalde vlakken dan anderen? (Are there between the different parties involved obvious differences in resources like money?) (If yes, which parties have more or less budget than others?) (Do the parties with more budget also have more power?) (Are there parties involved that have more knowledge or expertise in certain fields?) (Is there also available budget for the addition of green to the project or enlarging the biodiversity?) (Are there parties that have more or less knowledge or expertise in certain fields?)
Rules and regulations	Zijn er wetten die de implementatie van groene infrastructuur kunnen hinderen? Zo ja, welke zijn dat dan? Voorbeeld?

	(Are there formal rules to which you as policymakers need to keep in mind?) (If yes, what are these?)
Discources	Wat is naar uw mening de voornaamste manier van overstromingsbeheer in Nederland? Is het antwoord dijken? Dan vragen of dijken in de toekomst altijd de oplossing zullen bieden. (Do u think that the way flood risk is managed in the Netherlands has changed over the last few years? if so, why?
	Dat waren al mijn vragen, ik wil u hartelijk bedanken voor het interview en wens u nog een fijne dag.

Appendix V Interviewguide Rosalie Oomen (10-6-2022, 16:30)

Wat ik van wim van hengel hoorde is dat jij aan het kijken of er nog doelen voor de pagw in het project well betrokken kunnen worden, kun je als eerst misschien kort vertellen wat de pagw inhoudt?

(I heard that you are working on incorporating PAGW goals into the project Well, can you firstly explain what the PAGW is?)

En kijk je dan of er doelen voor de pagw behaald kunnen worden in Well?

(Do you look if PAGW goals can be incorporated into the project Well?)

Wat zijn je bevindingen hierin tot nu toe?

(What are findings in this so far?)

Worden deze doelen dan ook vanuit de PAGW gefinancierd?

(Are these goals also financed by the PAGW)

Kan je iets zeggen over waarom er niet eerder naar de pagw doelen is gekeken?

(Can you tell something about why only as of now is being looked at incorporating PAGW goals?)

Appendix VI Invitation Email

Beste heer/mevrouw,

Voor mijn bachelorscriptie doe ik onderzoek naar de verschillende factoren die de implementatie van groene infrastructuur in overstromingsbeheer steunen of juist hinderen. De casestudy die ik gebruik voor mijn scriptie is de Groene Rivier Well. Om een beter inzicht te krijgen in welke factoren een rol spelen bij het opzetten en uitvoeren van dit project zou ik graag alle betrokken partijen willen interviewen. Vandaar ook deze mail en de vraag of het mogelijk is om iemand van de gemeente Bergen die hierbij betrokken is te interviewen. Dit zou mij enorm helpen! Het is voor mij geen probleem om het interview online af te nemen en het interview zal ongeveer 30-45 minuten duren. Ik hoor graag van u!
Met vriendelijke groet,
Mees van den Broek (Radboud Universiteit Nijmegen)