Building flood resilience

A CASE STUDY ON CLIMATE-DRIVEN FLUVIAL FLOODING IN VULNERABLE NEIGHBOURHOODS

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Beyond the technical backbone of flood management, my thesis aims to go one step further, to address its profound human and community impacts, particularly in areas vulnerable to climate-change-induced flooding. Flood risk management is more than an engineering challenge—it's about real people and communities, their immediate needs, and their long-term resilience. As the realities of climate change become more apparent, discussing flood risks in everyday conversations becomes essential. By actively engaging with the media and fostering public dialogue, we can make the issue both accessible and relevant to a wider audience. This shift in discourse aims not only to address immediate challenges, but also to inspire innovative solutions through the lens of climate justice. This approach encourages continuous learning and international collaboration, enriching our collective understanding and response to these challenges. The topic of flood risk often conjures images of crisis and panic. Yet, with increased public awareness that crosses political and academic lines, public perception can be transformed. It is this broad engagement that I believe will drive effective, inclusive strategies, inspired by other cultures and countries' approaches, making flood resilience a collective responsibility. By embedding an understanding of flood risks into our daily lives, we can ensure that communities are not only well-informed but also prepared and resilient. This thesis advocates for an extra, rather small, step towards the empowerment of vulnerable communities to thrive in the face of disaster, through knowledge and preparation.

Thoughts inspired by a discussion with Adriaan Geuze, landscape architect and founder and owner of West 8

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Until next time...

Abstract

Despite extensive research on flood governance, there remains a significant gap in understanding how these strategies specifically address socioeconomic vulnerability within urban neighbourhoods. This thesis, conducted at the Delft University of Technology, examines flood governance strategies in the socioeconomically vulnerable neighbourhoods of Krispijn and De Staart in Dordrecht, the Netherlands. It critically assesses the government-initiated flood resilience strategies, investigating both the institutional approach and the community perception, examining their effectiveness in preparing and empowering the vulnerable communities, their ability not only to mitigate the immediate effects of flooding, but also to address the underlying vulnerabilities that exacerbate the community's susceptibility to such disasters. The research uses a qualitative methodology, combining theoretical exploration with empirical investigation through a detailed case study approach. Data collection included reviews of secondary sources, policy documents, and primary data collected by semi-structured interviews and questionnaires with key stakeholders such as institutional actors and community members. Findings indicate that while Dordrecht's flood management strategies are developed, their inclusiveness and effectiveness varies significantly due to socioeconomic diversity and characteristics of the neighbourhoods. Although these strategies generally address immediate flood risks, they often overlook deeper socioeconomic vulnerabilities. In addition, this study highlights the critical need for increased community engagement and the inclusiveness of vulnerable groups' needs into governance processes, which is essential for improving the resilience of flood management practices. Recommendations for refining flood governance emphasise the importance of involving stakeholders, such as citizens, in both planning and implementation, tailoring interventions to specific community needs, and strengthening the adaptive capacity of governance frameworks to effectively incorporate emerging risks and community feedback. This thesis concludes that for flood resilience strategies in Dordrecht to be truly effective, a deeper integration with the community-specific needs and vulnerabilities is imperative, underscoring the need for a more inclusive and comprehensive approach to flood resilience.

Personal motivation

Urban floods, caused by climate change, is a global concern, widely recognized in academia and news. And while we are all more or less aware of their significance, you only truly understand the impact of something when it happens to you, when it hits home, as they say! And that's exactly what raised my awareness and sensitivity too this past year….with the impacts of climate change induced flooding on vulnerable communities being my main interest. My commitment to this research is driven by its potential to positively impact disaster management and urban resilience. Therefore, this topic not only aligns with my academic and long-term professional goals, but is also deeply personal. My motivation stems from indirectly witnessing the devastating effects of a recent major flooding event in Thessaly, Greece, which revealed significant gaps in current management strategies and showcased the excessive sensitivity and exposure of certain vulnerable groups. This experience solidified my commitment to researching and addressing the challenges of flood resilience management, with the aim of contributing to effective solutions that enhance resilience and mitigate the impacts of climate change on vulnerable communities. I am eager to tackle the challenges and embrace the learning opportunities that this research will bring, driven by a strong sense of academic and social responsibility.

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A. Introduction

In recent decades, climate change has exacerbated the frequency and intensity of floods in urban areas, creating the urgent need of urban resilience strategy planning. According to the Special Report on Extreme Events and Disasters (SREX) by the Intergovernmental Panel on Climate Change (IPCC) a further increasement of natural hazard events is anticipated in the twenty-first century. Natural hazards that lead to disasters can have a significant influence on the economies, environments, and societies of the afflicted areas. A very representative and characteristic hazard is the increased water levels, which is also increasing due to climate change, affecting the frequency of flooding events (Banholzer et al, 2014). Such catastrophic outcome can be caused by natural hazards (e.g., fluvial flood), but also by man-made factors such as the inadequate preparedness level or existing differential vulnerabilities (Cutter and Emrich 2006), which can be technical, financial, but also social. Studies have so far focused a lot on the technical and financial aspects of urban resilience in the context of floods, such as engineering infrastructure and financial recovery programs. The requirement for such investment and research is of high importance, as disastrous consequences in the case of a flood can undoubtedly be decreased with investment in flood control infrastructure (Colgan, 2017; Sohn et al., 2021). However, less has been investigated about the special needs and aspects of flood resilience governance strategies, particularly in vulnerable communities in the context of climate-change-induced floods. The methodical process of managing – preparing, responding, recovering, and adapting – to floods, known as 'flood governance', involves cooperation between governments, local authorities and communities (Morrison et al., 2018; Ishiwatari, 2019). It involves a wide range of tasks such as risk assessment, infrastructure construction, early warning systems and community involvement (Ishiwatari, 2019; Morrison et al., 2018). By implementing resilience strategies, flood governance aims to reduce the impact on people, property and the environment. All stakeholders need to work together to develop comprehensive flood management plans (Ishiwatari, 2019). Floodplain management policies, regulatory frameworks, structural and non-structural measures, public awareness campaigns and risk communication are important components (Morrison et al., 2018). Moreover, while flood risk management (FRM) is often viewed as a technical issue (Eakin et al., 2021), it inherently involves decisions that can lead to exacerbation or preservation of inequality through the allocation of resources and risks (Johnson et al., 2007). As such, there is an acute need for research that explores the integration of socioeconomic factors into the fabric of flood management and examines the practical application of resilience strategies within affected communities.

The impact of floods to individual communities varies significantly based on their geographical location and socioeconomic factors, which influence their capacity to respond to floods (O'Hare & White, 2018; Thaler et al., 2018; Forrest et al., 2020). Acknowledging these disparities is essential in FRM to mitigate the uneven effects on vulnerable groups (Forrest et al., 2020; de Goër de Herve, 2022). Nevertheless, there is a notable gap in understanding how to enhance the inclusivity and fairness of FRM, and discussions on integrating principles of recognition justice within FRM are still limited (Matczak & Hegger, 2021; de Goër de Herve, 2022). Policy-making serves as a crucial tool for driving social transformation (de Goër de Herve, 2022) and provides a framework for addressing inequalities and vulnerabilities in individuals' capacity to manage floods. Recognising this, this study acknowledges the importance of the community's risk perception and awareness on the current flood resilience strategies developed by governmental

actors. More specifically, it aims to bridge the gap between the theory and practice of FRM, with a particular focus on cross-evaluating the effectiveness of government flood governance strategies within the community. Effectiveness encompasses inclusiveness in policy design, ensuring that the socioeconomic vulnerabilities of communities are taken into account in the implementation process, and optimized coordination between stakeholders, reflecting a collaborative effort towards community resilience. In other words, this thesis seeks to understand whether efforts to increase flood preparedness are resonating and being adopted by the community. Through this research, potential governance improvements will be proposed to increase the resilience of vulnerable neighbourhoods. By delving into the intricacies of this targeted intervention, this research aims to contribute valuable insights to the broader discourse on flood resilience governance and its effectiveness, particularly in the context of vulnerable communities.

Therefore, the goal of this study is to investigate the following research question:

> ***What flood governance strategies do governmental actors develop and implement to enhance resilience against climate-change-induced fluvial flooding in vulnerable neighbourhoods in the Netherlands?***

Although policy departments are being requested more frequently to help vulnerable groups, the concept of vulnerability and how to address it through inclusive policies meaningfully remain ambiguous (Keay & Kirby, 2017). The term "vulnerable communities", in this specific study, refers to areas or groups that are more susceptible and exposed to flooding risk due to a variety of reasons, from geographical to socioeconomic, such as flood-prone location, income inequality, poor housing condition, lack of infrastructure facilities and services, etc. Socio-spatial aspects – which are multifaceted and multidimensional – are frequently linked to socioeconomic variables, physical location, and they refer to the variety of resources and opportunities distributed within urban regions (Han, 2022).

Main overarching goal of this research is to shed light on the complexity of governing the climate change-induced floods, the methods used by authorities in coordination with the communities to protect the most vulnerable neighbourhoods in the pre-flooding, planning phase, and lastly to highlight the opportunities and challenges of flood governance strategies in practice in vulnerable neighbourhoods. In order to do so, the study will be concentrated on one urban area, and more specifically in the Dutch context.

The Netherlands faces flood risks due to the location's physical vulnerability to floods as has been established in flood governance and flood risk management (FRM) strategies. The country has implemented a number of strategies in recent years, exporting knowledge and expertise globally (Ten Veldhuis, 2014; Huang et al., 2021). However, it's important to investigate how these strategies are, in practice, addressing the flooding and the consequential social issues in vulnerable neighbourhoods during the preparation phase from a real case study perspective, as they can function as stress-tests to highlight the opportunities and burdens of such FRM strategies.

To effectively address and investigate the main research question, several sub-questions need to be answered:

- *Which governmental actors are involved in flood resilience strategies, and what specific strategies have been implemented to address flood resilience?* (RQ1)

- *How have vulnerabilities to flooding been recognized and articulated by governmental actors, particularly in socioeconomically vulnerable neighbourhoods such as Krispijn and De Staart?* (RQ2)
- *What are the perceptions of non-governmental actors regarding the flood governance strategies and actions in Krispijn and De Staart (Dordrecht), and what barriers or challenges have been highlighted?* (RQ3)

- *Considering the current strategies and the perceptions of both governmental and non-governmental stakeholders, how can flood governance be improved or refined to better support flood resilience in vulnerable neighbourhoods?* (RQ4)

Societal value

This research addresses a critical societal need by focusing on improving flood resilience in vulnerable neighbourhoods facing climate-change-induced flooding. The study provides valuable insights into the often-overlooked socio-spatial aspects of flood management, in particular the effectiveness of flood governance strategies developed by government actors in coordination with communities during the preparation phase. By examining a real case study in the Netherlands, the research aims to provide practical recommendations for policy makers, urban planners and communities to better protect vulnerable populations. The societal value lies in the potential improvement of flood management strategies, ultimately minimising the adverse impacts of floods on people, property and the environment. As climate change continues to pose challenges, the results of this research can inform evidence-based policies and practices to improve the resilience of vulnerable communities.

Scientific value

Scientifically, this research fills a gap in the existing literature by focusing on the practical aspects of flood governance, specifically focusing on the preparation phase and the vulnerable neighbourhoods. By examining the components of governmental flood governance, the study contributes to the academic understanding of effective flood resilience measures. By examining past experiences of flood governance strategies and identifying challenges and opportunities for community engagement, it adds depth to the academic discourse on flood governance. The research also provides practical recommendations for the implementation of evacuation strategies through its case study, ensuring alignment with flood governance principles and the unique characteristics of vulnerable neighbourhoods. This scientific contribution adds to the knowledge base of disaster management and resilience, providing a nuanced understanding of how flood governance strategies can be tailored to address the socio-spatial complexities of vulnerable communities.

B. Literature review – Theoretical debate on flood resilience governance

The starting point for this framework is an examination of how the built environment is affected by a climate-change-induced hazard, with a particular focus on the consequences of climate-related fluvial flooding. In this context, the study narrows its lens to examine urban resilience and urban vulnerability as the other sides of the same coin, as they are both crucial elements to develop effective strategies for risk reduction and sustainable development. This framework recognises the inextricable link between vulnerability and resilience and considers vulnerability as an integral part of the broader concept of resilience, and vice versa. By acknowledging this link, the study narrows down and focuses its lens on the resilience governance of flood risk in vulnerable neighbourhoods. This research seeks to unravel the challenges and burdens of building resilience to climate-related floodings, and to identify effective governance strategies that can contribute to more sustainable and resilient vulnerable neighbourhoods and, by extension, the built environment.

B.1 Climate change and flooding in urban areas

Climate change is defined as the long-term change in the Earth's climatic conditions due to both natural and human-induced phenomena and behaviours, leading to global warming and changes in temperature, precipitation, and weather patterns (USGS, 2023a). The impact of climate change is not only limited to incremental changes in climate; it also has profound effects on the occurrence and severity of natural hazards, including urban flooding (Denchak, 2019).

Increasing frequency and intensity of urban flooding

Urban flooding is becoming more frequent and intense due to climate change (Denchak, 2019). This is a growing concern, particularly in densely populated areas and cities (McBean & Henstra, 2003). Urban flooding is caused by a number of factors, including the built environment, impervious surfaces, and inadequate drainage systems. Climate change is exacerbating these challenges by increasing the frequency of river flooding and heavy rainfall events (Denchak, 2019). Global warming allows the atmosphere to hold more moisture, leading to more intense and prolonged rainfall events, which can overwhelm urban drainage systems and cause flooding. In addition, climate change is causing sea levels to rise due to the melting of polar ice caps and the thermal expansion of seawater (USGS, 2023a). As sea levels rise, coastal areas become more vulnerable to tidal and coastal flooding, especially in low-lying urban areas. In addition, climate change may lead to more frequent and intense tropical storms, hurricanes and cyclones (USGS, 2023a; USGS, 2023b), which can trigger storm surges and significant rainfall, increasing the risk of flooding.

To fully understand the future impacts of climate change, it is critical to study how natural disasters, particularly floods, affect cities (USGS, 2023a; USGS, 2023b). Significant international policies have been developed over the years, including the Sendai Framework for Disaster Risk Reduction, the Addis Ababa Action Agenda on Financing for Development, the 2030 Agenda for Sustainable Development with its 17 SDGs, and the Paris Agreement on climate change. These policies highlight the need to build resilience, manage urban risks, while emphasising the importance of social sustainability in cities. As climate change will continue to alter natural hazards, exacerbating existing vulnerabilities and threatening the social sustainability of cities (Forrest et al., 2020), urban flooding can have a domino effect on public safety, infrastructure, but also socioeconomic equity. This underlines the urgent need for urban resilience strategies to effectively protect cities.

B.2 Urban resilience and vulnerability

In the face of increasing natural hazards and climate change, understanding urban resilience and vulnerability is critical to building sustainable and adaptive cities. This chapter explores the concepts of resilience and vulnerability, examining their definitions, frameworks and applications in urban contexts. By examining how cities can both withstand and recover from disruptions, we aim to provide a comprehensive understanding of the strategies needed to enhance urban resilience while addressing the inherent vulnerabilities that exacerbate risk. This dual approach will provide essential insights for the empirical part of the research.

Urban resilience

'The worst is yet to come' in the context of natural hazards, warns the United Nations International Strategy for Disaster Reduction (UNISDR, 2013). This statement underscores the urgent need to mitigate the catastrophic impacts of such hazards, a sentiment echoed by Banholzer et al. (2014), who emphasise the importance of building urban environments that are resilient to environmental uncertainty, and climate change. In light of these challenges, the pursuit of urban resilience has become a paramount goal for cities worldwide, as highlighted by Meerow et al. (2015). However, the definition of 'urban resilience' is complex and requires clarification in order to fully understand its implications and scope.

Firstly, it's critical to define and frame the concept of resilience in broader terms. Resilience has Latin etymological roots that mean to 'bounce back' (Klein, Nicholls, & Thomalla, 2003). The concept's origins and meaning are less clear when used in academic contexts and this ambiguity might make it challenging to operationalise it, create broadly applicable indicators, or to translate it into practical actions (Esteban, 2021). The concept of resilience emerged in ecology in the 1960s and has been applied in various scientific fields (Davoudi, 2012, as cited in Esteban, 2021). Two different approaches to resilience have been discussed in the literature. One, termed 'engineering resilience', focuses on the ability of a system to return to a stable state, as highlighted by Holling (1973) and further explored by Davoudi (2012). The other, 'ecological resilience', outlined by Gunderson in 2000, focuses on the adaptability of a system to change. The latter approach differs in that it recognises multiple possible alternative systems and challenges the notion of a singular, stable equilibrium as is argued by Davoudi (2012) and further discussed by Esteban (2021). This perspective allows for the analysis of cities and their components as interconnected social and spatial systems that are dynamic and vary across different scales and historical contexts (Wilkinson, 2010, as cited in Davoudi 2012). Therefore, a refinement of the term 'urban resilience' was necessary in order to collect all the various forms and aspects of it in one inclusive definition (Meerow et al., 2016). This version is the following: "Urban resilience refers to the ability of an urban system – and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales – to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity." (Meerow et al., 2016, p. 2).

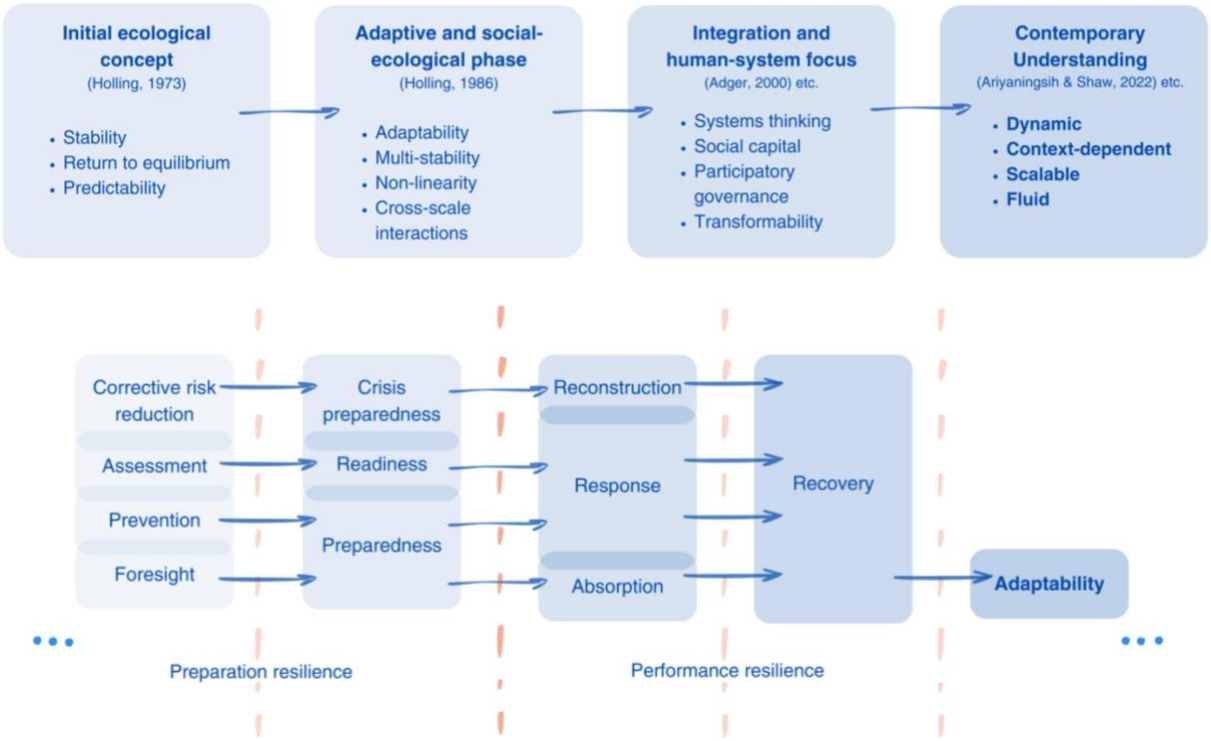

Figure 1: Evolution of flood resilience framework in accordance to the evolution of the 'resilience' definition, own work (2023) adapted by Holling, 1973; Holling, 1986; Adger, 2000; Lu & Stead (2013); McClymont et al. (2020); Wardekker et al. (2020); Ariyaningsih & Shaw (2022).

Given the previously described background, it is crucial to clearly define the objectives and focus of resilience-building, as resilience is a dynamic, multi-dimensional term that encompasses who, what, when, where, and why resilience (Meerow & Newell, 2019). Various players will view things differently and have different objectives. For this reason, making demarcations related to time, spatial scale, and topic stand of high importance. The 5 Ws framework of urban resilience consists of five key questions that emphasize the need to consider specific factors and choices when putting resilience into practice (Meerow & Newell, 2019). This way, a holistic and stakeholder-centred approach to resilience is provided, enabling a comprehensive understanding of the various dimensions and considerations involved in building resilient cities.

Figure 2: Definition of resilience (own illustration adapted by Meerow & Newell, 2019).

Apart from these 5W questions resilience's various dimensions and considerations are also translated and shaped by a number of elements that affect a city's ability to withstand shocks and stresses and to recover (Suárez et al., 2016; Xun & Yuan, 2020; Huang et al., 2021; Cao, 2023). These factors, which contribute to urban resilience, can be broadly grouped into physical, social, economic, environmental and institutional-governance categories and are further analysed in the Appendix, Table 1.

Resilience governance in combating floods

In light of these discussions on urban resilience, it is crucial to explore the various phases and principles of resilience, and more specifically flood resilience. It's crucial for this research's focus to understand how these principles are specifically applied in the development of flood resilience governance strategies, according to the literature.

Phases of intervention (principles of flood resilience)

After having analysed the definition of the term it's crucial to explore the focus of this thesis on building flood resilience strategies. To set up the basis of resilience strategy building, a theoretical framework for urban resilience is used, aligning flood resilience with the established principles of urban resilience, adjusting the various phases and layers to the hazard of flood. Based on the four principles of urban resilience - plan/prepare, absorb, recover and adapt (Wardekker et al., 2020) – this approach proposes and translates these principles into distinct phases of intervention in the context of flood resilience (see Figure 3). Each phase is defined by specific resilience strategies, aiming to a holistic and dynamic response to flood disruptions.

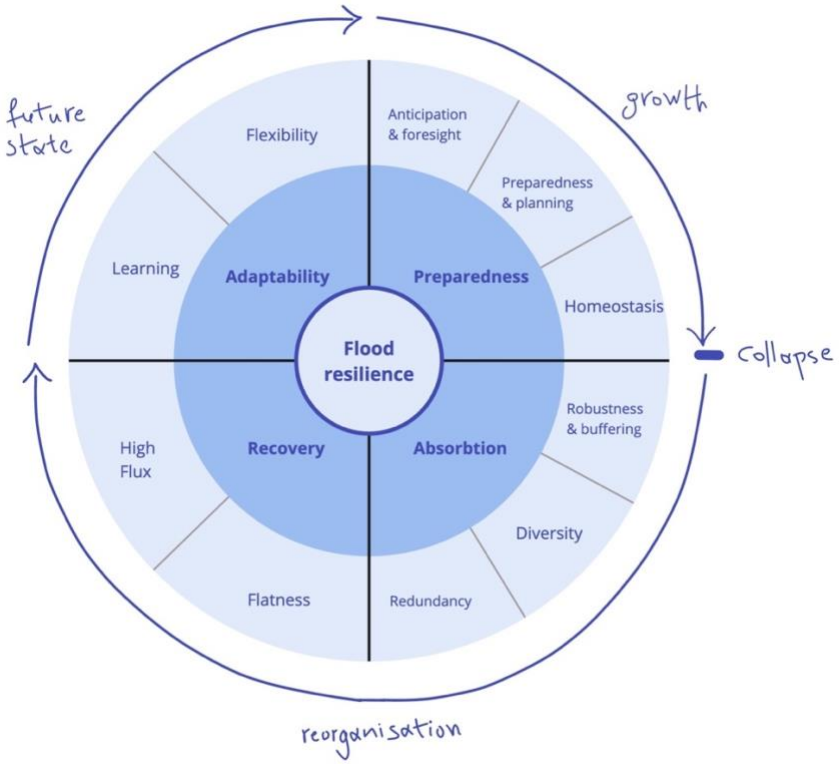

Figure 3: Flood resilience framework, own work (2023) adapted by (Wardekker et al., 2020)

The four phases of managing flood disruptions, as outlined by Wardekker et al. (2020), encompass a cyclical approach to flood resilience starting from growth while preparing for the event; the collapse, moving on to re-organisation and adaptability towards the future state. The 'Planning & Preparedness' phase emphasises the importance of foresight, research, and

community awareness for proactive flood preparedness. The ‘Absorption' phase focuses on building resilience through diverse, redundant infrastructure and planning strategies to minimise the impact of floods. ‘Recovery’ involves decentralised, inclusive processes that enable rapid recovery after disruption, drawing on the availability of resources and the strength of networks. Finally, 'Adaptability' emphasises the need for continuous institutional learning and innovation to remain flexible and responsive to changing flood risks. Together, these stages create a dynamic, iterative framework aiming to enhance flood resilience, as depicted in Figure 3. More information regarding the flood resilience phases of intervention and their translation into sub-phases and strategies can be found in the Appendix, Table 2.

These phases of intervention, as mentioned before, are further broken down into strategies. These flood risk management (FRM) strategies can be broadly categorised into two closely related and complementary types; spatial planning and governance. Spatial planning involves the strategic arrangement and use of land and water resources to mitigate flood risks, while governance encompasses the processes and policies through which collective goals for managing these risks are pursued, involving a wide range of actors and institutional frameworks.

FRM: Spatial planning strategies

Flood resilient spatial planning is an important approach that involves the careful management and use of land to reduce the impacts of flooding (Meng et al., 2022). This approach includes designating flood-prone areas primarily for water absorption or buffering purposes, rather than for residential or industrial development. Effective spatial planning can include restoring natural floodplains, creating green infrastructure such as parks and wetlands to absorb rainfall, and regulating development in high-risk floodplains (Neuvel & Van Der Knaap, 2010). Strategic relocation of communities out of high-risk areas and adaptation of building codes to increase structural resilience to flooding are also key components. These methods not only reduce immediate flood risks, but also contribute to long-term sustainability by aligning development efforts with flood protection and sustainable growth.

FRM: Governance strategies

Governance, the focus of this research, is widely recognised as the set of processes through which collective goals are achieved, involving different actors and power distributions within an institutional framework. Scholars such as Lange et al. (2013), Driessen et al. (2012) and Alexander et al. (2016) emphasise the importance of incorporating resilience principles into governance strategies to improve their overall resilience. Addressing complex environmental challenges highlights the need for alternative governance models. Traditional monocentric governance, characterised by structural reforms, is often inadequate for these challenges (Termeer et al., 2010; Renn et al., 2011). In contrast, models such as multi-level governance, polycentricity, and adaptive governance are increasingly recognised for their flexibility and transformative potential (Newig & Fritsch, 2008; Ostrom, 1961; Rijke et al., 2012; Chaffin et al., 2014). These models are valued for their ability to manage conflicts between governance scales and promote efficiency through coordination (OECD, 2015; Alexander et al., 2016).

Effective FRM governance requires transparent, accountable, and participatory decision-making within robust, inclusive structures to enhance sustainability and resilience while integrating broader context-related concerns (Alexander et al., 2016). In the context of flood resilience governance, this means a framework that encompasses a range of actors and strategies for informed decision-making, risk communication, and the implementation of flood risk reduction,

preparedness, and response measures (Renn et al., 2001; Alexander et al., 2016). Therefore, understanding the roles of different governance actors is critical to building flood resilience.
As mentioned, FR governance involves the collaboration of different stakeholders – including local and national governments, NGOs, community groups, the private sector, and international agencies – each of which holds different responsibilities and brings unique insights, resources, and expertise which might differ depending on the national context. In general, local governments provide immediate planning and emergency response, while national governments set overarching policy and standards. Community groups and NGOs provide grassroots knowledge and mobilization, the private sector brings technological innovation, and international agencies guide with best practices and funding. Given the diverse roles of these actors and the need for close coordination, it seems reasonable for flood governance strategies to prioritise inclusive and collaborative mechanisms (Ishiwatari, 2019).

The literature suggests that flood governance strategies should prioritise inclusive and collaborative mechanisms that bring together all segments of the population (Ishiwatari, 2019; Tate et al., 2021). This integrated approach aims to establish a governance framework that not only protects but also empowers communities by providing them with the tools and resources to actively participate in resilience-building processes (Atanga, 2020; Tate et al., 2021). In doing so, governance strategies can bridge the gap between top-down policy directives and bottom-up community needs, combining vertical and horizontal governance to promote resilience that is both equitable and sustainable (Ishiwatari, 2019). However, this is accompanied by particular challenges and inherent problems, as the the dependence of the flood risk management (FRM) on other contextual factors, such as the socioeconomic profile of the area (Forrest et al., 2020; Ermagun et al., 2024) and, also due to that, the complexity of managing multiple actors with different backgrounds, interests and power dynamics complicates the process. This necessitates careful coordination and negotiation to align their contributions toward a unified goal. Such multi-actor governance frameworks require not only strong leadership but also flexible, adaptive strategies that can accommodate the evolving needs and circumstances of different communities.

Concluding, the urban resilience debate highlights the need for cities to adapt and transform in the face of natural hazards. Building resilient urban environments requires a comprehensive approach that considers physical infrastructure and governance strategies. However, resilience alone does not fully capture a city's preparedness and ability to recover. Urban vulnerability, the counterpart of resilience, identifies weaknesses in urban systems that amplify the impact of hazards. Examining both resilience and vulnerability provides a holistic understanding of flood resilience management and governance. This ensures that efforts to build resilient cities also address underlying vulnerabilities that may hinder recovery from disasters. The next section explores the complexities of urban vulnerability, analysing the factors that contribute to a city's risk profile and how a vulnerable neighbourhood is defined for the purposes of this research. Once defined and analysed, it is possible to examine how its resilience can be improved and then applied in the empirical research.

Urban vulnerability

Vulnerability, as the counterpart to resilience, broadly refers to the potential for damage to a system or entity when exposed to various perturbations or stressors (De Sherbinin et al., 2007; Batica, 2014). This concept emphasizes understanding how systems respond to stress, which involves more than merely identifying the stressors themselves, whether they are environmental, socioeconomic, or technological. It is about recognizing a system's ability and capacity to mitigate stress or cope with its consequences through various strategies or mechanisms, which plays a crucial role in determining both response and impact (De Sherbinin et al., 2007). This understanding helps identify who and what is at risk, and how specific stresses translate into risks and impacts.

In the social sciences, vulnerability encompasses three main components: exposure to crises, sensitivity to shocks, and resilience capacity; coping and adaptation capacity, where risks are associated with slow or inadequate recovery (Turner et al., 2003). The most vulnerable groups are those most exposed and sensitive to disruptions and have the least capacity to respond and recover (Laurien et al., 2020)

Urban vulnerability, particularly to natural hazards, is a complex phenomenon with multiple dimensions (Moreira et al., 2021; Ruá, 2021). Physical aspects include the built environment, where poorly constructed or outdated infrastructure, such as buildings and bridges, increases risk during disasters. Social vulnerability focuses on the resilience of individuals and communities, considering population density, poverty levels, and access to resources (Batica, 2014). Economic vulnerability relates to the economic structure and stability of the city, while environmental vulnerability considers geographical location and interaction with the natural environment. Institutional vulnerability includes the effectiveness of governance and disaster risk reduction strategies, and cultural vulnerability involves norms and practices that affect disaster response (Turner et al., 2003; Batica, 2014).

Additionally, three distinct dimensions of vulnerability have been identified. First, 'health' encompasses individual resilience and the effectiveness of societal support systems, infrastructure, and governance mechanisms in mitigating vulnerability (Cannon, 1994). Secondly, 'livelihood resilience' refers to the robustness and recovery capacity of an individual's or community's livelihood systems in the face of hazards, indicative of overall economic resilience (Cannon, 1994). Finally, the level of preparedness of individuals and societies as a whole is determined by the protective measures in place, dependent on both individual actions and broader social conditions (Cannon, 1994; Bankoff et al., 2004).

In urban areas, the vulnerability of a community to flood hazards and the severity of their effects are often manifested in areas lacking basic services, with dilapidated buildings, adverse social conditions, and gender inequalities (De Sherbinin et al., 2007; Ruá, 2021). These areas, consisting of their own community, struggle with social mobility and overcoming social exclusion, making them particularly vulnerable to natural hazards as limited access to resources and opportunities hinders their ability to prepare for, respond to, and recover from from disasters, exacerbating their vulnerability.

This observation highlights the critical link between social inequalities and increased susceptibility to natural hazards because communities facing social exclusion and limited opportunities often lack access to risk awareness information and are often less able to implement effective risk reduction measures (De Sherbinin et al., 2007; Batica, 2014; Ruá, 2021). Understanding urban vulnerability is essential to improving the resilience of urban areas, as it

helps to design targeted interventions that address specific vulnerabilities and enable cities to better with stand and adapt to a wide range of hazards (Batica, 2014).
A closer examination reveals that urban vulnerability is influenced by multiple factors, each of which contributes to the overall risk profile of a community. In particular, community vulnerability has several dimensions, including physical, sociocultural, economic, environmental, institutional and coping capacity considerations. More information regarding the specific factors can be found in the Appendix (see Table 3 of appendix).
However, not all indicators are equally important in relation to this research's specific focus. Understanding the distribution of population in flood prone areas in relation to the size of urban areas affected by flooding (urban area) is crucial for effective evacuation planning, emergency response, and resource allocation during flood events (Song et al., 2019). This understanding can help identify high-risk areas, optimise evacuation routes, ensure rapid and coordinated emergency response, and inform long-term urban planning and resilience-building efforts. As highlighted in the study by Song et al. (2019), addressing these aspects is crucial for reducing the impacts of urban flooding and improving the overall resilience of cities. Moreover, demographic indicators (Demographics & social structure), such as population density and socioeconomic characteristics, help to identify vulnerable populations and assess their capacity to cope with floods. Finally, governance and policy indicators, such as the quality of institutional governance and emergency preparedness, are essential for coordinating actions among stakeholders and ensuring efficient allocation of resources to increase urban resilience and reduce vulnerability to flooding (Song et al., 2019; De Bruijn et al., 2022).

B.3 Vulnerable communities in flood-prone areas – vulnerable neighbourhoods

This research explores the multidimensional concept of vulnerability through the lens of a vulnerable neighbourhood. For the purposes of this thesis, a vulnerable neighbourhood is defined by the physical, social, and economic factors that affect it. Within the broad framework of urban vulnerability analysis, particular attention is paid to two distinct types: flood or geographical vulnerability, which refers to the susceptibility of an area to flooding due to its location and proximity to rivers, and socioeconomic vulnerability, which refers to the ability of individuals and communities to prepare for and respond to such flood events. By examining these two interrelated aspects, this research aims to uncover the intertwined dynamics between environmental hazards and societal resilience.
The concept of vulnerability captures a complex and dynamic reality (Lankao & Qin, 2011). It refers not only to the potential negative impact of a hazard or stress on a system, but also to the relative sensitivity and capacity of that system to cope with the stressor (Lankao & Qin, 2011). Therefore, flood vulnerability cannot be defined solely by the hazard itself, nor can it be represented strictly by the internal characteristics of the stressed system. Instead, it must be seen as an interaction between external stressors and internal capacities. This interaction has several dimensions: the impact of the stressor, the exposure of the system to it, its sensitivity, its adaptive capacity, and its actual responses to the stress (see Figure 4). By considering these dimensions, the research aims to provide an understanding of how environmental hazards and social resilience interact in vulnerable urban neighbourhoods.

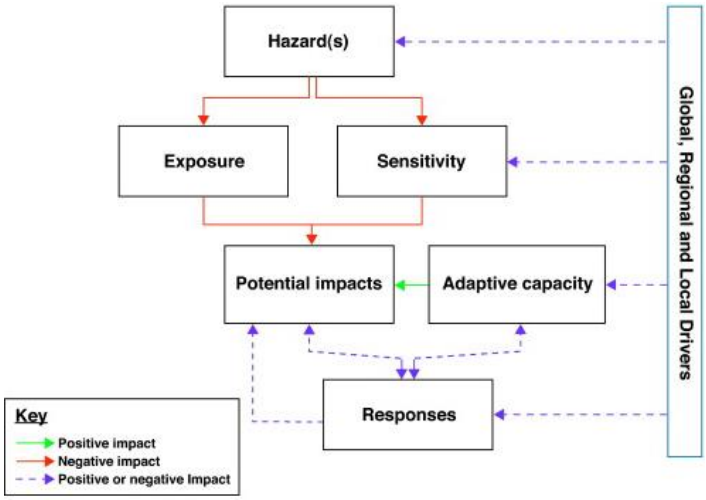

Figure 4: A conceptual framework of urban vulnerability to global climate and environmental change (Lankao & Qin, 2011)

"Disasters occur when hazards, like climate change, meet vulnerability" a quote said by Friederike Otto, according to Raju et al. (2022). Otto of Imperial College London, a climatologist who is co-founder of World Weather Attribution, argues that there are various factors that contribute to vulnerability, such as poor water or forest management, unplanned urbanization, and social inequities that put the weak and underprivileged at danger. Disasters are better understood as the "realization of social vulnerability" rather than as solely physical occurrences (Bankoff et al., 2004, p.4). Disasters are not natural whereas hazards are. Some people are more vulnerable to disaster than others due to social processes, and these disparities are mostly a result of the power dynamics present in every culture. Therefore, flood vulnerability might vary depending on the context and it comes in many different shapes and definitions (Ahmad & Simonovic, 2013; Nasiri et al., 2016) – an overview of which is presented in Figure 5.

Source	Definition
United nations (1982)	Vulnerability is a degree of damage to a certain objects at flood risk with specified amount and present in a scale from 0 to 1 (no damage to full damage)
Cannon (1994)	People's conditions and their social, political and economic behaviors in the face of risks provide different degrees of vulnerability
Menoni and Pergalani (1996)	Vulnerability term is damage goods, people, buildings, infrastructures and activities in hazard condition
Mileti (1999)	Degree of the capacity to endure or recover from the impacts of a hazard during the time
Alexander (2002)	The vulnerability of people and things to losses attribute to a certain amount of danger and probability that it will visible in a special condition and with a certain degree
UNDP (2004)	Vulnerability is a condition which is influenced by physical, social, economic and environmental factors that raises the susceptibility of people to the hazard impact
Wisner (2004)	The characteristics of an individual or group of people and their condition that affect their ability to predict, tackling, struggle, and recover from the effects of environmental threats
Adger (2006)	Susceptibility to harm from exposure to pressures related with environmental and social changes, and in lack of adaptation ability
Næss (2006)	A function of exposure, sensitivity, and adaptive capacity, generated by multiple factors and processes
Borden et al. (2007)	Distinct vulnerability means potential or sensitivity to losses or harm. Social vulnerability contains the susceptibility of society or social groups to potential losses from hazards
Balica and Wright (2010)	Vulnerability is defined with interaction between Exposure, susceptibility and resilience of each community in risk condition

Figure 5: Overview of the concept of hazard vulnerability (Nasiri et al., 2016)

Flood vulnerability, particularly in the context of fluvial flooding, is a dynamic and evolving characteristic that tends to increase globally, reducing the ability of populations to respond and cope effectively (Bankoff et al., 2004). Flood vulnerability evolves over time and is significantly influenced by the type of flood event, with each type posing unique challenges to community resilience (Kreibich & Dimitrova, 2010; Mohor et al., 2020). The onset of floods varies widely, from the slow progression of river floods to the rapid and often unexpected onset of flash floods, complicating the landscape of vulnerability. These variations require different approaches to preparedness and affect the ability of populations to respond and cope effectively (Kreibich & Dimitrova, 2010; Rufat et al., 2015). Vulnerability is a dynamic, evolutionary process that reflects changing social and economic conditions in relation to the nature of the hazard. Examining disasters through the lens of vulnerability provides valuable insights, especially as disasters are becoming more frequent and severe (Bankoff et al., 2004). For this research, flood vulnerability is measured in terms of the exposure to hazards due to the geographical context of an area, providing a precise understanding of the processes and impacts of fluvial flooding (Bankoff et al., 2004).

Vulnerability is closely linked to flood management measures and is a primary construct in flood risk management strategies. One of the main responsibilities of governments in flood-prone areas is to manage floods to protect the safety and well-being of people and the environment (Nasiri et al., 2016). Vulnerability varies across locations and over time due to context-specific factors such as environmental conditions, human activities, and societal norms about hazards. Therefore, in addition to the geographical elements of flood vulnerability, this research will also focus on the socioeconomic vulnerability factors of a community and examine governance strategies to manage and address both, with the aim of increasing flood resilience.

Socioeconomic vulnerability in flood-prone areas

The concept of socioeconomic vulnerability is multifaceted and approached through different academic lenses. The structural approach, as described by Hewitt (1983) and Watts and Bohle (1993), roots vulnerability in socioeconomic and political structures. Gibb (2018) categorises vulnerability research into physicalist and structural approaches, while Turner et al. (2003) are focusing on physical exposure and underlying socio-political structures respectively. Cutter's vulnerability models add further nuance by emphasising local geography and community-level resilience (Biswas & Nautiyal, 2023).

In flood-prone areas, socioeconomic vulnerability and spatial inequalities intertwine to define the characteristic of a vulnerable neighbourhood. Lack of access to essential social networks, political representation, quality services, and wider systemic issues such as stigma, and residency-based labour market discrimination (Wacquant, 1996) are critical factors that exacerbate vulnerability. These neighbourhood effects suggest that residents in segregated regions face greater challenges than those in more integrated areas, as empirical research has shown (Cassiers & Kesteloot, 2012). Tissot and Poupeau (2005) note that metropolitan societies exhibit various socio-spatial disparities, which point to deep-rooted social and territorial dysfunctions. These inequalities, arising from differences in housing quality, employment availability, and urban integration (Brun and Rhein, 1994; Najib, 2017), challenge the ideals of equality and social justice in contemporary democratic societies.

Characteristics of vulnerable neighbourhood

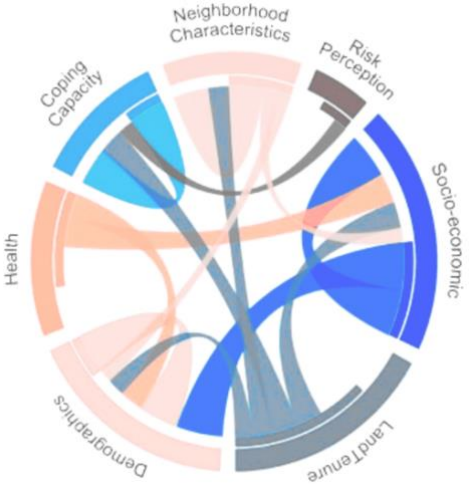

Figure 6: Interplay of core factors of socially vulnerable neighbourhoods in flood risk (Rufat et al., 2015)

To precisely define the factors that contribute and define neighbourhood vulnerability for the scope of this research, specific elements have been identified for detailed examination. More specifically, a socioeconomically vulnerable neighbourhood at risk of flooding is characterised by a complex web of factors. Limited coping capacity, diverse demographic challenges, health inequalities, insecure housing, stressed infrastructure, diverse risk perceptions, and socioeconomic deprivation are some of the core factors that define such neighbourhoods (see Figure 6). In order to precisely define these factors this research has identified specific indicators for detailed examination (see Table 1). These factors have been carefully selected to narrow the focus and increase the clarity of the study's analysis of how to define a vulnerable community or neighbourhood.

Table 1: Indicators of socioeconomic vulnerability factors in flood-prone areas, adapted from Grineski et al. (2014); Rufat et al. (2015); Chakraborty et al. (2022); Bailey (2023)

Factors	Indicators
Coping capacity & Socioeconomic status	income, education (community-wide)
Demographic characteristics	age, migration background, language proficiency
Health & Safety	pollution, disease, crime rate
Tenure (housing/ land)	owners, renters, squatters
Neighbourhood characteristics	housing quality, accessibility (resource/ transportation dependency), population density
Risk perception	awareness, prior experience, knowledge of flood resilience measures, risk denial/acceptance, trust in officials

The relationship between socioeconomic vulnerability and flood resilience is a critical focus for understanding how best to improve community preparedness and effectively mitigate flood impacts. Coping capacity is inherently linked to socioeconomic status, as communities with greater financial resources are better able to implement robust flood defences and recover more quickly after a disaster (Adger, 2003). Socioeconomic status determines both the resources available to build resilience and the degree of vulnerability to flood disruption (Rufat et al., 2015). This status determines not only material capabilities, but also access to education and

information, which are critical to understanding risks and implementing effective responses (Adger, 2003; Chakraborty et al., 2022; Bailey, 2023).

Demographic characteristics, including the age and mobility of the population, influence both the needs during a flood and the ability of individuals to respond during flood events; for example, areas with a higher proportion of elderly or disabled residents may have reduced mobility and therefore a reduced ability to evacuate during floods (Cutter et al., 2003). Health factors are also crucial; areas with higher proportions of vulnerable people (e.g. the elderly, chronically ill) require tailored emergency services and infrastructure to ensure safety during floods (Few, 2007; Rufat et al., 2015).

Housing or land tenure is another key element; secure tenure provides a basis for investment in long-term flood resilience measures, whereas insecure tenure may discourage such investment (Paton, 2007). Neighbourhood characteristics, such as community cohesion and the quality of local infrastructure, directly influence the effectiveness of collective responses and resilience-building activities (Cutter et al., 2003; Rufat et al., 2015). In addition, risk perception plays an important role in motivating individual and community preparedness activities. Communities that are more aware of and concerned about flood risks are more likely to engage in mitigation practices and support resilience policies.

In essence, a socially vulnerable neighbourhood facing flood risks is a complex tapestry of limited coping resources and deprived socioeconomic profile, diverse demographic challenges, health disparities, insecure housing, strained infrastructure, and diverse risk perceptions. These interrelated socioeconomic factors highlight the need for an integrated approach to flood resilience planning, recognising that improving resilience requires addressing underlying social vulnerabilities alongside physical and infrastructural measures. Therefore, the aim of this research is to examine flood resilience governance strategies in place and assess whether they not only mitigate the immediate impacts of flooding, but also address the underlying vulnerabilities and consequential socioeconomic inequalities.

Wrap-up

Overall, the relationship between urban resilience and vulnerability factors, underlines their interconnectedness and illustrates that addressing vulnerability enhances resilience (see Figure 7). By identifying and improving vulnerability indicators, urban areas can strengthen their resilience, demonstrating that the two are interrelated aspects of urban environments. As urban resilience focuses on the ability of urban systems to adapt, recover, and transform in response to challenges (Turner et al., 2003; Batica, 2014; Saja et al., 2018), it's the flip side of vulnerability, emphasising the strengths and adaptability of urban systems to hazards. Both vulnerability and resilience are critical in assessing the carrying capacity of a city or community and serve as tools for measuring and managing the impacts of environmental hazards (Batica, 2014; Laurien et al., 2020).

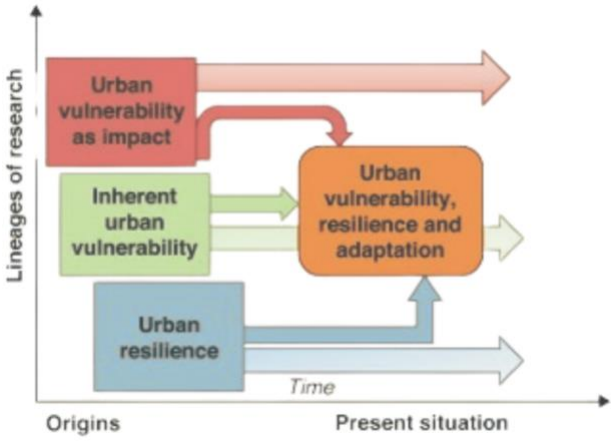

Figure 7: Integrated understanding of different dimensions and determinants of urban vulnerability in relation to urban resilience (Lankao & Qin, 2011)

Wrapping it up, by combining insights and gaining a nuanced understanding of vulnerability and resilience, policymakers and planners can develop strategies that not only mitigate risks but also enhance their ability to adapt and thrive in the face of environmental challenges.

As we have explored, urban resilience and vulnerability are deeply intertwined, with each influencing the effectiveness of the other in the context of flood risk management. Understanding these concepts has laid the groundwork for examining how they can be practically addressed through specific governance strategies. The next chapter looks at specific approaches and mechanisms that have been successful in increasing resilience and reducing vulnerability in flood-prone areas. This transition is critical because it focuses on practical, implementable strategies that build on the theoretical frameworks of resilience and vulnerability to ensure that urban areas are better prepared and more able to recover from flood events.

B.4 Governance strategies proven to enhance resilience and to address vulnerability

Building on the understanding of urban resilience and vulnerability, it is clear that effective governance strategies are essential to improve flood resilience and address vulnerability, particularly in socioeconomically disadvantaged neighbourhoods. Vulnerable neighbourhoods often face higher risks due to a combination of geographical vulnerability, inadequate infrastructure and socio-economic factors (Tate et al., 2021; Ermagun et al., 2024). Governance strategies should therefore prioritise inclusive and collaborative mechanisms that bring together all segments of the population, especially the most vulnerable groups (Ishiwatari, 2019; Tate et al., 2021).

This chapter explores governance strategies that have been shown to enhance resilience and address vulnerability. By establishing supportive governance frameworks, these strategies empower communities by providing them with the tools and resources they need to actively participate in resilience-building processes (Atanga, 2020; Tate et al., 2021). However, there are challenges to implementing these strategies, including meeting the specific needs of diverse demographic groups with limited resources (Rufat et al., 2015; Dieperink et al., 2016; Forrest et al., 2020).

One of the main challenges is to develop flood resilience plans that take into account the specific needs of the elderly, children, non-native speakers, people with disabilities and gender-based needs. This requires careful policy development and resource allocation (Dieperink et al., 2016; Forrest et al., 2020). In addition, effective risk communication and community engagement are critical to successful flood resilience management (Sanders, 2022). Building community trust and ensuring that all segments are informed about flood risks are essential steps in this process. Economic inequalities must also be addressed to ensure that flood resilience plans are equitable and do not exacerbate existing inequalities (Forrest et al., 2020). This includes government policies that support each community member equitably, with particular attention to the most vulnerable (Meng et al., 2022). Coordinating the efforts of multiple stakeholders - including local authorities, emergency services, not-for-profit organisations and community groups - is critical for coherent and successful flood resilience governance (Sanders, 2022).

The proposed flood resilience framework provides a progressive and adaptable model for urban resilience, advocating a shift from simple disaster recovery to a more nuanced strategies of adaptation and continuous improvement. The use and effectiveness of this model, particularly for vulnerable communities, is underexplored and requires further real-life case study investigation (Sanders, 2022; Ermagun et al., 2024). The following section breaks down the specific governance strategies that the framework consists of.

Governance strategies for improving flood resilience

In the pursuit of effective flood resilience, it is crucial to recognise the absence of a definitive 'one size fits all' approach and to acknowledge the limitations of decentralised programmes. Tailoring governance strategies to specific institutional, social and physical contexts becomes essential in this endeavour. Adaptive governance stands out as the overarching approach that underpins flood resilience initiatives. This approach revolves around decentralising decision-making, engaging diverse stakeholders, and possessing the adaptability to adjust policies in response to evolving circumstances (Dai et al., 2018; Hong & Lee, 2018; Molenveld & van Buuren, 2019). Beyond this foundational governance approach, six governance strategies provide a basic structure for designing context-specific flood resilience initiatives that apply to various or all phases of flood resilience cycle presented earlier (Driessen et al., 2018; Matczak & Hegger, 2021) (See Figure 8).

Figure 8: Six governance strategies proven to increase flood resilience (Driessen et al., 2018; Matczak & Hegger, 2021)

These strategies illustrate the importance of incorporating different governance approaches and involving different actors in flood resilience management.

I. Context-sensitive diversification of FRM strategies

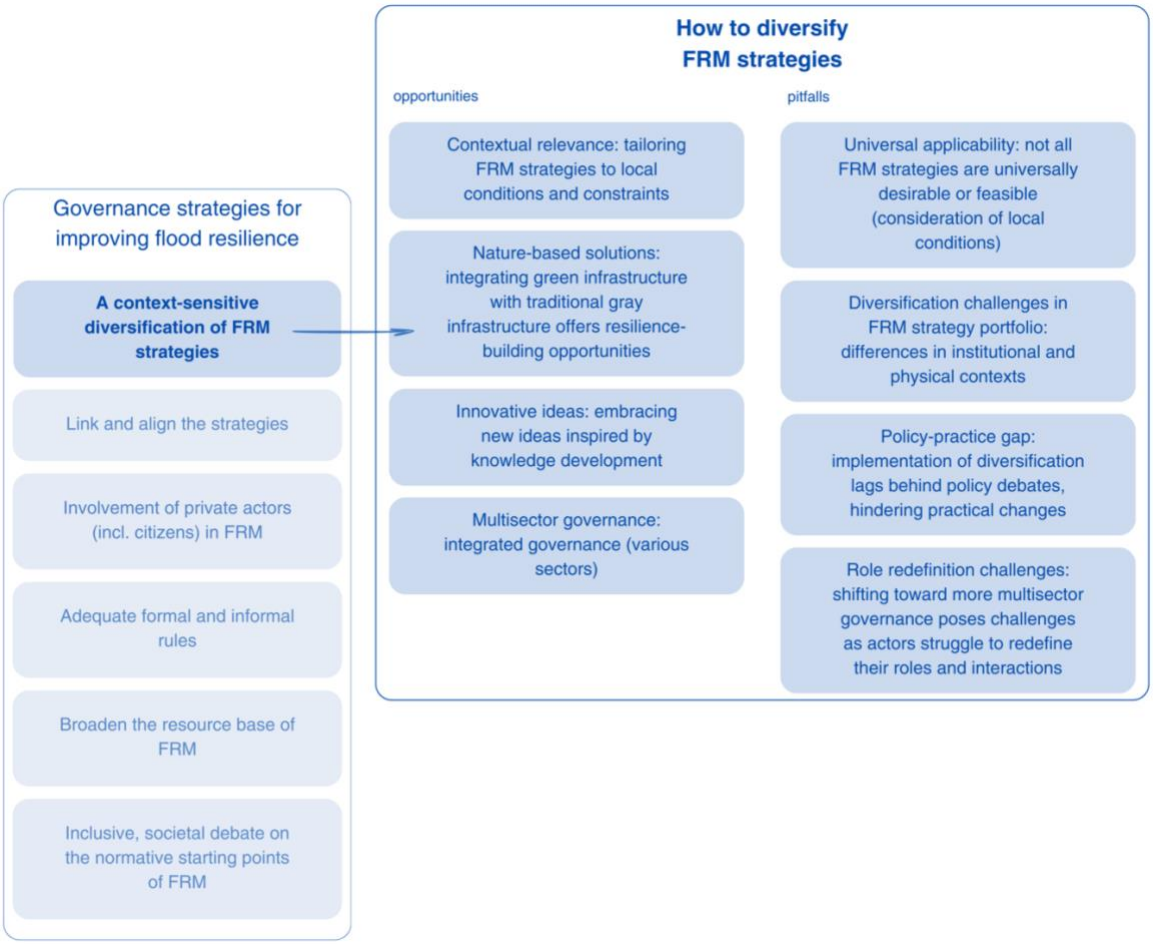

Figure 9: Focus on diversification of FRM strategies, own work (2023) adapted by Matczak & Hegger (2021)

Addressing flood risk management (FRM) requires a strategic approach tailored to the diverse and complex nature of social-ecological systems (Matczak & Hegger, 2021). It is important to recognise the need for adaptation to the different institutional and physical landscapes of different regions. Diversification of FRM strategies will be influenced by local nuances, with the selection and effectiveness of specific measures varying significantly across different settings (Matczak & Hegger, 2021). While policy discussions continue to evolve, the actual implementation of diversified strategies often falls short of expectations. To bridge this gap, the integration of nature-based solutions with conventional infrastructure, the use of new knowledge from ongoing research, and the promotion of integrated governance across sectors are critical mechanisms for facilitating meaningful change in FRM practices (Matczak & Hegger, 2021).

II. Link and align the strategies

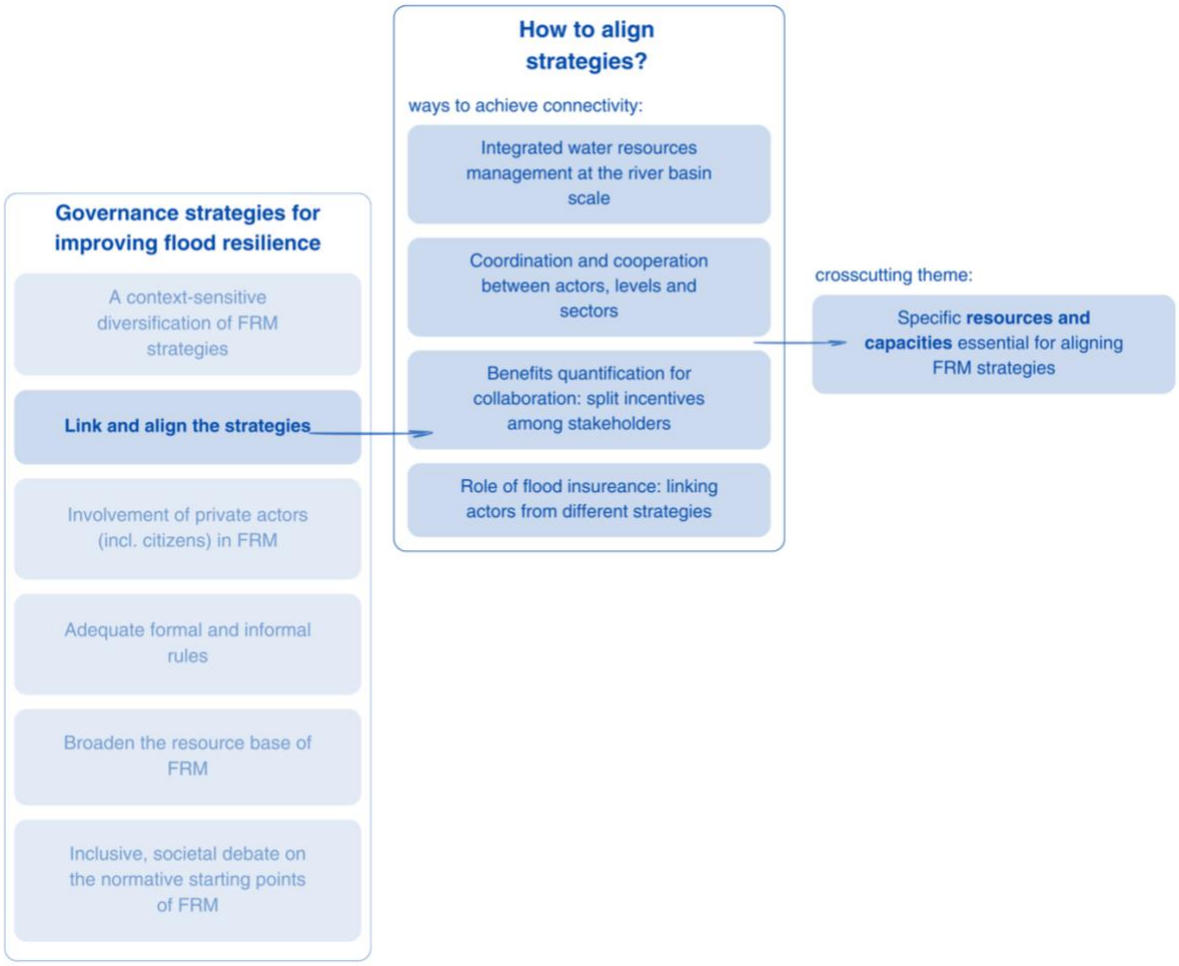

Figure 10: Focus on linkage and alignment of governance strategies, own work (2023) adapted by Matczak & Hegger (2021)

In addition, effective flood risk management (FRM) goes beyond the mere implementation of strategies and requires a harmonised approach, as these strategies are inherently interdependent. Recognising this interdependence is essential for a coordinated approach to FRM, where decisions in areas such as recovery can have a significant impact on preventive measures and vice versa. The literature suggests a multifaceted approach to achieving strategic coherence. Incorporating comprehensive risk assessments and regional planning to address flood risk at the macro level is paramount (Morrill & Becker, 2018). This strategy requires cross-government coordination, which can be achieved through proactive policy entrepreneurship, the application of bridging strategies and the establishment of clear regulations. Furthermore, effective collaboration between different actors across different sectors and levels of governance, exemplified by inter-municipal cooperation, is crucial for unified FRM efforts (Benson & Lorenzoni, 2017). In addition, the need to quantify the benefits of urban infrastructure measures is highlighted to encourage collaboration and to ensure that incentives are aligned for different stakeholders (Ossa-Moreno et al., 2017). Flood insurance also emerges as a key element in linking different FRM strategies, highlighting the importance of creating robust partnerships and incentives for risk reduction. Global perspectives further highlight the need to identify key resources, such as accurate flood mapping and comprehensive data support services, and coping capacities of the various relevant actors that are fundamental to aligning

FRM strategies (Klemešova, 2016; Crick et al., 2018; Holstead et al., 2017). Together, these strategies form a coherent framework that promotes enhanced collaboration and sustainable urban development within the broader context of flood risk management.

III. Involvement of citizens in FRM

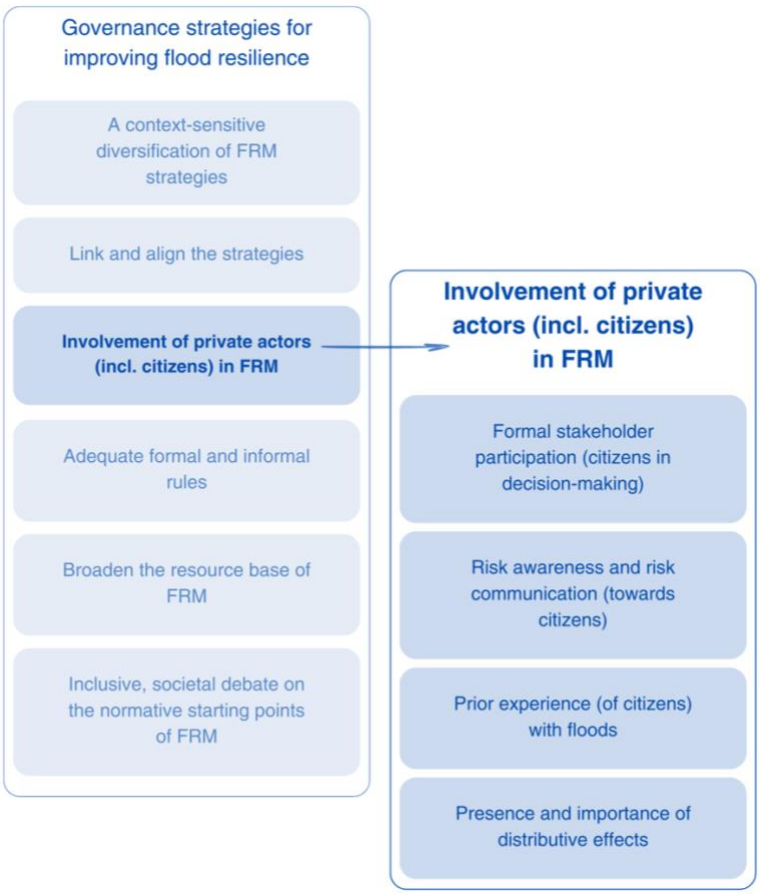

Figure 11: Focus on the involvement of private actors in FRM, own work (2023) adapted by Matczak & Hegger (2021)

Moreover, citizen participation in flood risk management (FRM) is multifaceted and critical to the development of effective strategies. The integration of different perspectives can improve decision-making, make it more adapted to local conditions, and increase stakeholder awareness, as noted by O'Donnell et al. (2018) and Löschner et al. Risk perception and communication to citizens is a central component of this engagement. Effective communication strategies that include cumulative risk assessments and co-production with citizens are essential, especially in areas increasingly affected by climate change (De La Maza et al., 2019; Strathie et al., 2017; Mann & Wolfe, 2016). While formal stakeholder participation is beneficial in integrating different types of knowledge, such as scientific and local insights, it also presents challenges and potential conflicts, as highlighted by Matczak & Hegger (2021) and Begg et al. (2018). More specifically, these strategies need to be context-specific and address both the general and localised needs of communities, particularly in flood vulnerable neighbourhoods (Solín et al., 2018). Citizens' experiences of past flood events have a significant impact on their responsiveness and proactive measures to flood risks. Understanding these experiences is essential for shaping socially responsible behaviours and effective disaster management,

especially in vulnerable areas where flood impacts are more pronounced (Soetanto et al., 2017; Matczak & Hegger, 2021). Finally, socioeconomic factors that influence citizens' coping capacity and participation (in voluntary insurance and mitigation measures etc.) need to be considered. Income, age, mobility, and education levels play a role in how communities engage with FRM strategies, highlighting the need for tailored approaches that address the specific vulnerabilities and capabilities of different demographic groups (Osberghaus, 2017; Shao et al., 2017; Hale et al., 2018).

Overall, the central theme across the literature is the importance of proactive and context-specific risk communication. Tailoring strategies to meet the needs of different communities, particularly those most at risk, is key to promoting a resilient response to flood risk. This approach ensures that the unique challenges and vulnerabilities of different neighbourhoods are effectively addressed and managed.

IV. Adequate formal and informal rules

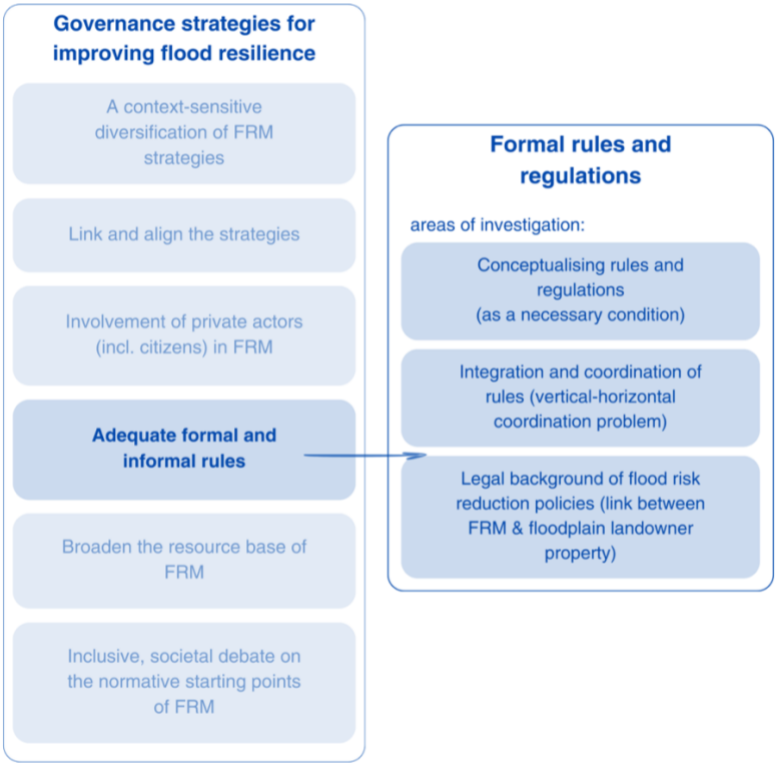

Figure 12: Focus on adequate formal and informal rules, own work (2023) adapted by Matczak & Hegger (2021)

In modern nations, flood risk is predominantly controlled through formal regulations and rules established by government entities. These legal frameworks specify the responsibilities and rights of all involved parties and steer actions pertaining to managing flood risks (Matczak & Hegger, 2021). This topic is explored through various approaches in the literature on flood risk governance. Firstly, there's the conceptualisation of rules and regulations as an imperative for policy implementation, exemplified by Li et al. (2017), highlighting that the adoption of appropriate legislation and licensing is both a barrier and one of the most important opportunities for improvement. Second, there's a focus on the integration and coordination of rules, with Green (2017) addressing the vertical-horizontal coordination problem in the implementation of the Floods Directive. Li et al. (2017) also highlight the critical need for coordination between government agencies at all levels. Finally, there's research on the legal

context of flood risk reduction policies, linking flood risk management (FRM) and property rights of floodplain landowners (Tarlock & Albrecht, 2018).

V. Broaden the resource base of FRM

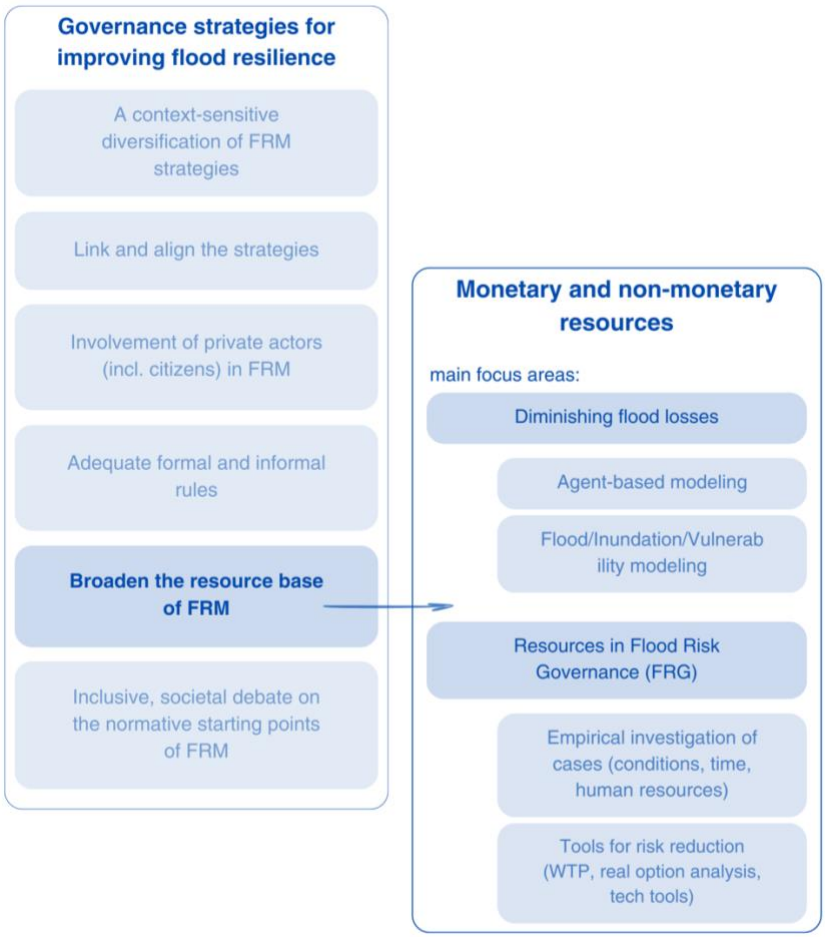

Figure 13: Focus on the broadening of resource base of FRM, own work (2023) adapted by Matczak & Hegger (2021)

Furthermore, broadening the resource base for flood risk management (FRM) is essential and focuses on two main areas: mitigation of flood losses and the resources required for such mitigation. Research in this area is diverse and advanced. The first stream of research uses agent-based modelling to inform flood loss reduction strategies, with a particular focus on how the timing of the last flood affects property values and the benefits of mitigation efforts (Beltran et al., 2018). The second stream explores the extent of flood damage using different models, taking into account factors such as spatial planning, rainfall intensity and the unintended effects of structural defences. This research is key to understanding the broad and complex nature of flood impacts (Johann & Leismann, 2017). In addition, there's a focus on resource availability and its critical role in the implementation of flood risk governance plans. Studies examine resource scarcity and the conditions necessary for effective management plans. Tools to measure local capacity for flood risk reduction are used (Devkota & Maraseni, 2018).

VI. Inclusive societal debate on the basic principles and values of FRM

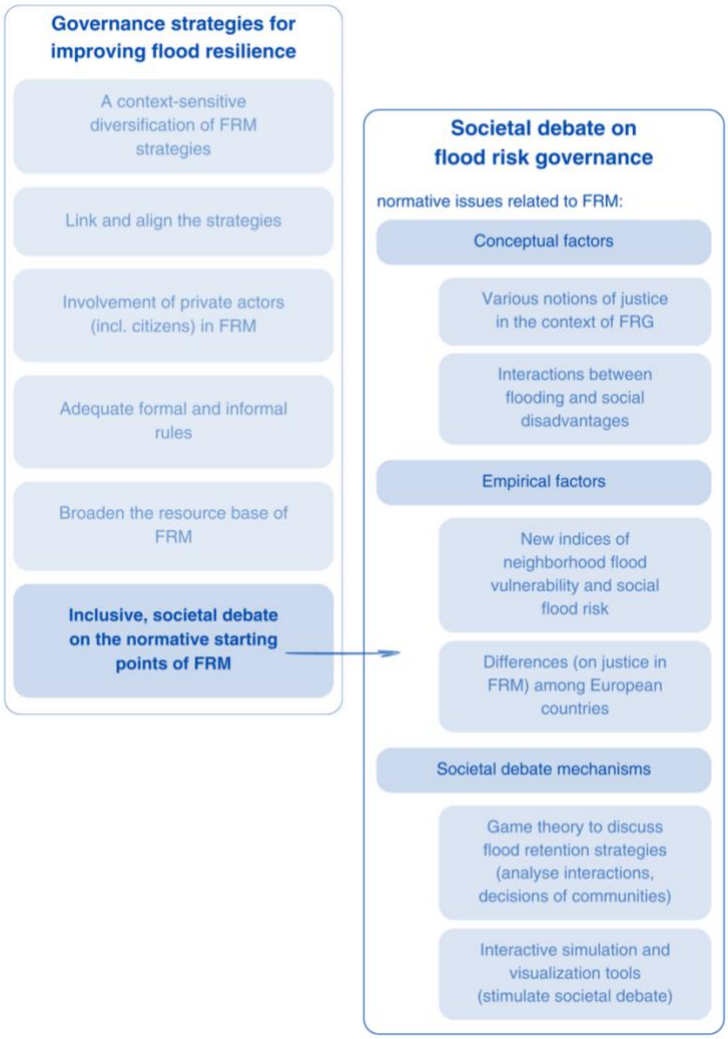

Figure 14: Focus on the societal debate on the normative starting points of FRM, own work (2023) adapted by Matczak & Hegger (2021)

Last but not least, conceptually, the literature examines the equity challenges associated with flood hazards, focusing on how they intersect with social disadvantage in different policy areas. Key issues include the legitimacy and fairness of flood risk strategies, and how they are perceived and accepted socio-politically (Thaler & Hartmann, 2016; Matczak & Hegger, 2021). In addition, the theory of goods is discussed, highlighting how distributional aspects and inequalities in the flood risk governance (FRG) can lead to inequalities in access to and use of public goods (Geaves & Penning-Rowsell, 2016). Empirically, studies have scrutinised social inequalities in flood risk management, revealing disparities in the distribution of resources before and after disasters and the impact on different communities (Muñoz & Tate, 2016). Examining social equity through novel indices reveals the differential vulnerability of socially disadvantaged neighbourhoods to flooding. Studies of models such as the Dutch approach show that while there are many resources available, discussions about fairness and equity are often overlooked (Kaufmann et al., 2018). Finally, literature focuses on mechanisms to stimulate inclusive societal debates on flood risk, using frameworks such as game theory to discuss flood retention strategies between different communities (Machac et al., 2018).

Wrap-up

In essence, the literature highlights two main challenges to resilience governance: institutional challenges, which include bureaucratic inertia, coordination difficulties, and resource constraints; and community engagement and trust, which include the difficulties of engaging vulnerable groups and the mistrust that can arise from top-down approaches. In other words, theory showcases that there is room for improvement in making flood FRM strategies more inclusive globally. Given the influence of socioeconomic factors on the effectiveness of flood resilience strategies in vulnerable neighbourhoods, discussed in the previous section, it is crucial to develop strategies that are tailored to the specific needs of these communities. This way, such vulnerable neighbourhoods would not only be protect but also empowered, making them more resilient to the increasing frequency of extreme meteorological events.

B.5 Critical review of theoretical debate: findings and conclusions

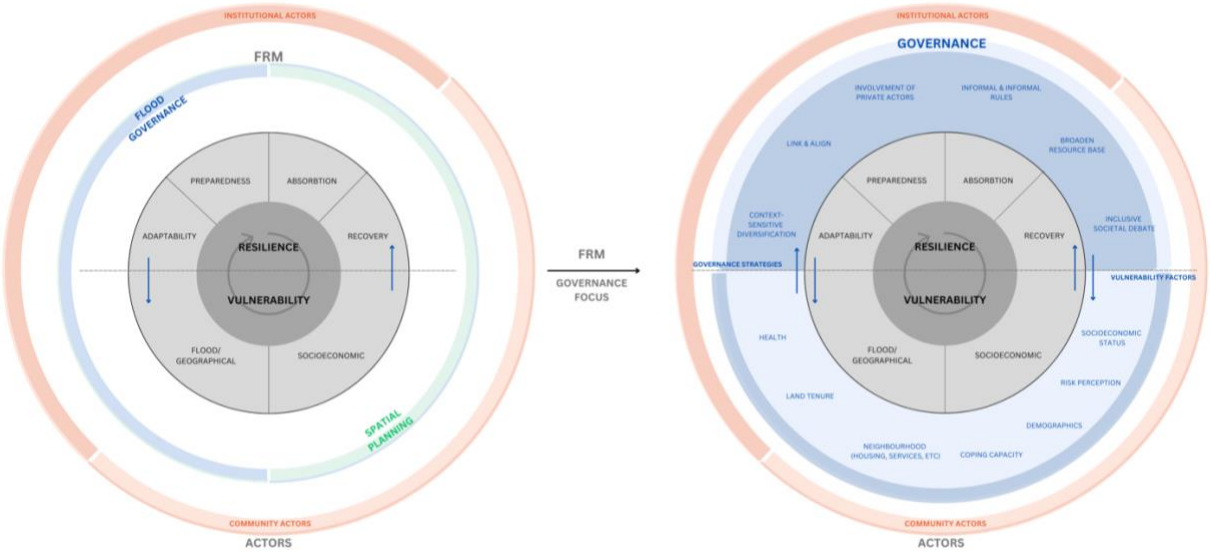

Figure 15: Theoretical framework (own work, 2024)

Theoretical framework

Figure 15 illustrates the conceptual relationship between vulnerability and resilience as interrelated but distinct concepts within flood resilience governance. This framework, divided by a dotted line, emphasises their dynamic interaction. In the diagram, flood resilience is categorised into four phases, each of which is supported by specific governance strategies aimed at enhancing resilience and addressing vulnerability. Conversely, vulnerability is divided into two main types, each defined by different factors that characterise a vulnerable neighbourhood. The double arrows symbolise the dynamic interaction between resilience and vulnerability, highlighting the need to examine how resilience strategies influence vulnerability levels and vice versa. Moreover, this research focuses on both the institutional (local authority's) approach and the community's perspective. This framework provides the basis for analysing whether and how flood resilience governance affects vulnerability and vice versa, and whether it is effective in improving resilience in real-world situations.

Overview of literature review

Current discussions on flood resilience governance often emphasise technical, financial and structural measures, but often overlook the unique social characteristics of vulnerable communities. Existing governance frameworks tend to adopt a one-size-fits-all approach that neglects social and economic contexts, leading to ineffective outcomes (Morrill & Becker, 2018), (Matczak & Hegger, 2021). Furthermore, a gap between policy design and community needs has been documented. Vulnerable communities often lack meaningful participation in decision-making processes, resulting in mistrust and non-cooperation (Begg et al., 2018), (O'Donnell et al., 2018). Resources for flood resilience are not distributed equitably, often neglecting socio-economically disadvantaged areas, increasing vulnerability and weakening overall resilience efforts (Forrest et al., 2020).

Furthermore, to these issues, the implementation of resilience strategies often faces significant institutional challenges, including bureaucratic inertia, coordination difficulties, and resource

constraints (Renn et al., 2011; Matczak & Hegger, 2021). Effective resilience governance requires seamless collaboration across different levels of government and sectors (Matczak & Hegger, 2021), which is often hampered by fragmented responsibilities and communication gaps. Engaging communities, especially vulnerable groups, is also a challenge. Top-down approaches can lead to mistrust and resistance of the community. Therefore, meaningful engagement requires building trust through inclusive, participatory approaches that ensure community voices are heard and taken into account in resilience strategies.

Flood resilience governance in vulnerable neighbourhoods needs to recognise the impact on vulnerable communities. Socioeconomic factors have a significant impact on the effectiveness of flood resilience strategies (Forrest et al., 2020). Communities with lower socioeconomic status or majority of specific demographic groups often lack the resources to adequately prepare, respond, and recover, making them more exposed to flooding (Rufat et al., 2015). Systemic, educational disadvantages further limit their ability to engage in resilience-building activities. Interventions must therefore be tailored to the specific needs of vulnerable communities, with community input to address specific challenges. This approach ensures that resilience strategies are relevant and effective, bridging the gap between top-down policy directives and local needs.

Consequently, effective governance of flood resilience needs to integrate the socioeconomic characteristics of communities, as proposed in the theoretical framework of this research (see Figure 15). The literature emphasises the importance of justice, equity, and societal engagement in flood risk management, highlighting that resilience is not just about hazard mitigation, but also about how urban systems and communities can cope with and recover from flood impacts.

Research objectives

This research aims to critically evaluate current flood resilience strategies, identifying strengths and areas for improvement. By examining successful governance practices and identifying gaps, the study will assess the operationalisation and impact of FRM strategies in vulnerable communities. The research focuses on the perspectives of multiple actors, both institutional and community-based, to understand how vulnerability influences and is influenced by governance strategies.

Table 2 summarises the main government strategies that have been shown to increase resilience, together with their practical interpretations from both a community and institutional perspective. These variables will guide the empirical research in assessing the effectiveness of current government flood resilience strategies in the Dutch context.

Table 2: Main governance strategies that are proven to increase resilience and the key variables for the empirical research (own work, 2024)

Governance strategy	**Variables**	**Interpretation** (institutional approach)	**Interpretation** (community perception)
Context-sensitive diversification of FRM strategies	Adaptability, local tailoring, environmental factors	Development of FRM strategies that consider specific district characteristics and environmental concerns.	Perception of FRM strategies: do they reflect the unique needs of the community?

Linking and aligning strategies	Coordination, interdependency, multi-level governance	Establishment of collaborative processes and policies across different governance levels and sectors.	Perception of how well different government actions and strategies align and feel cohesive *[recognising that detailed knowledge of these processes is likely to be limited]*.
Inclusion and involvement of private actors, including citizens, in FRM	Community participation, stakeholder engagement, risk communication, local knowledge	Strategies, methods, and tools for effective dialogue (between authority and public) raising community awareness and motivation.	The degree of community understanding, responsibility taking and influence on the FRM process.
Establish appropriate formal and informal rules and regulations	Decentralized governance, regulatory framework, stakeholder rights	The process and efficacy of rulemaking (safety norms), implementation, and ensuring rights within FRM frameworks.	Inclusivity and fairness of current local policies, are their needs addressed? *[acknowledging that they may not have detailed knowledge of the policy-making process]*.
Broaden the resource base for FRM	Resource management: financial and beyond that; community networks, effective governance, accurate information	Strategies to diversify and manage the economic aspects of FRM, including funding mechanisms and resource allocation.	Adequacy of practical (sandbags, barriers etc.) and financial resources for FRM preparedness and recovery.
Stimulating an inclusive societal debate on the basic principles and values of FRM	Inclusive debate, social equity, policy legitimacy	Initiatives to foster public discourse and ensure policy reflects diverse community needs (vulnerabilities).	Participation in and impact of societal dialogue on FRM policy and practice.

By understanding these governance strategies and their variables in theory and practice, this research will assess the impact of government efforts and determine their tangible effects on community resilience. This study aims to validate theoretical models and identify any gaps between policy intentions and community realities, in order to inform more effective and inclusive FRM strategies.

C. Method

C.1 Research questions

Main research question

The goal of this study is to clarify the following research question:

> ***What flood governance strategies do governmental actors develop and implement to enhance resilience against climate-change-induced fluvial flooding in vulnerable neighbourhoods in the Netherlands?***

Research sub-questions

To effectively address and investigate the main research question, several sub-questions need to be answered. These are the four key sub-questions:

- *Which governmental actors are involved in flood resilience strategies, and what specific strategies have been implemented to address flood resilience?*

- *How have vulnerabilities to flooding been recognized and articulated by governmental actors, particularly in socioeconomically vulnerable communities, such as Krispijn and De Staart?*

- *What are the perceptions of non-governmental actors regarding the flood governance strategies and actions in Krispijn and De Staart (Dordrecht), and what barriers or challenges have been highlighted?*

- *Considering the current strategies and the perceptions of both governmental and non-governmental stakeholders, how can flood governance be improved or refined to better support flood resilience in vulnerable neighbourhoods?*

C.2 Research method

Qualitative research

The study will use a qualitative approach, combining theoretical and empirical research, using qualitative data collection, analysis techniques (Blaikie and Priest, 2019). Such approach would allow the collection of a wide range of data from different sources, which would provide a more complete and nuanced understanding of the research problem. The qualitative data would provide a deeper understanding of the experiences and perspectives of various key stakeholders, as for instance governmental actors, and vulnerable communities themselves. More specifically, it's case study research. Secondary sources, such as government reports and statistics, will be used to provide a broad overview of the socioeconomic characteristics and flood vulnerabilities of the case study areas.

Moreover, the qualitative data will be collected through primary sources, such as in-depth interviews with key stakeholders, as for instance, government officials, relevant organizations, active in the case study area, community leaders, and residents. This will allow for a more in-depth understanding of the experiences and perspectives of vulnerable communities with respect to the existing flooding resilience strategies.

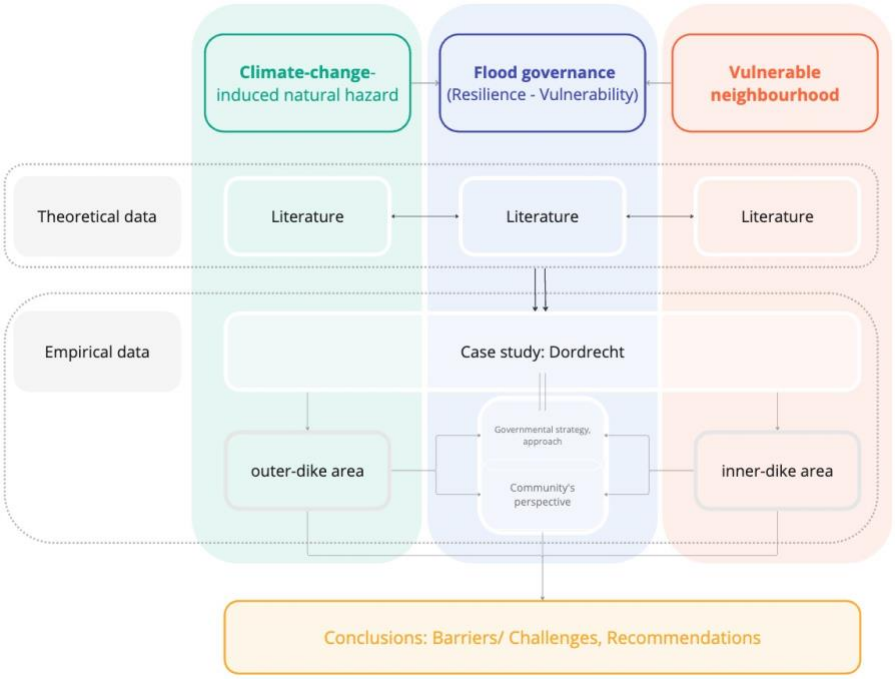

Figure 16: Research methods framework (own work, 2023)

Within the scope of this thesis, the transition from traditional flood hazard management to a more holistic approach to flood resilience, specifically through the lens of neighbourhood vulnerability in two urban areas in Dordrecht is explored (see Figure 16). The research framework builds on foundational theories from resilience, vulnerability theory, and disaster management. It posits that neighbourhood vulnerability is a key determinant of flood resilience and incorporates physical, social, and economic factors into the analysis. The case study explores

the practical application of flood resilience theories in vulnerable neighbourhoods, assessing the fit between government strategies and community realities. This includes an assessment of Dordrecht's city geographical and socioeconomic context, as well as specific flood resilience-building initiatives. Through an analysis of Dordrecht's approach to improving flood resilience, this thesis seeks to determine the extent to which theoretical concepts and governmental strategies match community's perception on the ground. Methodologically, the study employs qualitative data collection and analysis techniques to provide a nuanced understanding of the theory-practice nexus in flood resilience planning. By juxtaposing theoretical expectations with the practical experience of Dordrecht, the thesis aims to contribute to the broader discourse on flood resilience and neighbourhood vulnerability. It aims not only to validate existing theoretical frameworks, but also to identify gaps, challenges, and opportunities in the governance of resilience strategies.

Case study: Dordrecht

Using a qualitative research approach, as mentioned before, the study focuses on the case study of Dordrecht in the Netherlands. This deliberate choice is supported by the critical need for an in-depth examination of flood resilience governance strategies specific to this Dutch region that holds such a renowned position in FRM globally. The selection of Dordrecht provides a rich perspective, facilitating a nuanced understanding of the socio-spatial factors and vulnerability challenges that influence flood resilience strategies in the region.

City of Dordrecht

Dordrecht is situated in a strategic yet vulnerable location within the Rhine-Meuse-Scheldt delta, making it inherently susceptible to flooding. The city's commitment to enhancing flood resilience through comprehensive governance strategies and community engagement makes it an ideal case study for this research. The selection of Dordrecht allows for an in-depth analysis of how urban areas with differing characteristics approach flood resilience and evacuation planning within the same governance framework.

A comparative analysis

The focus on Krispijn and De Staart is predicated on their contrasting spatial characteristics, which present varied socioeconomic challenges and opportunities for enhancing flood resilience. Both neighbourhoods are socioeconomically vulnerable with Krispijn lying on low-grounds and within the dikes and De Staart being positioned on higher grounds outside of the dikes. The analysis and comparison of these two urban within Dordrecht serves multiple purposes. Firstly, it allows for an exploration of flood governance from a holistic perspective, considering both inner- and outer- dike areas, physical infrastructure, and social resilience mechanisms. Secondly, this approach highlights the importance of localized strategies that address specific vulnerabilities of different urban areas. By comparing these areas, this comparative framework not only provides insights into Dordrecht's flood management, but also serves as a model for other urban areas facing similar flood risks. It highlights the need for an integrated approach to FRM that addresses the complex interplay between physical and socioeconomic vulnerabilities.

Data collection

The research methodology used in this thesis project is structured to provide a comprehensive and nuanced investigation of flood resilience governance in the Netherlands. This involves a combination of theoretical and empirical insights to effectively address the research questions. Data collection methods include both secondary and primary data sources.

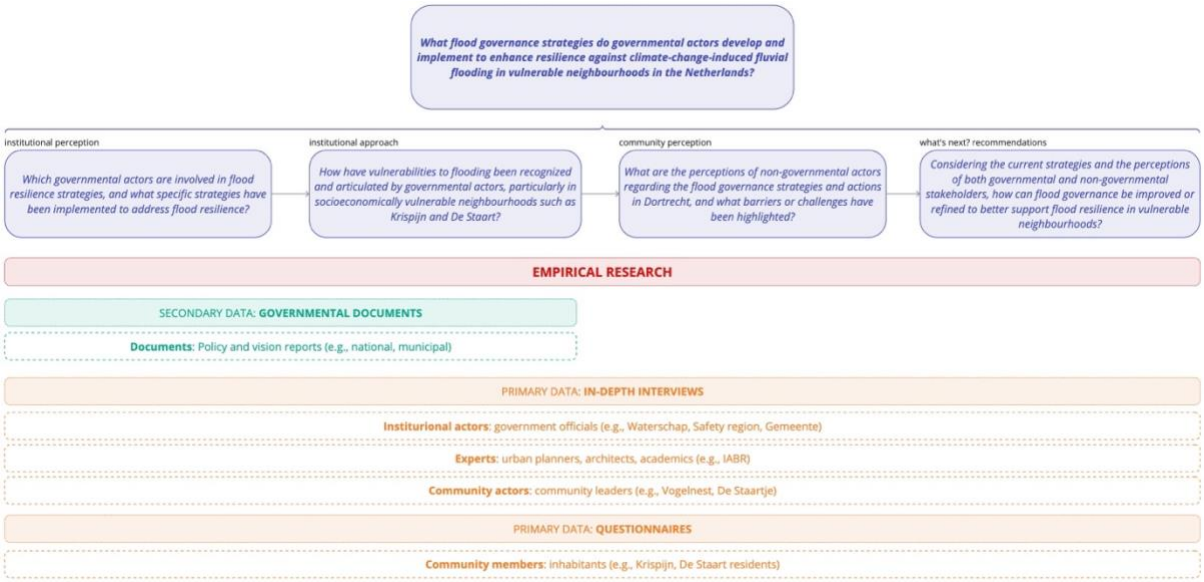

Figure 17: Methods used for data collection per RQ (own work, 2023)

Secondary data: Policy and vision reports

Secondary data sources, such as government reports and flood governance strategies, are an integral part of this research methodology. These sources provide a comprehensive overview of flood challenges, characteristics of vulnerable communities and their perceptions of vulnerability. The use of secondary data serves to establish a basic framework for the case study and provides a broad understanding of the context. In addressing research question 1 (RQ1), secondary data derived from literature reviews and exploratory interviews with institutional stakeholders contribute to initial insights into flood resilience governance. The research initiated with the selection of key policy documents within the Netherlands and more specifically Dordrecht, pivotal to directing the country's initiatives for managing and adapting to flood risks. The investigation scrutinised these documents for explicit acknowledgments or omissions of factors influencing individuals' capacities to confront flood-related challenges. Utilising policy documents as the secondary data source is instrumental because it permits an analysis of the contents officially sanctioned for FRM planning. While it is acknowledged that not everything set out in these strategic documents can be operationalised, it is recognised that such plans and strategies provide a basic framework for guiding action and determining access to adaptation planning (Juhola et al., 2022). The analysis will use a structured categorisation based on the six resilience-enhancing FRM strategies. These strategies will be operationalised by translating them into tangible variables, as outlined in Figure 17, to facilitate a more concrete and focused examination of the policies. This methodological approach ensures that each policy is assessed against specific, measurable criteria derived from the outlined FRM guidelines.

Primary data: semi-structured interviews

Primary data collection uses two main methods to address research questions 2 (RQ2) and 3 (RQ3). In addition to policy analysis, the study included formal, semi-structured interviews with a range of institutional actors. These include national and local policy-makers, public authorities, and experts and practitioners involved in the implementation of the various FRM strategies. These interviews served to corroborate the findings of the document analysis and to deepen the understanding of the nuances of policy implementation. In addition, discussions were extended to community members and relevant organisations to capture the realities on the ground, their participatory role and the effectiveness of FRM strategies from their perspective:

Exploratory interviews

Exploratory interviews play a central role in initiating primary data collection, specifically targeting institutional actors, especially those within local government units such as municipalities. These interviews aim to gather preliminary insights, establish rapport and identify key issues and priorities within the institutional framework of flood resilience governance. Conducted with government officials at different levels, these interviews will guide the formulation of subsequent in-depth interviews and ensure alignment with the perspectives and priorities of key stakeholders.

In-depth interviews

In-depth interviews represent a focused approach to primary data collection, addressing RQ2 and RQ3 exclusively. Targeting a wide range of stakeholders, including government officials, civil society organisations, community leaders and residents directly affected by the floods, these interviews delve into a rich tapestry of experiences and perspectives. Conducted in a one-to-one format, they allow for an in-depth exploration of individual experiences, decision-making processes and perceptions related to flood management. The qualitative data collected through the in-depth interviews contribute to a nuanced understanding of the dynamics of flood resilience and inform recommendations for flood risk management (FRM) strategies and policies.

Questionnaires

In addition to the strategies outlined for data collection, it's essential to include the use of questionnaires distributed to community members. These questionnaires, presented in Dutch to ensure accessibility and comprehension, are designed to capture the perspectives and experiences of the residents of the focus urban areas - Krispijn and De Staart. This quantitative method complements the qualitative data from the semi-structured interviews, providing a broader statistical base to assess community engagement and perceptions of flood management strategies. The inclusion of questionnaires will help to address the third research question (RQ3), which is to examine community's perception on governmental flood governance strategies. They serve as an important tool for assessing whether deliberate efforts to increase flood preparedness and risk awareness resonate with the community and are integrated into their daily lives.

Operationalisation variables: Main interview themes

Table 3: Main themes and variables of discussion in the semi-structured interviews per stakeholder group (own work, 2024)

Stakeholder group	Main themes	Sub-themes	Explanation
Authorities: Local, Provincial, National	• Adaptability and local tailoring • Coordination and governance	• Environmental factors • Interdependency • Multi-level governance	Policies and actions are tailored to local environmental contexts; coordination across various governance levels is assessed.
Urban Planners & Architects	• Community-centric design • Integrated development strategies	• Incorporating local knowledge • Stakeholder engagement • Regulatory framework	Design practices that reflect local needs and knowledge; integration of urban development with broader FRM strategies.
NGOs & Organisations	• Advocacy and inclusive governance • Resource mobilization	• Community representation • Decentralized decision-making • Diverse funding • Economic tools	Advocacy roles for community representation in governance; strategies to diversify funding and utilize economic tools for FRM.
Community Members/Residents	• Participatory resilience • Policy interaction and legitimacy	• Personal experiences and perspectives • Self-efficacy and action • Inclusive debate • Social equity	Residents' experiences with flood risks; their involvement in FRM policy debates and advocacy for equitable practices.
Researchers/Academics	• Policy development support • Socioeconomic resilience analysis	• Research informing policy • Analytical perspective on needs • Advocacy for evidence-based governance	How research informs policy-making; empirical analysis of socioeconomic resilience and advocacy for evidence-based governance.

The empirical research detailed in the report used primarily qualitative methods, combining theoretical insights with practical investigations. Key stakeholders from various sectors were targeted for in-depth interviews, including government officials, community leaders and residents of vulnerable neighbourhoods, to gather nuanced perspectives on flood resilience strategies (see Table 4). In addition, structured interviews and questionnaires were distributed to community members in Dordrecht to overcome the language barrier with community members, focusing on the urban areas of Krispijn and De Staart. These structured discussions and

questionnaires were designed in Dutch in order to comprehensively assess community engagement and perceptions of flood risk and current FRM strategies. This methodological approach aims to create a comprehensive understanding of the dynamics of flood resilience by juxtaposing policy frameworks with actual community experiences and perceptions, thereby providing an informed view of the effectiveness and challenges of current flood management practices.

Table 4: Interview and questionnaire participants (own work, 2024)

Semi-structured interviews			
Interviewee	**Interviewee profile**	**Means**	**Duration**
Interviewee I	Urban planner I	Online	80 mins
Interviewee II	Urban planner II & ex-Dordt-resident	Online	50 mins
Interviewee III	Water board ZHZ actor	In-person	40 mins
Interviewee IV	Safety region ZHZ actor	Online	45 mins
Interviewee V	Local authority actor I	In-person	45 mins
Interviewee VI	Community leader	Online	45 mins
Interviewee VII	Local authority actor II	In-person	35 mins
Interviewee VIII	Community leader	In-person	50 mins
Interviewee IX	Neighbourhood inhabitants	Online	45 mins
Interviewee X		In-person	40 mins
Interviewee XI		In-person	40 mins
Interviewee XII	International expert (THW advisor)	Online	40 mins
Questionnaires (as structured interviews; to overcome language barrier)			
Participants	**Participant profile**	Means	
Participant I	De Staart residents	via 't Staartje's community centre (directly)	
Participant II			
Participant III			
Participant IV			
Participant V			
Participant VI			
Participant VII			
Participant VIII	Krispijn residents	via Energiehulp's door-to-door action (indirectly)	
Participant IX			
Participant X			
Participant XI			
Participant XII			
Participant XIII			
Participant XIV			

Sampling

Sampling strategies include purposive sampling for authorities, based on expertise in flood resilience governance and representation from vulnerable communities. Snowball sampling is used for community perspective, where participants suggest additional field contacts for potential interviews and survey participation. This ensures a wide range of perspectives and access to key informants.

Data analysis

Thematic analysis is used for data analysis, which involves identifying recurring themes and patterns in the qualitative data. This systematic approach allows for the exploration of key issues related to flood resilience governance, from both perspectives; both institutional and communal.

Ethical considerations in research: Ensuring validity, reliability and integrity

Ethical considerations are crucial in research, particularly with regard to deontological aspects, validity and reliability of data. Ensuring ethical integrity enhances the credibility of research while respecting the rights and welfare of participants.

Triangulation is used to increase the reliability and validity of data by comparing findings from different sources and methods, such as interviewing different actors and consulting different documents. Informed consent is obtained from participants prior to data collection to ensure that their autonomy and rights are respected. Confidentiality is maintained by coding and anonymising private identifiable information to protect participants' identities and sensitive information. Transparency is also maintained by providing participants with a summary of the study findings and their contributions, ensuring that they are informed about the research findings. The research methodology is underpinned by a robust ethical framework.

In addition, approval from the Human Research Ethics Committee (HREC) has been secured, ensuring adherence to ethical standards and the protection of participants' rights and welfare. This approval underlines the researcher's commitment to ethical conduct throughout the study. Lastly, to ensure the validity and reliability of the research, the key gaps identified and the recommendations based on them were reviewed and validated through discussions with an expert and my internship supervisor from the municipality of Dordrecht. This process involved discussing my findings and recommendations with the expert to obtain feedback and ensure that the research reflected practical realities. The insights gained from this collaboration were instrumental in refining the focus of the recommendations and validating the strategies discussed, thus ensuring the credibility of the study's proposals.

Timeline and milestones for data collection

The research is structured in several phases, starting with an ongoing literature review. Subsequent phases include in-depth interviews with key stakeholders within vulnerable communities, and data analysis and synthesis, completing the empirical research phase.

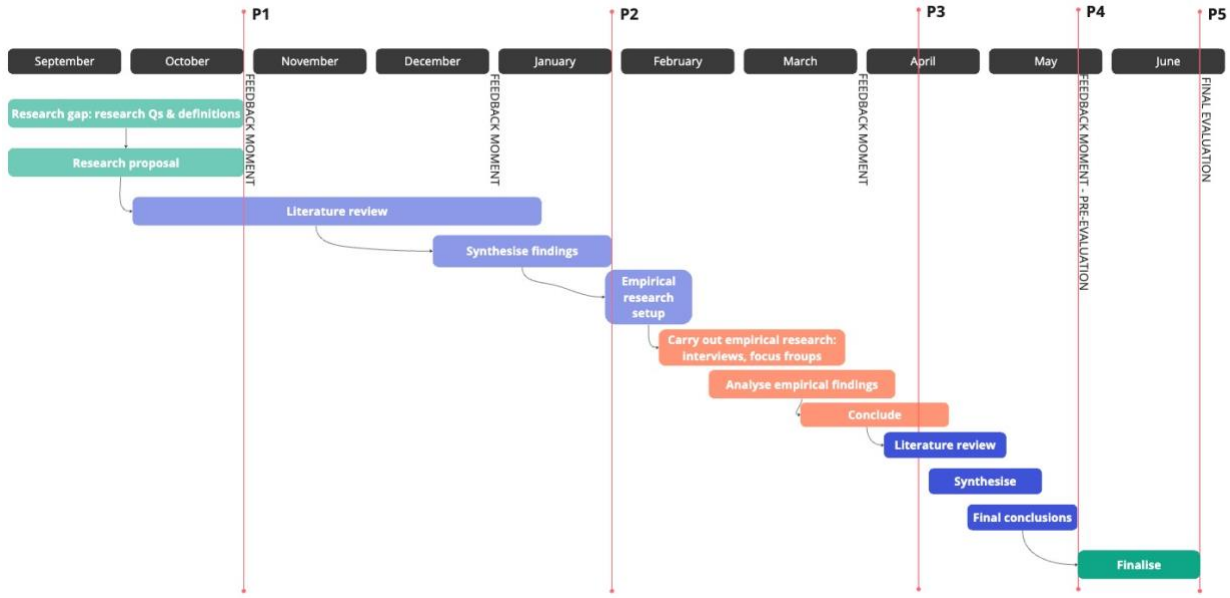

Figure 18: Time schedule and milestones of research process: from P1 to P5 (own work, 2023)

C.3 Research output

Goals and objectives

This research aims to investigate the effectiveness of flood resilience governance within vulnerable neighbourhoods, focusing on its implementation and impact. Specifically, it will assess the implementation of flood mitigation policies, both governmental and non-governmental, within these communities to identify any gaps between policy formulation and practical implementation. In addition, the study will analyse the perspectives of different stakeholders, with a focus on vulnerable community members, to gain a comprehensive understanding of how different actors perceive and engage with flood resilience strategies. It will also seek to identify and highlight best practices in flood resilience governance by examining successful approaches that have yielded positive results and analysing the contributing factors. This study aims to improve flood resilience through a comparative analysis of institutional governance strategies and community perceptions of these approaches. It will highlight stakeholder perspectives, particularly in socioeconomically vulnerable neighbourhoods, and identify challenges and barriers inherent in current flood governance practices. The ultimate aim is to provide actionable insights that can inform the refinement of flood resilience frameworks in Dordrecht and in comparable contexts.

Research objectives

The expected outcome of this specific research emphasises a critical and insightful examination of the gaps within current flood resilience governance strategies in vulnerable neighbourhoods. By carefully identifying and highlighting the specific local vulnerabilities and challenges faced by communities in areas such as Krispijn and De Staart in Dordrecht, the Netherlands, the study aims to pave the way for a more inclusive, responsive and coordinated approach to flood resilience management. This detailed analysis aims not only to uncover the intricacies of

socioeconomic vulnerability and the effectiveness of existing flood management strategies, but also to propose potential improvements. The ultimate aim is to inform and guide local authorities, policy makers, urban planners and communities towards the implementation of improved governance strategies that are aware of and tailored to the specific needs and circumstances of vulnerable populations. By providing a knowledge base of specific local challenges and gaps in current practice for vulnerable neighbourhoods, the research aims to promote a more inclusive, responsive and coordinated approach to flood resilience and contribute to the development of flood resilience governance that effectively mitigates risks and harnesses opportunities to build stronger, more resilient urban environments in the context of climate change.

Limitations

While this research project holds potential, it is important to recognize the potential limitations that may affect its scope and generalizability. First, the geographical focus on the Netherlands, although chosen for its natural vulnerability to flooding and its expertise in flood risk management, may limit the direct application of the findings to other regions with different characteristics. In addition, constraints related to data availability and stakeholder access may pose challenges, necessitating transparency regarding any data limitations. The time constraints of the research should be taken into account, especially when it is based on historical data, and the specific time frame of the findings should be explicitly defined. In addition, the research may be limited in terms of its generalizability to other cities with different social, economic, and environmental contexts. Variations in stakeholder perspectives, influenced by subjectivity and bias, should be considered as a potential limitation. Finally, the direct impact of the research on policy changes or implementation of recommendations may be limited by factors beyond the scope of the research. Ethical considerations should be carefully considered, particularly when vulnerable communities are involved, ensuring that their rights and privacy are safeguarded throughout the research process.

D. Case study – Empirical research

This case study covers the first phase of flood resilience, the phase of growth before the incident of flood, the so-called 'preparation and planning' phase of the flood resilience cycle and will mainly capture the local authority's approach and the community's perception on the flood resilience governance within vulnerable neighbourhoods in Dordrecht.

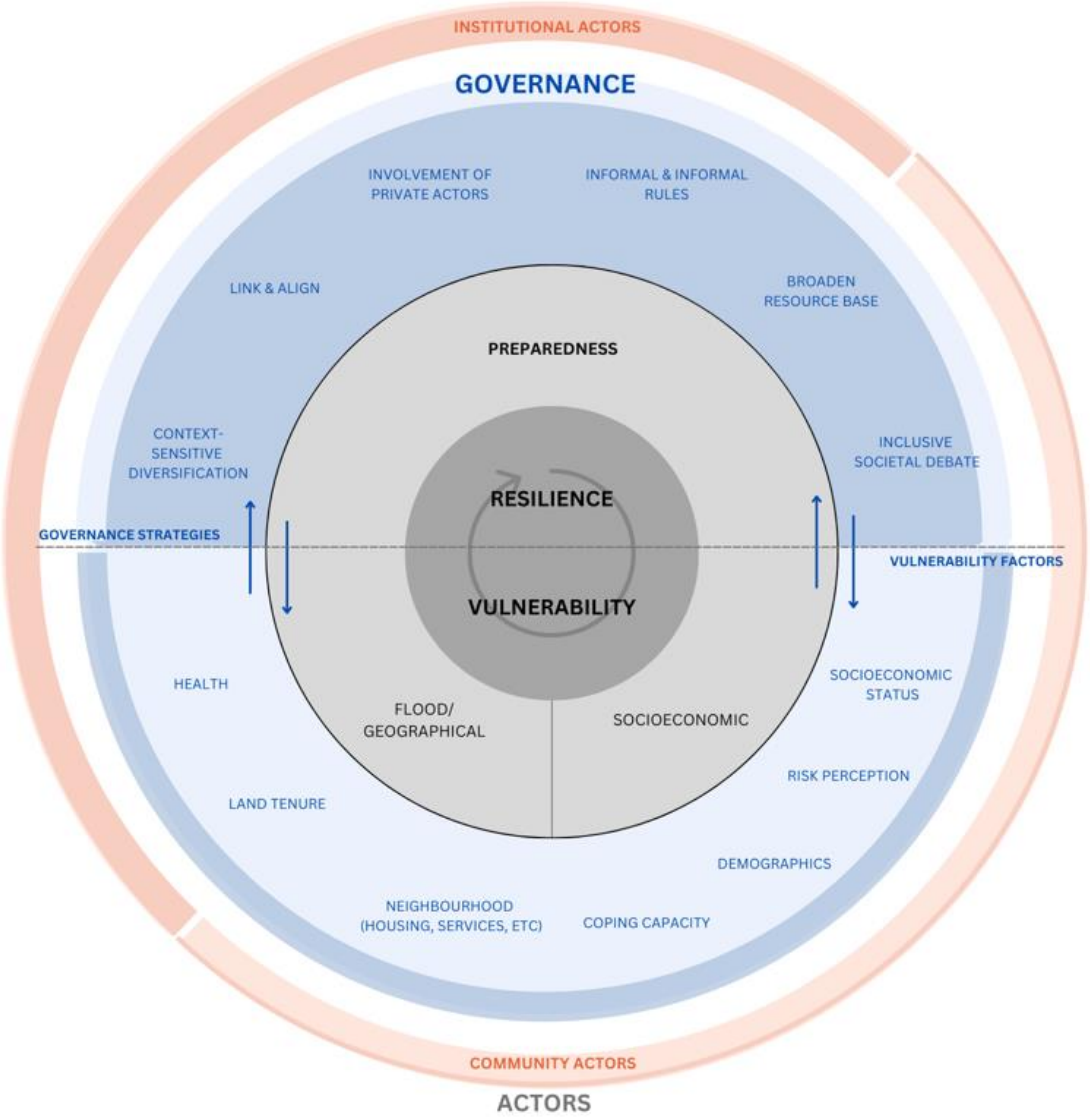

Figure 19: Empirical research's focus (own work, 2024)

D.1 Introduction to case study: Dordrecht

Figure 20: Dordrecht on the map of the Netherlands, adapted from Encyclopædia Britannica (2024)

This empirical study focuses on South Holland, an area protected from flooding by a system of dunes and dikes, including primary and regional defences. Due to climate change, there is an increasing risk of higher sea and river levels, which could increase the risk of flooding both inside and outside the defences. Although the probability of a barrier failure is low, the unpredictable nature of the effects of climate change could have significant consequences in such a densely populated region.

Dordrecht, one of the largest municipalities in South Holland, has certain vulnerabilities, both geographical and socioeconomic. Geographically, its location makes it vulnerable to flooding, which has led to the development of renowned flood resilience strategies. This makes Dordrecht a valuable case study from which much can be learned.

In addition, Dordrecht is one of the most socioeconomically deprived municipalities in South Holland. This aligns with the focus of my research on understanding and addressing the needs of vulnerable communities and provides an opportunity to explore these issues in practice. The city's rich history, shaped by water, and its evolving understanding of flood resilience further enhance its relevance to this analysis.

Dordrecht's vulnerability landscape

City's geographical vulnerability

Dordrecht's response to the threat of water is deeply rooted in its history. The catastrophic St. Elisabeth flood of 1421 reshaped the landscape and led to the creation of enclosed dike rings that turned Dordrecht into an island (Encyclopædia Britannica, 2024). This event, together with the city's unique geography at the confluence of three major rivers – Merwede, Oude Maas, Noord – and some modern water challenges that function as wake-up calls laid the foundation for Dordrecht's approach to flood resilience towards an adaptive, anticipatory perspective.

Dordrecht's geographical vulnerability is exacerbated by its location at this strategic confluence, which makes it highly susceptible to fluvial flooding. The city is surrounded by water on all sides, creating a natural basin that is prone to flooding when river levels rise. The network of embankments and levees provides considerable protection but also means that any breach could lead to rapid and widespread flooding (Gersonius et al., 2016; Oukes et al., 2022). The low-lying nature of Dordrecht means that it is particularly vulnerable, however, there are some areas within the 'island' that are located on higher ground, providing opportunities for shelter during flood threats within the city's boundaries. This unique topography takes away but also gives potential to Dordrecht to become independent leading to the city's main goal to become 'self-reliant', reducing the need to rely on infrastructure links with neighbouring cities for emergency

shelter. Overall, such geography requires a complex and robust flood management system to mitigate potential risks (Hudson et al., 2008).

City's socioeconomic vulnerability

Dordrecht's socioeconomic vulnerability further complicates its flood resilience efforts. This city faces challenges due to economic constraints, educational disparities, and diverse demographic characteristics. High levels of income inequality and low levels of education among residents can limit the community's ability to respond effectively to flood risks. Furthermore, the presence of vulnerable groups such as the elderly, children, and migrants potentially exacerbates these challenges. Therefore, the socioeconomic profile of Dordrecht will be examined to comprehensively understand how socioeconomic vulnerability affects the preparedness and resilience of communities to flood risks, and to provide actionable policy recommendations. The established theoretical framework from the theoretical research will be used to guide this analysis, consisting of coping capacity and socioeconomic status, demographic characteristics, health and safety, housing tenure, neighbourhood characteristics, and risk perception (see Table 1, p. 25).

The city of Dordrecht, with a population of 121.434 in 2023 (CBS, 2024), presents unique challenges in terms of flood preparedness due to its distinct socioeconomic characteristics (see Table 5). Understanding these vulnerabilities is crucial for effective risk communication, awareness raising, and planning efficient evacuation strategies.

Coping capacity and socioeconomic status

Economic and educational constraints have a significant impact on Dordrecht's ability to cope with floods. With 39.6% of the population at the lowest income level and 22.2% classified as low educated (Drechtsteden, 2024; CBS, 2024), there is a significant portion of the community that may lack the resources and knowledge necessary for effective flood response and recovery. These groups could benefit from targeted educational programmes and support services to ensure equitable access to flood risk information and resources.

Demographic characteristics

The city’s profile includes vulnerable groups, such as the elderly (19,4%), children (15,2%), and migrants (33,5%) (CBS, 2024; Drechtsteden, 2024). The elderly and children are particularly vulnerable during disasters due to their potential limited mobility and health problems. The high proportion of migrant residents may face barriers, such as language, which can affect the reach and effectiveness of risk and emergency communications. Therefore, there is a high demand for tailored approaches in different languages and formats that are essential to increase inclusiveness in disaster preparedness and response plans.

Health and safety

Dordrecht’s crime rate, although relatively not very high at 5-6 incidents per 1.000 inhabitants, could affect community cohesion and trust – key elements in collective crisis response (Drechtsteden, 2024; CBS, 2024). Efforts to strengthen community ties among each other, to build a strong self-reliant community-network and to empower trust in local authorities could enhance collective engagement and response.

Housing tenure

The composition of the city's housing stock - 58% owner-occupied and 42% rented - may influence residents' responses to flood risk (CBS, 2024). Owners may be more likely to invest in flood protection measures than renters. Policies that incentivise and support flood resilience measures across housing tenures could improve overall community preparedness.

Neighbourhood characteristics

With 89% of the housing stock built before 2000, many residential areas in Dordrecht do not meet the maximum of the available modern flood resistance standards (CBS, 2024). Improving the resilience of infrastructure, together with improving access to basic amenities and public buildings, can play a crucial role in preparing these neighbourhoods for flooding. For such an arrangement a multi-faceted strategy that combines public, private, and community resources could be combined and further explored.

Risk perception

Last but not least, variations in risk perception among different demographic groups, influenced by factors such as age, language proficiency, and socioeconomic status, can affect community preparedness. Programmes designed to improve flood risk awareness and encourage personal preparedness need to address these differences in needs and perception to be accessible by most and therefore effectively informative and empowering.

Table 5: Vulnerability factors of Dordrecht, own work (2024) based on data retrieved from CBS (2024) and Drechtsteden (2024)

City of Dordrecht	**Inhabitants (2023): 121.434 people**	
Vulnerability Factor	**Description**	**Identification metric**
Coping capacity & Socioeconomic status	Affected by income and education levels	39,6% lowest income level 22,2% low educated
Demographic characteristics	Includes age, migration background	19,4% aged 65 + 15,2% aged 0-15 33,5% with migration background
Health and safety	Effects of crime rate (theft, vandalism, violence-sexual)	Crime rate 5-6 per 1.000 inhabitants
Housing tenure	Divided between property owners and renters	58% owner-occupied 42% rental properties
Neighbourhood characteristics	Affects access to amenities, population density, and housing quality	1.574 inhabitants per km^2 89% pre-2000 housing stock
Risk perception	Influenced mainly by demographics	Varied due to age and migration background (language barriers)

Overall, the vulnerabilities identified in Dordrecht (see Table 5) significantly exacerbate the city's flood preparedness and response challenges. Economically, the high percentage of residents with low income (39.6%) and limited education (22.2%) creates a potential barrier to accessing and understanding flood risk information, thereby limiting the ability of these residents to effectively prepare for and respond to flooding. Demographically, the significant presence of the elderly (19.4%), children (15.2%), and migrants (33.5%) adds further complexity. The elderly and children are particularly vulnerable due to mobility and health constraints, while migrants may face language barriers that hinder their access to vital emergency communications. The tenure landscape, with a mix of owner-occupied and rented properties, affects the likelihood of residents investing in flood defences, potentially leading to uneven community resilience. In addition, the predominance of older housing stock (89% built before 2000), which – very likely – does not meet modern flood resistance standards, puts the physical infrastructure at risk. Together, these socioeconomic characteristics interact to increase the city's overall vulnerability to flooding, requiring targeted, multi-faceted strategies to improve both individual and community resilience.

D.2 Focus urban areas: Krispijn and De Staart

In order to better understand the different aspects of the city and to gain a more representative perception of the community, this study examines two key urban areas within Dordrecht: Krispijn and De Staart. This approach will help to develop targeted, actionable recommendations. Krispijn (oud & nieuw), located in the southwest of the city, has a population of approximately 15.875 (CBS, 2024) and is characterised by its potential as a flood evacuation area. De Staart, located in the northern part of the city, has approximately 5.290 inhabitants (CBS, 2024) and is identified as a future host or shelter area during flood events. These case studies highlight the different needs and capacities of Dordrecht's vulnerable communities and provide a basis for targeted flood resilience strategies.

Krispijn neighbourhood

The research carried out in Krispijn, Dordrecht, aims firstly to explore the vulnerability profile of the area, and then also, in the next chapter, the community's awareness and preparedness for flood risks. It evaluates local characteristics and challenges exploring the community's socioeconomic profile. The aim is to identify areas for improvement to strengthen Krispijn's resilience to potential flooding.

Figure 21: Krispijn - location in Dordrecht, own work (2024) based on the map created by Google (2024)

Socioeconomic vulnerability and evacuation dynamics

Oud & Nieuw Krispijn, with a large population of 15.875 shows significant socioeconomic vulnerability (see Table 6) (CBS, 2024). Approximately 45.7% of the 15,875 inhabitants have the lowest income level, which may limit their ability to invest in flood prevention or recovery measures (Drechtsteden, 2024; CBS, 2024). In addition, the significant number of residents with low levels of education could limit their understanding of flood risks and reduce the effectiveness of preparedness campaigns. The ageing housing stock in Krispijn, mostly built before 2000 (CBS, 2024), raises concerns about the structural vulnerability and the potential need for retrofitting to meet modern flood resilience standards. This issue is of particular interest and should be given special attention due to the limited financial capacity of the community in Krispijn, which may hinder efforts to upgrade these houses and reduce their vulnerability to flood damage. Another critical factor is the high population density in Krispijn, with 7,153.5 inhabitants per km^2. High population density can exacerbate flood vulnerability by increasing the demand on emergency

services and infrastructure during flood events, complicating evacuation efforts, and increasing the potential for loss of life and property damage. The densely populated areas may also face challenges in providing adequate shelter and resources during floods, further straining the community's ability to respond effectively. The main vulnerability indicators in Krispijn include a financially disadvantaged and low-educated population, a significant number of elderly residents, children, and individuals with migration backgrounds, majority of them residing in quite outdated housing stock.

These factors highlight the urgent need for Dordrecht to develop flood risk management strategies that are not only infrastructurally sound, but also more socially equitable, ensuring that all community groups, regardless of socioeconomic status, are well prepared and protected.

Table 6: Vulnerability factors of Krispijn (oud/nieuw) in Dordrecht, own work (2024) based on data retrieved from CBS (2024), Drechtsteden (2024,) and Telli (2024a)

Oud- & Nieuw Krispijn	**Inhabitants (2023): 15.875 people**	
Vulnerability Factor	**Description**	**Identification metric**
Coping capacity & Socioeconomic status	Affected by income and education levels	45,7% lowest income level 30,4% low educated
Demographic characteristics	Includes age, migration background	14,4% aged 65 + 17,2% aged 0-15 45,4% with migration background
Health	Access to care and effects of crime rate	Access to care <1,4 km Crime rate 3-4 per 1.000 inhabitants
Housing tenure	Divided between property owners and renters	48% owner-occupied 52% rental properties
Neighbourhood characteristics	Access to amenities, population density, and housing quality	<1,4 km to basic amenities 7.153,5 inhabitants per km^2 86% pre-2000 housing stock
Risk perception	Influenced mainly by demographics and property types	Varied due to age, migration background, and housing tenure

De Staart neighbourhood

The research conducted in De Staart, Dordrecht, aims to firstly explore the area's vulnerability profile. It examines socioeconomic factors that are potentially closely related to flood risk and governance strategies, to identify possible challenges, barriers, and gaps that could be addressed to strengthen De Staart's role in Dordrecht's emergency planning.

Figure 22: De Staart - location in Dordrecht, own work (2024) based on the map created by Google (2024)

Socioeconomic vulnerability and sheltering capacities

De Staart, in comparison to Krispijn, has a smaller group of inhabitants, with a population of 5.290, but faces accordingly similar challenges as Krispijn (see Table 7) (CBS, 2024). A significant proportion of the population, with 41% in the lowest income bracket and more than 1,700 people with low levels of education, may lack both the financial resources to implement personal flood protection measures and the knowledge to prepare for and respond to floods (Drechtsteden, 2024; CBS, 2024). Pre-2000 housing stock in De Staart in Dordrecht (CBS, 2024) may not meet modern flood resilience standards, potentially posing a threat during flood events. This is particularly concerning given the financial capacity of the community. Older buildings often lack the structural integrity and modern materials necessary to withstand severe flooding, which could lead to increased damage and longer recovery times. In addition, existing soil and air pollution exacerbates health risks during flood events, with the potential for contaminants to be spread by floodwaters, adding another layer of complexity to the community's ability to prepare for and recover from such disasters. In essence, the major vulnerability indicators in De Staart include low income and education levels, and health risks from pollution.

The location of De Staart adds another layer of complexity to its vulnerability to flooding. The neighbourhood is located on an island within the city of Dordrecht and is only connected to the rest of the city by a bridge. This limited accessibility poses significant challenges during flood events, as evacuation routes are limited and can easily become bottlenecks. In the event of severe flooding, the bridge could become impassable, cutting off residents from essential services and assistance. This isolation could delay emergency response times and hinder the delivery of aid and resources, increasing the community's vulnerability to flooding.

Taken together, these socioeconomic factors underscore the need for tailored, inclusive flood preparedness strategies that take into account the economic constraints, educational needs, infrastructure robustness and health vulnerabilities unique to the shelter areas, aiming to empower the people that will potentially act as the 'saviours', the safe haven of Dordrecht.

Table 7: Vulnerability factors of de Staart in Dordrecht, own work (2024) based on data retrieved from CBS (2024), Drechtsteden (2024,) and Telli (2024b)

De Staart	**Inhabitants (2023): 5.290 people**	
Vulnerability factor	**Description**	**Identification metric**
Coping capacity & Socioeconomic status	Influenced by socioeconomic status	41% at lowest income level 32,5% low educated
Demographic characteristics	Age and migration background are key	20,9% aged 65+ 13,3% aged 0-15 44,2% with migration background
Health	Comprised by pollution concerns	High health risk due to (air and soil) pollution
Housing tenure	Ownership influences investment in flood prep	55% owner-occupied 45% rental properties
Neighbourhood characteristics	Connectivity, access to amenities, population density, and housing quality	1,4-2,7 km to basic amenities 1.169 inhabitants per km^2, but limited connectivity to the rest of the city (island) 100% pre-2000 housing stock
Risk perception	Influenced mainly by demographics	Varied due to age and migration background

D.3 Flood resilience governance: Institutional approach

This following section captures the institutional approach; the local authority's perspective on flood resilience governance in Dordrecht, namely that of preparation and planning, focusing on existing policies, gaps, and areas for improvement. The analysis is based on policy and vision documents as well as in-depth interviews with government actors.

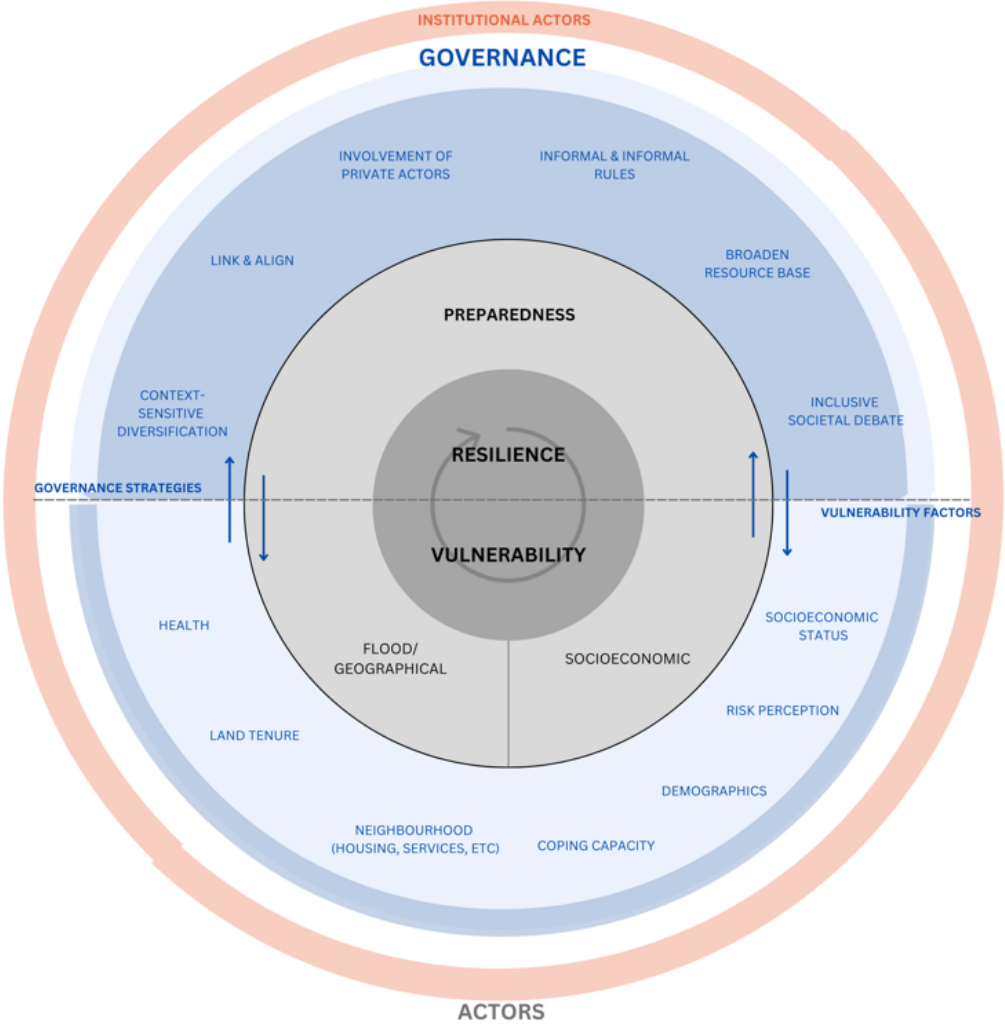

Figure 23: Preparedness from the institutional perspective (own work, 2024)

Dordrecht's flood management strategy is an example of a multi-level, 'horizontal' cooperation involving various government actors, from national agencies to local authorities. This integration aims to align the various institutional strategies and to ensure that all levels of government actively contribute to the formulation and implementation of a comprehensive flood resilience approach (interviewee III & IV, 2024).

National strategic framework

At the national level, agencies such as Rijkswaterstaat, develop overarching flood policies, norms, and frameworks that set the strategic direction for flood resilience in the Netherlands. Additionally, relevant tools, capturing and visualising the current situation and risks, as maps, are provided by the province. These frameworks and maps are essential in establishing a consistent approach that local governments, including the city of Dordrecht, can tailor to their

specific urban planning, governance needs, and community engagement efforts (interviewee III, 2024).

The cornerstone of the Netherlands' approach to flood resilience is the Multi-Layered Safety (MLS) strategy. This integrated approach was integrated into Dordrecht's strategy in 2008 and it combines three layers: direct flood protection through infrastructure, spatial adaptation to mitigate flood impacts, and crisis management to enhance emergency response capabilities (Esteban, 2022; Oukes et al., 2022).

Figure 24: Multi-layer safety: prevention, spatial planning and crisis management (Beleidsnota Waterveiligheid 2009-2015)

- Direct flood protection: focuses on lowering the likelihood of flooding by using flood defence facilities including dams, dikes, dunes, levees, and other building blocks.
- Resilient spatial planning: focuses on adopting proactive planning and flood-proof spatial solutions to reduce the effects of flooding. Dike ring zoning, avoiding construction in high-risk locations, and creating flood-proof plans for sensitive facilities like schools and hospitals are a few examples.
- Crisis management: focuses on improving readiness in order to reduce the effects of a flood. Adequate emergency response (e.g., early warning systems, disaster management, evacuation) and risk communication can accomplish this.

Responsibilities of actors

Each phase comprises different stakeholders represented by governmental organisations accordingly. Every organisation is responsible for different layer(s) as briefly explained before. Collaborative efforts involving government agencies at all levels, residents and experts have fostered a participatory culture in urban planning and spatial design, aiming to increase awareness and open communication between stakeholders (Esteban, 2022; Interviewee III & IIII, 2024). The administrative framework for flood protection in Dordrecht comprises a single municipality, a water board, a unified safety region within the boundaries of South Holland-South province, and a regional division of the national agency Rijkswaterstaat as the main actors regarding flood management (Herk et al., 2011). The distribution of flood management responsibilities and FRM actions between these different stakeholders and entities is examined and described in Table 8.

Table 8: Authorities, responsibilities, and key actions per governmental stakeholder (own work, 2024)

Layers	Governmental stakeholders	Actions
1st layer: Flood protection	Rijkswaterstaat	Set safety norms for dykes and levees; National policy
	Waterschap	Technical check and maintenance of dikes and levees; Risk assessments
2nd layer: Spatial planning	Province	Advise on spatial planning; Necessary maps; Zoning regulations
	Municipality	Municipal policies; Implementing spatial planning
3rd layer: Crisis management	Safety Region	Coordinate regional disaster response and preparedness; Coordinating disaster management and public education
	Municipality	Local risk communication (public awareness campaigns, water festivals); Shelter areas (higher grounds); Evacuation strategy; Localizing policies

From national policy to local action

Dordrecht's water management strategies illustrate the shift from national policy to local action, incorporating initiatives such as 'Room for the River', the Delta Programme and the forthcoming 'Water en Evacuatie'. In particular, the forthcoming local version of the 'Water en Evacuatie' policy will focus on improving local preparedness, effective communication and community resilience by developing detailed evacuation plans and conducting exercises tailored to Dordrecht's urban layout and population. The 'Waterplan Dordrecht' addresses the city's unique geographical and hydrological challenges through tailor-made flood protection measures, water quality improvements, and urban water management strategies designed for Dordrecht. In addition, Dordrecht works closely with academic and research institutions to apply cutting-edge research and innovation to local water management solutions, ensuring that the city's flood resilience is continually improved. Through all these broad-based, national policies, Dordrecht is focusing on and working towards spatial and governance improvements tailored to the specific needs of Dordrecht (interviewee III & V, 2024). Moreover, the city (gemeente) has been investing and building on its collective memory of historic floods to cultivate a culture of awareness and self-reliance. By both typical measures, as involving residents in flood defence exercises or sharing knowledge with other cities and countries through various national and European programmes, as FIER (Flood, Infrastructure, Evacuation, Resilience) and more alternative engagement methods, as organising art festivals for the public.

Local strategic framework and implementation

This local adaptation is crucial, particularly in addressing the unique geographical and environmental challenges of the area. The operational aspects of these strategies are managed by the water board ZHZ, which play a crucial role in maintaining and monitoring flood defence infrastructure such as dikes, levees, and waterways (interviewee III, 2024). These structures are

essential for direct flood risk mitigation and are regularly assessed to ensure their effectiveness and safety. Moreover, safety region ZHZ play a key role in coordinating disaster response and crisis management, ensuring that emergency services are well coordinated and effective during flood events (interviewee IV, 2024). This coordination is crucial for the rapid activation of crisis management plans and the successful implementation of evacuation procedures when necessary. Finally, the municipality of Dordrecht is the main one responsible for the preparation phase of flood resilience. This scope consists of strategies to raise awareness through strengthening risk communication and acceptance within the local communities, designating higher-ground shelter areas, implementing evacuation strategies, and localizing policies to meet community-specific needs, making sure that their level of preparedness is growing (interviewee V & VII, 2024).

City's current approach and strategies

The municipality of Dordrecht, therefore, has a crucial role in improving the resilience and water safety of the city and for that is implementing several targeted strategies. These strategies intend to be multi-faceted and are designed to address both the risk awareness and spatial aspects of flood preparedness (interviewee V & VII, 2024).

First, the municipality conducts public awareness campaigns and organises events such as water festivals to educate and engage the community about flood risks. These initiatives are interactive and designed to promote a culture of preparedness. Efforts are being made to involve a wider range of age groups in community preparedness initiatives. This includes organising events, festivals and workshops that are accessible to children and young people (interviewees V & VII, 20-24). A notable example is 'de redders', an engaging and educational programme for primary school children in Dordrecht that teaches water safety skills and raises awareness of water-related risks. In addition, the 'tij festival' uses art installations and light projections to demonstrate the effects of climate change and rising water levels, targeting young adults and middle-aged people to increase their understanding and acceptance of flood risks. These initiatives aim to educate younger generations in the hope that they will share this knowledge with their families and friends (Interviewee VII, 20-24).

Recognising the critical importance of efficient evacuation, the municipality is in the early stages of developing a comprehensive evacuation strategy. This plan aims to facilitate the orderly relocation of residents from high-risk, low-lying areas to designated safe zones. As part of this strategy, the municipality is also identifying and developing higher ground evacuation areas, which are recognised as the safest places to be during flood events in Dordrecht due to their elevated position, comparable to the height of the dikes (interviewees V & VII, 20-24). This proactive measure ensures that residents have predefined safe havens, thus reducing the potential chaos and confusion during an actual flood. The strategy is driven by the municipality's goal to ensure that all residents can be moved quickly and safely in an emergency, minimising potential casualties and damage.

Overall, by tailoring these measures to the specific needs of Dordrecht, the municipality aims to strengthen the long-term resilience of the city. These efforts are in line with Dordrecht's overarching goal of becoming 'self-reliant' in the face of increasing fluvial flood risks and reflect an adaptive approach to flood resilience governance (Esteban, 2021; Interviewee VII, 2024). The local overarching strategy focuses on implementing 'soft' measures to raise awareness and preparedness for flood risks without causing panic (interviewee V & VII, 2024). This includes organising risk awareness events such as fun workshops and festivals, and integrating

evacuation routes and shelters into everyday urban life and sustainable development. This approach ensures that residents become instinctively aware and prepared, and minimises confusion during a flood event by embedding emergency strategies into daily routines (interviewee V & VII, 2024).

Challenges and areas for improvement: socioeconomic vulnerability lens

Despite the comprehensive nature of Dordrecht's FRM strategies, there remain some significant challenges, particularly in terms of inclusiveness in communication (interviewee V & VII, 2024) and resource allocation (interviewee V, 2024). While there is a general awareness of the city's vulnerability to flooding, there is a lack of specific strategies or protocols tailored to socioeconomically vulnerable groups' needs, in neighbourhoods such as Krispijn and De Staart. The city's efforts have primarily focused on broad-based awareness and preparedness for the general population and more recently young kids, with an emerging recognition of the need to better involve specific vulnerable groups in these plans.

A critical challenge is the inclusiveness of communication strategies. Current approaches often fail to address the diverse needs of vulnerable groups, such as those with language barriers, the elderly, those with health problems, and those with reduced mobility (interviewee V & VII, 2024). For example, non-native speakers may struggle with emergency information and elderly residents may not be fluent users of social media and the digital platforms. Effective communication is essential to ensure that all community members understand and accept the risks and know how to respond in an emergency. However, existing strategies often overlook the specific needs of vulnerable groups, leading to gaps in preparedness and response. Although government actors recognise the impact of social vulnerability, there are no clear protocols or handbook taking into consideration these groups' needs in the context of FRM (interviewee V, 2024).

Political will is another factor that partially influences decision-making and resource allocation in Dordrecht's FRM strategies (interviewee VI & VII, 2024). The commitment of political leaders to prioritise and fund inclusive and comprehensive flood resilience measures can vary over time, affecting the consistency and effectiveness of the strategies implemented. Political will also encompasses the message that government actors wish to convey to the public about flood risk, including how much they are willing to change public perceptions about the urgency of flood risk and how they want people to rely on and take pride in flood-related infrastructure investments (interviewee VI & VII, 2024). Overall, it influences the balance between creating a sense of urgency and maintaining public confidence.

Conclusion

The institutional approach in Dordrecht, based on empirical research, emphasises a broad, city-wide approach with a particular focus on engaging children and young people. However, it lacks tailored strategies to address the specific characteristics and socioeconomic needs of different other vulnerable groups comprising Dordrecht's population. The city recognises this gap and the need for more inclusive and responsive strategies and although specific manuals or protocols for vulnerable groups have not yet been established, there is a clear understanding within the local government of the need to improve current practices. Efforts are underway to develop an evacuation plan and a more inclusive communication strategy to improve engagement with all segments of the community. This evolving approach aims to strengthen the preparedness phase of flood resilience by ensuring that all residents, especially those from socioeconomically vulnerable groups, are informed and able to respond effectively to flood risks.

D.4 Flood resilience governance: Community perception

This section, on the other hand, captures the community's perspective on flood resilience governance in Dordrecht, focusing on residents' risk perceptions, awareness, preparedness, and potential perceived gaps in existing strategies. The analysis is based on data collected from statistical research, in-depth interviews, and some targeted questionnaires conducted in Dutch to overcome language barriers with community members.

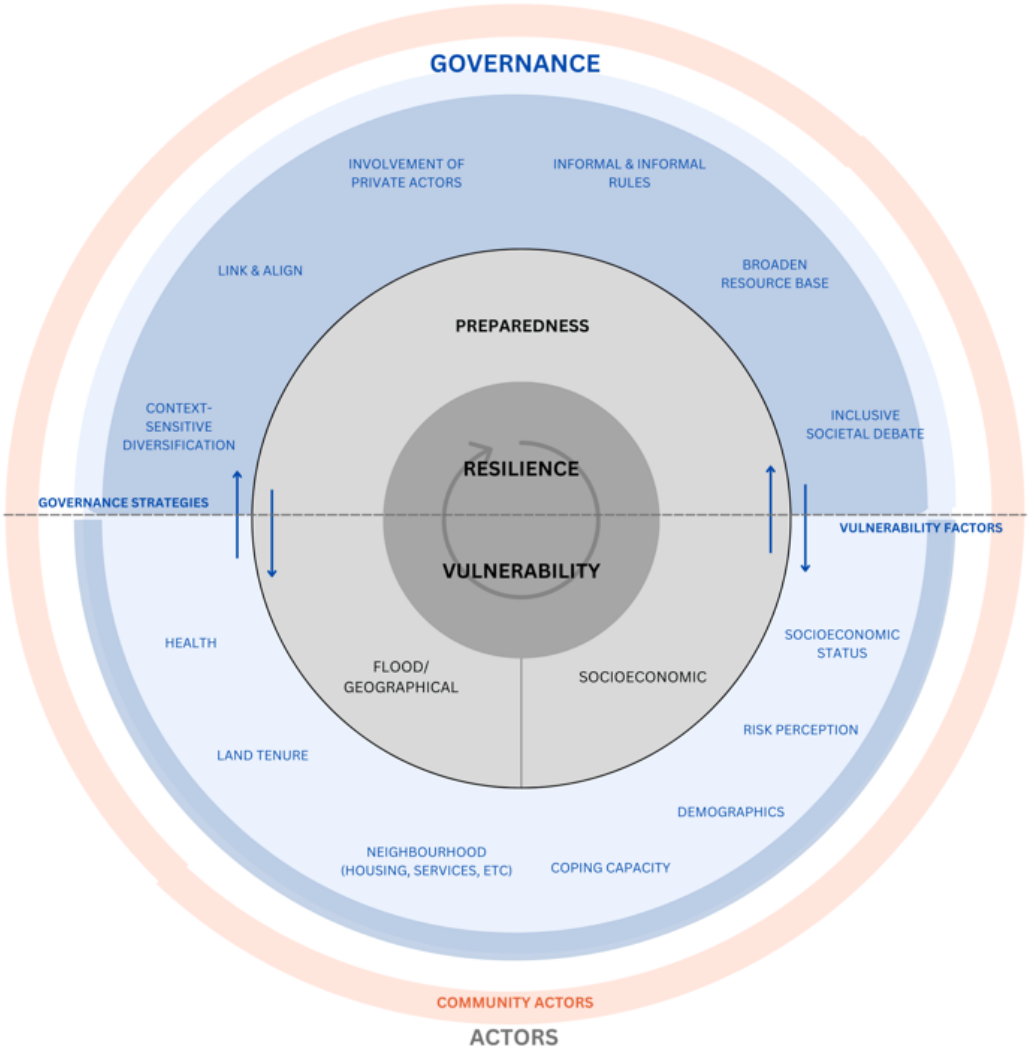

Figure 25: Preparedness from the community's perspective (own work, 2024)

Previously, the institutional approach and perspective were explored and presented. This section presents the findings from the community perspective collected from the areas of Krispijn and De Staart. Understanding community perceptions is crucial because it provides insights into the awareness and preparedness of residents, which are essential for effective flood resilience planning. Krispijn and De Staart were specifically chosen to represent areas with different roles in flood scenarios - evacuation and sheltering - thus providing a comprehensive view of the community resilience landscape.

Krispijn: Community's perception

The community perspective of Krispijn's neighbourhood were collected and discussed regarding flood risk, flood resilience, and current flood resilience initiatives, exploring residents' risk awareness, acceptability, and overall perception. In Krispijn, a neighbourhood located in the low-lying areas of Dordrecht, residents' perceptions of flood risk are characterized by a disconnect from their geographical vulnerability. Despite being in a flood-prone area, residents' immediate socioeconomic concerns often overshadow the potential dangers of flooding. As one resident put it, "I don't see the risk of flooding as a present risk; it's not something that I feel close to me in the near future" (interviewee IX, 2024). This sentiment is echoed by another who admitted, "There is no awareness of this issue. To be honest, we don't really think about it" (interviewee X, 2024). These comments highlight a significant issue: many residents of Krispijn do not view and accept flood risk as an important community concern.

The demographic diversity in Krispijn, which includes older residents and various migrant groups such as Turkish-Dutch and Polish immigrants, adds complexity to community engagement in flood resilience measures. Current efforts primarily target younger populations, neglecting migrant groups who often face language barriers and consequently their integration in the community is limited (interviewee X & XI, 2024). This oversight leaves a substantial portion of the community excluded from important conversations about flood resilience. As one interviewee noted, "Oh yeah, for sure, there's definitely language problems with the migrants and expats around here, on top of all the money issues" (interviewee X, 2024).

Additionally, many houses owned by migrant families are often unoccupied for large parts of the year. "Most of the houses in Turkish and Moroccan families, most of the parents bought a house when they came here years and years ago, and now their children live in the houses and they are only here a few months a year and then they go back home." (interviewee XI, 2024). The temporary occupation of the property in some cases in Krispijn area further complicates consistent community engagement and preparedness efforts.

A common belief among residents is that robust flood management infrastructure is sufficient, leading to a lack of interest in personal responsibility and flood preparedness measures. As one resident noted, taking such measures feels like an overreaction: "I would feel like a doom-thinker...that's something that stops me from doing it" (interviewee IX, 2024). There is also a common concern about the lack of clarity regarding what to do and where to go in the event of a flood with residents stating: "I don't know where to go or what to do in case of a flood risk" (questionnaire participants, 2024). Even those who are aware of necessary actions express a need for more specific guidance on safe locations, further reducing the perceived urgency to prepare individually for potential flood scenarios.

Overall, there is a consensus that communication and information sharing about flood risks and safety measures are inadequate. The residents of Krispijn have a relatively passive attitude towards flood preparedness, influenced by more pressing daily socioeconomic challenges. The majority of the research participants expresses a need for better and more detailed information in order to feel adequately prepared and more actively involved and only a few of them are not yet accepting the need and urgency of the flood risk itself. The pulse of the community reflects a mixture of disengagement and a reliance on existing infrastructure, highlighting the need for more inclusive and effective communication strategies tailored to their specific needs.

As mentioned in the previous chapter, the flood resilience strategies implemented often lack specificity for unique socioeconomic conditions, a point that appears to be confirmed in the case of Krispijn. Existing strategies do not sufficiently address the low income and low education levels that characterise Krispijn. An apparent gap has been detected between perceived and actual flood risk among residents, highlighting the need for more targeted risk communication and community engagement.

De Staart: Community's perception

In De Staart neighbourhood, community insights were gathered and analysed concerning flood risk, flood resilience, and ongoing flood resilience initiatives, with a focus on understanding their risk awareness, acceptability, and overall perception of its role as a shelter-area. De Staart presents a contrasting scenario where the community's perception of flood risk is heavily influenced by the area's elevation, providing a false sense of security against flood threats. Long-term residents expressed a strong attachment to their place, often pointing to its geographical elevation as a key factor in their sense of security and pride. One resident confidently stated, "This is the safest place to live in Dordrecht in case of a flood" (interviewee VIII, 2024), illustrating a prevailing sense of safety in the neighbourhood. Another resident expressed a similar opinion, saying, "Like, we have the 'Deltawerken' [Delta works] and it kind of stops there for me then, you know?". This reflects a deep trust in the existing flood infrastructure, believing it to be sufficient protection. However, despite this strategic geographical advantage, complexities arise in how the community perceives and prepares for flood risks. The neighbourhood is seen as a refuge for evacuees from lower-lying areas during flood events, adding a layer of responsibility to the local community. This level of personal responsibility and involvement by hosting evacuees in their homes seems to be fully recognised, as people still feel unaffected by the flood risk, even though they would be directly affected.

Communication and information gaps further complicate the situation. One resident remarked, "City government should drive, give more information to us, brainstorming with residents" (questionnaire participant, 2024). There is a repeated theme of needing better communication and more detailed information on flood safety and emergency protocols. Many residents do not feel adequately informed about what to do to prepare as a shelter area during a flood event and express a need for more proactive communication from the city.

The demographic diversity of De Staart also contributes to different responses to discussions about flood risk. Language barriers and a focus on other pressing socioeconomic challenges hinder effective communication about the importance of the area's role in an emergency. Some residents view evacuation primarily as an infrastructure project by the government, intended to better connect the area to the city center, offering land and public spaces - 'crisis centres' as one interviewee called them - to evacuees. "They can come, why not? We have enough space here" (interviewee XII, 2024) referring to the outdoors, public spaces and facillities of the area. This sentiment reveals a misconception about the extent of responsibilities that hosting evacuees entails. Responsibility for preparedness is a pressing issue. There is a strong feeling that both the municipality and the community should share responsibility for preparing De Staart as a shelter or reception area in the event of an emergency. This suggests a desire for joint efforts in disaster preparedness. However, some residents are less willing to support the process and the reception of evacuees. "To be honest, I don't want them here" (interviewee XII, 2024).

Participation in safety programs is another area of concern. Some find the programs vague and not very helpful, suggesting a need for more targeted and practical engagement strategies. There is a clear desire for concrete plans and scenarios. Residents want more concrete emergency scenarios and detailed plans that they can easily understand and follow. This includes a clear delineation of emergency roles, safe locations, and specific actions to be taken during floods. This highlights the fact that their role as a safe haven has not yet been adequately integrated into the collective consciousness of the community, and there remains a gap in understanding the true extent of their potential contribution to the evacuation plan. One participant's realization encapsulates this: "I didn't realize until now that it [evacuating to De Staart] could also mean that residents should take in families in their homes" (interviewee XII, 2024).
In conclusion, while De Staart's geographical elevation provides a theoretical advantage, translating this into practical, community-wide resilience requires more than just infrastructure. It necessitates a change in how the community perceives its role, transforming it from a place of refuge to an active participant in broader flood resilience efforts.

De Staart is part of a broader flood management plan that focuses on its role as a shelter area. However, the strategies often do not fully involve the community and do not address the specific socioeconomic vulnerabilities to effectively prepare – educate, involve, and support – them in that process. The main challenge is the lack of community acceptance of the shelter role, coupled with existing socioeconomic vulnerabilities and health risks from pollution. While there is general trust in government efforts, inadequate communication and engagement undermine the effectiveness of these strategies.

Conclusion: Krispijn vs De Staart

In the comparative analysis of flood resilience between Krispijn and De Staart (see Table 9), two distinct but interconnected urban areas within Dordrecht, several core themes, as geographic vulnerability, socioeconomic challenges, risk perception and preparedness, community involvement, and communication, emerged. Krispijn, characterised by its lower elevation, faces inherent physical vulnerabilities that predispose it to a higher risk of flooding. Combined with socioeconomic challenges, such as lower income and education levels, the community's ability to respond effectively to flood risks is compromised. In particular, there is a noticeable gap between residents' perceived and actual flood risks, indicating potential disengagement and lack of flood awareness. This disparity points to a critical need for targeted risk communication strategies that take into account the specific socioeconomic and geographical context of the area. Residents' immediate socioeconomic concerns overshadow the potential hazards of flooding, resulting in a lower priority for flood preparedness. Moreover, language barriers and the temporary occupation of homes by migrant families may act as factors for reduced community engagement and awareness-raising efforts. This suggests that communication strategies need to be tailored to overcome these barriers to ensure that flood risks are understood and accepted, and preparedness measures are taken seriously.
De Staart presents a contrasting scenario in which its relative elevation gives its residents a sense of security, positioning it as a potential safe haven during flood events. However, this perceived security could lead to complacency, as the community has not fully acknowledged and accepted the extensive responsibilities that come with its role as a refuge for evacuees from more vulnerable areas such as Krispijn. Despite its elevation, De Staart shares community

vulnerabilities with Krispijn, highlighting the need for flood resilience strategies that address not only the physical but also the socioeconomic aspects of vulnerability.

To elaborate on the socioeconomic vulnerabilities shared by De Staart and Krispijn, both areas have a significant proportion of low-income and low-educated residents, which limits their ability to invest in personal flood protection measures. Residents in these areas may face financial constraints that prevent them from taking the essential preparedness measures, as making the necessary home improvements, to withstand flood events. In addition, the high percentage of residents with low levels of education may hinder their understanding of flood risks and the importance of preparedness, leading to a reliance on existing infrastructure rather than proactive measures. Health vulnerabilities due to pollution in De Staart compound these issues, making it critical that flood resilience strategies are holistic and address both the structural and social dimensions of vulnerability. By supporting the community in becoming a receiving area for evacuees, these strategies should include clear, accessible communication about emergency procedures and the community's role in disaster preparedness, fostering a sense of shared responsibility and active participation.

Empirical research highlights the importance of integrating government initiatives with community-led needs and perceptions through inclusive and well-coordinated approaches. While formal structures and policies exist, their effectiveness depends on active community involvement and recognition of the unique role of Krispijn and De Staart in flood resilience. In addition, both areas have expressed a need for practical and direct guidance on flood preparedness. Residents are looking for clear support from institutional actors who they see as responsible for preparation, awareness raising and organising resilience efforts.

These findings highlight the urgency of implementing community-specific strategies that leverage institutional support to enhance the preparedness of vulnerable communities facing increasing flood threats.

Table 9: Comparative table: Krispijn vs De Staart (own work, 2024)

Comparative themes	Krispijn	De Staart
Geographical vulnerability	[Elevation] Low-lying area with higher flood risk.	[Elevation] Higher ground perceived as a safe haven.
Socioeconomic challenges	[Income] 45.7% at the lowest income level.	[Income] 41% at the lowest income level.
	[Education] 30.4% low educated.	[Education] 32.5% low educated.
	[Impact] Limited resources for flood prevention and recovery.	[Impact] Similar socioeconomic constraints affecting preparedness.
Risk perception and preparedness	[Awareness/ Acceptance] Low due to prioritization of socioeconomic concerns.	[Awareness/ Acceptance] Overconfidence due to elevation; misconceptions about emergency preparedness.

	*"**I don't see the risk of flooding as a present risk.**"* (interviewee IX, 2024)	*"**This is the safest place to live in Dordrecht in case of a flood.**"* (interviewee VIII, 2024)
	[Preparedness] Residents feel taking precautions is overreacting.	[Preparedness] Limited proactive measures; some resistance to hosting evacuees.
	*"**I would feel like a doom-thinker.**"* (interviewee IX, 2024)	*"**I didn't realize until now that it** [evacuating to De Staart] **could also mean that we would have to host families in our homes.**"* (interviewee XII, 2024)
Community involvement and communication	[Involvement] Limited; disconnect between risk perception and reality.	[Involvement] Limited due to comfort in elevation.
	[Communication] Need for better and more detailed information.	[Communication] Desire for more detailed emergency plans and clear roles during floods.
	"So if there are more points from the gemeente where we can learn about it, maybe a flyer is hanging or a poster or something like that, because I don't see that in the area." (interviewee X, 2024)	*"**City government should drive, give more information to us, brainstorming with residents.**"* (interviewee XII, 2024)
Residents' demands from authorities	[Needs] Clear guidance on flood preparedness, evacuation, and shelter areas.	[Needs] Clear guidance on flood preparedness and organization of shelter areas.
	[Community feedback] Current communication strategies do not reach out to the community.	[Community feedback] Better organization for accommodating evacuees.
	*"**There is no awareness of this issue. To be honest, we don't really think about it.**"* (interviewee X, 2024)	*" **I don't want them here.**"* (interviewee XII, 2024)

Summarising, the findings presented above, both the institutional approach and the community perception, can be further grouped under the governance conceptual framework, specifically under the six categories that served as variables and guidelines for the empirical research.
The findings from the institutional approach and community perceptions are consistent with the conceptual governance framework in several key areas. Context-sensitive diversification of flood risk management (FRM) strategies is evident in multi-level government cooperation and tailored local strategies. However, there is a disconnect with the community, particularly in Krispijn, where socio-economic concerns overshadow flood risks. Coordination and adaptation strategies are well established at the institutional level, but communication gaps remain, leading to scepticism among community leaders about the effectiveness of these strategies. Inclusion and involvement of citizens in FRM show efforts through public awareness campaigns, but

significant parts of the community, especially the elderly and migrants, remain excluded. Formal regulations are well defined by national authorities, but residents lack awareness of these frameworks, indicating a need for better dissemination. Resource allocation efforts are broadened through participation in collaborative projects, but economic constraints among residents limit their ability to implement flood protection measures. Finally, while institutional initiatives such as the 'Tij Festival' promote societal debate on flood resilience, there is a clear demand from the community for more inclusive and participatory approaches. This alignment highlights the need for increased community engagement, improved communication and more inclusive policies to effectively bridge the gap between institutional strategies and community needs in Dordrecht's flood resilience efforts.
This structured approach helps to effectively categorise and interpret current flood governance strategies, as shown in Table 10, in order to identify existing gaps and provide relevant recommendation.

Table 10: Explanation and interpretation of variables: overview table (own work, 2024)

Governance strategy	**Variables**	**Institutional approach**	**Community perception** (Krispijn, De Staart)
Context-sensitive diversification of FRM strategies	Adaptability, local tailoring, environmental factors	Multi-level government cooperation with tailored local strategies. Authorities actively prepare for crises and maintain water safety.	De Staart residents see higher ground as safe but don't discuss flood risks or evacuation plans. Krispijn residents prioritize socioeconomic concerns over flood risks.
Linking and aligning strategies	Coordination, interdependency, multi-level governance	Collaborative governance framework with national policies set by agencies like Rijkswaterstaat and tailored by local policies.	Communication gaps exist between government efforts and community awareness. Community leaders are sceptical about the alignment of flood strategies with local experiences.
Inclusion and involvement of private actors, including citizens, in FRM	Community participation, stakeholder engagement, risk communication, local knowledge	Involving by informing; public awareness campaigns and events to engage the community, initiatives to enhance public knowledge and preparedness.	Some residents are informed, while others (especially elderly or migrants) are more excluded. Residents lack adequate information and participation in relevant events.
Establish appropriate formal and informal rules and regulations	Decentralized governance, regulatory framework, stakeholder rights	Formal regulations by national government for managing flood risks; national safety norms guide local management and reinforcement of levees.	Residents are unaware of the regulatory framework.

Broaden the resource base for FRM	Diverse funding, resource management, broad/strong network, knowledge resources, support tools	Participation in collaborative or EU projects to broaden the resource and networking base. Concerns exist over resource allocation for inclusive FRM.	Economic constraints limit residents' ability to implement flood protection measures. Concerns about emergency resources and shelter options for those with limited mobility and social networks.
Stimulating an inclusive societal debate on the basic principles and values of FRM	Inclusive debate, interaction between institutions and community, social equity	Community engagement initiatives like the 'Tij Festival' and 'De Redders' to promote flood resilience dialogue. Supported by media.	Community leaders call for grassroots engagement and participatory approaches. Residents see the local authority as fully responsible for FRM, highlighting the need for better communication and inclusive strategies.

Overall, Dordrecht's current flood management broad-based strategies reflect a well-structured institutional approach but face significant challenges in terms of community engagement and inclusiveness. The findings suggest that while the strategies are sound in theory, they often fall short in practice, particularly in addressing the specific needs of vulnerable groups such as the elderly and migrants. Increased community engagement, improved communication strategies, and more inclusive policies appear to be essential to bridge this gap and strengthen Dordrecht's flood resilience.

E. Discussion

E.1 Connecting findings to literature

This study examines flood risk management (FRM) strategies in the urban areas of Krispijn and De Staart in Dordrecht, focusing on their effectiveness, community involvement and socioeconomic integration. The main objectives are to understand how these strategies fit with theoretical frameworks in socioeconomically vulnerable neighbourhoods and to identify gaps between policy intentions and community realities.

Theoretical implications

Dordrecht's approach to flood resilience governance is an example of a strategic and thoughtful response to flood risk, embodying a multifaceted and collaborative effort across levels of government. However, the insights gained from both the institutional and the community side of this analysis reveal crucial areas for further development, particularly in strengthening community engagement, inclusivity, and the overall connection of the community to flood resilience governance. Strengthening these aspects would not only strengthen the city's flood resilience, but also ensure that its FRM strategies are deeply rooted in the fabric of the community they seek to protect.

There are certain main gaps or underdeveloped factors within the existing flood governance strategies that have been identified collectively from this empirical research per variable, governance category.

Context-sensitive diversification of FRM strategies

Krispijn and De Staart's findings highlight the importance of not only adapting to different institutional and physical landscapes, but also addressing the socioeconomic vulnerability of communities. However, the actual implementation of current flood resilience strategies often falls short of expectations, as these strategies either fail to effectively address socioeconomic vulnerabilities or neglect them altogether. In comparison with the theory focus, practical applications in these areas are often lacking, potentially due to insufficient investment or political will. This gap highlights a general, common problem where policies look promising on paper but are not translate into effective action on the ground. For example, including more target groups in the risk communication campaign requires not only innovative thinking but also significant investment and political will, which is often lacking.

Linking and aligning strategies

The empirical findings in Krispijn and De Staart reveal significant limitations in coordination between governmental and community actors in the scope of flood resilience strategies, with MLS approach, a cross-governmental structure, being the cornerstone of the institutional approach. Despite the theoretical framework advocating strategic coherence, practical implementation faces challenges such as conflicting priorities among stakeholders.

Involvement of citizens in FRM

The results of the study show that community participation in Krispijn and De Staart is mainly in the form of informing residents, which has significant gaps in depth, scope, and diversity. The lack of effective communication strategies and the minimal impact of citizen input on decision-making processes underline the need for more inclusive and participatory governance mechanisms. Effective communication strategies that include collective risk assessment and

co-production with citizens are essential, especially in areas potentially increasingly affected by climate change.

Formal and informal rules

Flood risk management in the Netherlands, particularly in Dordrecht, is mainly governed by formal regulations and rules set by governmental bodies. However, the study shows that these regulations are mainly infrastructure-based and do not take into account the socio-economic characteristics of areas such as Krispijn and De Staart. There are currently no specific protocols or regulatory guidelines that address socio-economic needs as an integral part of flood resilience strategies. This lack of integration results in policies that may be less effective in addressing the true extent of flood risk, as highlighted by the research findings.

Broaden the resource base for FRM

Empirical research has shown that financial constraints have a significant impact on flood risk management (FRM) efforts. Due to limited resources, communication campaigns had to prioritise a single approach rather than multiple targeted efforts as originally planned. This prioritisation involved focusing on a general, broad-based campaign with city-wide reach. High distribution costs led to the use of more cost-effective communication methods, such as online platforms and community meetings, rather than more expensive methods such as direct mail to households. In addition, practical constraints on resource allocation meant that certain actions were prioritised over others, such as immediate infrastructure repairs over long-term community engagement. This often left the needs of vulnerable groups unmet. These examples illustrate how financial constraints can have a significant impact on the implementation and inclusiveness of FRM initiatives.

Inclusive societal debate on the basic principles and values of FRM

The literature examines the equity challenges associated with flood hazards, focusing on how they intersect with social disadvantage in different policy areas. Ensuring that flood risk management strategies and policies are perceived as legitimate and equitable is crucial for their public acceptance and effectiveness, as it contributes to community risk acceptance and memory preservation. However, Krispijn and De Staart's findings suggest that facilitating an inclusive societal debate on the principles and values underlying FRM is complex. This complexity arises because marginalised communities often lack the initial awareness necessary to recognise flood risk as a critical issue. They may also lack access to the forums in which these debates take place, the power to voice their concerns, or the capacity to engage effectively. This highlights the need for more inclusive and equitable engagement processes to ensure that all voices are heard and considered in FRM discussions.

Overall, the findings reveal a significant gap between the theoretical ideals of inclusive, adaptive flood resilience governance strategies and their practical implementation in Krispijn and De Staart. While the theoretical framework advocates inclusive community participation and adaptability to local conditions, in practice these strategies often fail to effectively involve all community members. According to this research's findings, this mismatch is particularly noticeable among socioeconomically disadvantaged groups, who may not have the necessary resources, awareness or access to participate in resilience planning and decision-making processes. As a result, existing multi-level governance structures among state actors do not fully bridge this gap, resulting in a lack of representation and consideration of the needs of these vulnerable populations. Vulnerable groups, such as the elderly and migrants, are often not

adequately informed about the risks or aware of the necessary actions to take in emergency situations. For these communities, other pressing issues, such as paying their bills, tend to take priority, overshadowing the importance of disaster preparedness. This highlights the urgent need for targeted and accessible community engagement initiatives, including more effective communication and tailored support for vulnerable populations, to ensure that flood resilience strategies are truly inclusive and effective.

The literature emphasises the importance of extensive community engagement, adaptive governance, and socioeconomic integration in FRM strategies to enhance resilience. Authors such as Ishiwatari (2019) and Tate et al. (2021) advocate for governance frameworks that are inclusive and responsive to the diverse needs of vulnerable communities. This theoretical perspective is consistent with the findings from Dordrecht, where strategies based on empirical research often failed to meaningfully engage and inform socially diverse groups. For example, one respondent noted: "These are not rich people. Many of the communities have socioeconomic problems and are not considered to be clearly represented all the time' (interviewee II, 2024). This highlights the need for governance to be more adaptable and responsive to specific community contexts, as also discussed by Morisson et al. (2018). To be truly effective, governance needs to be flexible and continuously adjusted based on ongoing feedback and changing circumstances within the community.

Furthermore, effective FRM requires the integration of local knowledge and preferences through participatory governance mechanisms. Empirical evidence supports this notion to some extent, showing that community participation mainly takes the form of informing the general public. However, this approach lacks depth (detailed, actionable information), scope (broad coverage of all relevant issues) and diversity (inclusion of different community perspectives and needs). For example, residents of Krispijn and De Staart indicated in the questionnaire that they had not attended any awareness-raising events or received any relevant information. This gap in effective participation is echoed by Eakin et al. (2021), who highlight the need for targeted communication strategies, especially for socio-economically disadvantaged groups. As one resident of Krispijn remarked: “We lack awareness, I don't think we [the people of Krispijn] think about this issue. If I want to be honest, I don't really think about it” (interviewee X, 2024).

Institutional approaches in current FRM strategies often involve multi-level governance structures that are well coordinated between different government actors. As one institutional actor pointed out: “We have a strong multi-level governance framework among government actors” (interviewee II, 2024). However, the empirical findings reveal significant limitations in 'vertical' coordination between institutions (state actors) and the community (non-state actors). While horizontal coordination between state actors is strong, vertical coordination involving the community is weak. This gap between the theoretical ideal of multi-level governance, which should include both horizontal and vertical coordination, and its practical implementation highlights the need for more inclusive and effective engagement processes that truly involve the community.

To address these gaps – highlighted from the scope of this research – it is essential to refine the conceptual framework that guides FRM strategies. The current framework emphasises adaptive capacity, local tailoring and multi-level governance. However, integrating socioeconomic vulnerability factors in the core of strategies can increase the effectiveness of FRM strategies by grounding them in the socioeconomic realities of each region. This approach focuses on communities most vulnerable to flood risks and includes targeted community outreach

programmes to improve disaster preparedness among vulnerable groups. As one local government actor emphasised, “Communication with the public is crucial; we need to inform everyone about what they can do and how they can prepare for flood situations” (interviewee V, 2024).

Concluding, the research’s findings reveal a complex interplay between theoretical expectations and real-world applications, highlighting consistencies and divergences that are crucial for refining the conceptual framework that guides FRM strategies. While the theoretical framework emphasises multi-level governance and adaptive strategies, Krispijn and De Staart's empirical data show that these ideals are not fully realised in practice. The gap between theory and practice highlights the need for more robust mechanisms to integrate community feedback and effectively address socioeconomic vulnerabilities. Overall, the study supports the theoretical framework's emphasis on governance structures that are inclusive and adaptive. However, it also questions the adequacy of these frameworks in addressing real-world complexities without effective feedback mechanisms and genuine, meaningful community engagement. The findings suggest that FRM strategies need to evolve to better incorporate local knowledge, preferences and the socio-economic realities of different communities.

E.2 From identified gaps to improvement recommendations

Figure 26: Governance strategies with identified areas for improvement based on empirical research (own work, 2024)

Building on the findings of the previous section, this part presents strategic recommendations to address the urgent and apparent gaps in current flood resilience strategies, identified during the empirical research. These recommendations specifically focus on the more underdeveloped governance strategies highlighted in the empirical research and further analysed in the discussion section. Four of the six governance strategies from the theoretical framework - context-sensitive diversification of FRM strategies, linking and aligning strategies, engaging and involving private actors in FRM, and stimulating societal debate on FRM - appear to be less developed and could benefit from further refinement. These recommendations, mainly derived from theoretical reviews, aim to motivate community engagement, awareness, and consequently resilience in vulnerable neighbourhoods, inspired by successful international practices and tailored to Dordrecht's unique challenges.

General governance guidelines

Context-sensitive diversification of FRM strategies

A major problem highlighted by the empirical research is the low level of community involvement in flood preparedness, despite its high-risk status. This indicates a gap in environmental awareness and risk perception that is not well adapted to the socioeconomic realities of the region. It is suggested by literature that localized flood risk assessments be carried out, taking into account the specific vulnerability of areas such as Krispijn and De Staart. Comparative analyses with regions such as the Netherlands and Germany could help in the development of detailed flood risk maps, which could guide specific infrastructure improvements and evacuation protocols. This would ensure that the strategies are context-sensitive and directly address the identified lack of awareness (Hemmati et al., 2021).

Linking and aligning strategies

Current strategies are mainly top-down, indicating a need for better coordination, communication and involvement of non-state actors to improve community adaptation and effective response. To address this, it is recommended to link experiences within municipalities to improve local resilience practices (external linkage). In addition, promoting interdepartmental and cross-sectoral cooperation within municipalities is crucial for synchronizing climate adaptation initiatives (internal linkage). This approach aims to integrate community's role and needs into local planning to ensure coherent and interconnected emergency response strategies.

Inclusion and involvement of private actors in FRM

Language barriers and socioeconomic challenges limit effective community participation in both Krispijn and De Staart. To overcome these barriers, it is suggested that inclusive platforms for community engagement be developed. These platforms could include multilingual workshops and educational sessions, modeled and adjusted from successful initiatives in the UK or Germany, where web-based platforms were used to enhance stakeholder participation through collaborative modeling in flood risk management (Almoradie et al., 2013). These efforts would enable residents to meaningfully contribute to FRM processes by overcoming both language and economic barriers.

Stimulating societal debate on FRM

Finally, there is a communication gap in discussions on flood risk, particularly among migrant communities and lower-income groups. To bridge this gap, it is proposed to initiate public dialogues and use various means and platforms of communication (Driessen et al., 2016). This approach should be informed by practices in the rest of the Netherlands, where local media and digital platforms play a key role in engaging different segments of the community, thereby aligning flood resilience measures with the ethical and social expectations of the community.

These recommendations, a summary of which is presented in Table 11, aim to draw on some reported best practices and expert insights to strengthen Dordrecht's flood resilience framework and ensure that it is more robust and inclusive.

Table 11: Overview of recommendations per governance category (own work, 2024)

Governance strategy category	Identified gaps	Recommendations	Connection to area vulnerabilities
Context-sensitive diversification of FRM strategies	Low level of community awareness; need for tailored risk communication to address specific community concerns.	Conduct localised flood risk assessments to guide the development of flood risk maps and tailored evacuation protocols.	Addresses vulnerability due to socioeconomic challenges by tailoring strategies to its specific needs.
Linking and aligning strategies	Strategies are currently mainly top-down. There is a need for improved coordination, communication and involvement of non-state actors in order to strengthen community alignment and effective response.	Linking experiences within municipalities to improve local resilience practices (external linkage). Promote interdepartmental and cross-sectoral cooperation within municipalities to synchronise climate adaptation initiatives (internal linkage).	Enhances De Staart's role as a potential safe haven during floods by ensuring that its strategic elevation and infrastructure are integrated into broader emergency planning.
Inclusion and involvement of private actors in FRM	Language barriers and social vulnerabilities limit effective community participation; need for inclusive communication strategies	Organise workshops and educational sessions to increase community participation and knowledge. Facilitate inclusive initiatives and platforms that consider diverse demographic contributions.	Improves engagement in both areas, particularly important for De Staart's diverse population, ensuring all community members understand and contribute to FRM.
Stimulating societal debate on FRM	Communication gaps in flood risk discussions among vulnerable groups; need for more accessible dialogues	Initiate public dialogues on flood resilience values and priorities using means like traditional media (newspapers) and social media, but also graphical/ physical on-site signs to engage the broader public and increase transparency in governmental actions.	Encourages active participation from all demographic segments in Krispijn and De Staart, fostering a better understanding of flood risks and the roles residents can play during floods.

Detailed suggestions on city's priorities

In response to the urgent needs identified by the municipality of Dordrecht, in particular the focus of this research on the vulnerable neighbourhoods such as Krispijn and De Staart, the final step of the research focused on providing more elaborative recommendations for Dordrecht's risk communication strategy and evacuation planning. The prioritisation of these areas stems from their critical role in improving the overall resilience of the community and ensuring the safety and well-being of residents, and especially the vulnerable groups and communities. This has led to a detailed examination of these elements, drawing on international best practice to develop

tailored recommendations that address the unique challenges and characteristics of these neighbourhoods.

Risk communication & awareness strategy

Dordrecht's risk communication campaign should be carefully designed to be comprehensive and multimodal, using different communication channels to ensure that key messages about risk awareness and preparedness effectively reach every segment of the community. Main ideas have been collected through interviews, focused literature review on international practices (Apte et al., 2015; Christensen et al., 2007), and researcher's proposals.

Official partnership with community networks

Local networks play a key role in distributing information. Community leaders, religious institutions, and local non-governmental organisations (NGOs) are actively involved in spreading messages. This leverages the trust these individuals have within their communities, making it particularly effective in reaching isolated individuals, the ones with no access to the proper media, or those sceptical of mainstream communication channels. Regular training sessions are held for these key figures to provide them with the latest information and teach them how to communicate it effectively. These training sessions is proposed to be organised quarterly by the municipal emergency management department in cooperation with the local safety regions.

Multimodal communication strategies

Multimodal communication strategies involve the use of multiple forms of communication to ensure that messages are accessible and effective for different audiences. It is recommended that the campaign includes online platforms, face-to-face interactions and print media to meet the diverse access needs of the community. Given the high demand for tailored approaches in different languages and formats, visual aids and symbol-based signage should be strategically placed in public areas such as town squares, community centres, and shopping areas. These tools are essential to visually communicate the risks to people who are illiterate or do not speak the local language. In addition, audio messages broadcast over public address systems and community radios will extend the campaign's reach to those without access to digital media. This multi-faceted approach ensures inclusivity, regardless of digital connectivity or language skills.

Inclusive content design

The content of all communications is recommended to be designed to be inclusive, using simplified language and avoiding technical jargon to ensure clarity and actionability. Materials are also culturally tailored, taking into account the local context of Dordrecht to increase engagement and understanding. The development of these materials is overseen by a dedicated team within the city's communications department, which consults with cultural consultants and language experts to ensure appropriateness and effectiveness.

Door-to-door campaigns

Door-to-door outreach is another critical component that provides direct interaction with residents. Teams of trained volunteers, coordinated by local community centres and supported by the city government, visit homes to distribute printed materials and talk to residents to ensure they understand emergency procedures and have a practical plan of

action. These visits focus on neighbourhoods identified as more vulnerable, such as Krispijn and De Staart, and could take place twice a year.

Training and capacity building

Training and capacity building are fundamental to empowering residents. Workshops are organised in partnership with local community centres, focusing on engaging older adults and those who are reluctant or unable to access digital information. These workshops take place on a half-year basis and are designed to transform passive recipients of information into active participants in community resilience efforts.

Integrated climate risk communication strategy

In order to improve climate risk communication in Dordrecht, an integrated messaging approach is recommended, addressing both flood risks and heat stress. This strategy will ensure that residents receive clear and comprehensive information without confusion. Combining flood risk communication with other climate hazards, such as heat stress, provides a holistic understanding of climate threats. Consistent communication materials that address multiple risks prevent information overload and ensure clarity. Additionally, consistent messages that reinforce different climate risks help build a coherent narrative for residents to follow.

By adopting these integrated communication strategies, Dordrecht can improve public awareness and preparedness for climate hazards collectively, thereby increasing the community's resilience to both immediate and long-term impacts.

Feedback and evaluation

To ensure the effectiveness of Dordrecht's risk communication strategies, robust feedback mechanisms are implemented, including annual community meetings and suggestion boxes placed in key locations where residents can provide direct input. The effectiveness of these strategies is assessed through a mix of quantitative metrics, such as social media engagement, reach and number of interactions from door-to-door campaigns, and qualitative insights from community feedback. This combination of data collection methods is essential to refine communication efforts and ensure they meet community needs and improve overall preparedness.

The risk communication campaign is a foundational layer of the broader evacuation strategy. By ensuring that all segments of the community are reached through a variety of communication channels – from outline platforms to direct, face-to-face interaction – the campaign not only disseminates vital information, but also builds a base of well-informed citizens. These educated and prepared residents are more likely to actively participate in evacuation drills, which are crucial for testing and refining the practical aspects of an emergency response. In addition, this widespread community awareness and understanding greatly increases the likelihood of a quick and orderly evacuation in an actual crisis. This direct link between informed citizens and effective emergency response underlines the integral role of a comprehensive risk communication in strengthening the overall effectiveness of Dordrecht’s evacuation plan regarding the vulnerable communities.

Evacuation plan for Dordrecht: Ensuring accessibility and comprehensive preparedness

The proposed evacuation plan for Dordrecht is designed to be accessible and understandable to all community members, especially for those with special needs. It involves the integration of local knowledge and successful international practices to develop plans that are practical and effective for the specific socioeconomic fabric, capacity, and geographical layout of Dordrecht.

Communication and education strategies

The plan includes the implementation of yearly evacuation drills throughout Dordrecht, coordinated by the local emergency services in collaboration with the various care organisations, schools, community centres etc. These drills are essential to simulate different emergency scenarios, with a special focus on the participation of vulnerable groups. This practice aims to continuously assess and improve the practical aspects of the evacuation process for these individuals (Apte et al., 2015). In addition, targeted training programmes will be developed and delivered by emergency personnel. These programmes will equip community health workers and carers with the necessary skills to assist older people, people with disabilities, and people with mobility issues during evacuation. Training will include the use of accessible transport and the operation of special equipment required in shelters (Christensen et al., 2007). Lastly, to increase the effectiveness of these efforts, it is recommended that standard messages be developed that are tailored to the local situation, both in terms of flood risk and the socioeconomic profile of the community. This will ensure that the communication is relevant and easily understood by all community members and addresses their specific needs and concerns.

Legal and organisational framework

A clear and detailed framework will define the roles and responsibilities of all stakeholders involved in the evacuation process, including local government officials, emergency responders, (community) organisations, and inhabitants. This framework is advised to be documented in the official municipal evacuation plan, ensuring that is readily and proactively available and communicated to the public. Moreover, a local emergency management committee, consisting of local neighbourhood members and community leaders in coordination with the local institutional actors, to ensure that the community needs are integrated into each evacuation planning phase; during preparation and crisis (Florek & Kołodziejczyk, 2021).

Accessibility and accommodation provision

The plan includes contracting with local transport companies to provide accessible transport, such as buses with wheelchair ramps and secure seating. A register of residents requiring these services will be developed to ensure their rapid and efficient mobilisation in the event of an emergency. Additionally, specific buildings are proposed to act as special shelters – within the shelter areas – to be identified and retrofitted to be fully accessible. These shelters will include ramps, accessible toilets and emergency medical facilities, and will be strategically located throughout Dordrecht's shelter areas to ensure easy access via accessible transport routes. Lastly, it's important to mention that people without mobility issues, or disability should be informed and strongly advised to take the pedestrian evacuation route, to avoid traffic jam, as much as possible.

Table 12: Overview of actionable recommendations for Dordrecht's evacuation plan with a focus on the vulnerable groups identified (own work, 2024)

Actionable recommendations	Description
Mapping and resource allocation	Conduct a comprehensive mapping to identify areas with high densities of vulnerable populations and their existing resources, such as accessible transport vehicles, potential extra independent shelter locations suitable for upgrades in collaboration with private entities.
Community engagement	Organize community forums and workshops to gather insights from vulnerable populations, ensuring their specific needs and concerns are integrated into the evacuation plan.
Partnerships	Collaborate with private entities, local hospitals, nursing homes, and disability advocacy organizations to align emergency preparedness efforts; evacuation protocols, share resources.
Policy development	Ensure that policies support the necessary funding and legal backing for an inclusive evacuation plan/ route, e.g., complying with safety and accessibility standards, such as the Americans with Disabilities Act (ADA).
Public awareness	Regulardly engage the public with familiarisation activities, potentially integrating them into daily routine, e.g., outdoor markets on the evacuation route.

By integrating these detailed strategies, the proposed recommendations aim to significantly improve the flood resilience of Dordrecht, ensuring that the community is not only better prepared for emergencies, but also actively involved in shaping resilience initiatives. This comprehensive approach, based on empirical research and informed by international best practices, provides valuable insights for policy makers, urban planners and the academic community.

F. Overall conclusion

F.1 Answering the research questions

This research explored the multifaceted strategies and challenges faced by government actors in improving flood resilience in Dordrecht, with a particular focus on socioeconomically vulnerable neighbourhoods such as Krispijn and De Staart. The study addressed several key research questions and revealed the complex layers of flood management, community engagement, and the inclusion of vulnerable groups in flood resilience governance.

Identification of government actors and strategies implemented (RQ1)

The flood management framework in Dordrecht is characterised by a institutional multi-level cooperation between national agencies such as Rijkswaterstaat, regional bodies such as the water board ZHZ and the safety region ZHZ, and local authorities including the municipality. At the national level, agencies such as Rijkswaterstaat develop overarching flood policies and frameworks that set the strategic direction for flood resilience in the Netherlands. These frameworks are crucial for establishing a consistent approach that local authorities can tailor to their specific needs.

Local authorities play a crucial role in the operational aspects of these strategies. The water board ZHZ is responsible for maintaining and monitoring flood defence infrastructure, while the safety region ZHZ coordinates disaster response and crisis management. The municipality of Dordrecht focuses on raising awareness, communicating risks, and implementing local policies and evacuation strategies. Public education initiatives such as water festivals and community engagement programmes complement these efforts to improve preparedness and resilience.

Despite these comprehensive strategies, there are significant challenges, particularly in terms of inclusiveness in communication leading to a lack of community engagement and insufficient consideration of local knowledge also due to socioeconomic barriers. Current approaches often fail to address the different needs of vulnerable groups, such as non-native speakers, the elderly, and people with reduced mobility. Primarily, effective communication strategies tailored to these groups stand of high importance and are considered essential to ensure that all community members understand the risks and how to respond in an emergency. Secondarily, political will plays a crucial role in decision-making and resource allocation, affecting flood resilience measures' consistency and effectiveness within socioeconomically vulnerable groups and communities.

In conclusion, Dordrecht has made significant progress in developing a multi-faceted flood resilience strategy. However, there is a clear understanding that current strategies need to be more responsive and inclusive in regard to vulnerable groups' needs by improving its engagement methods and developing specific protocols for vulnerable communities.

Recognition and articulation of vulnerabilities (RQ2)

The second sub-question examined how flood vulnerability is identified and articulated by government actors, particularly in socio-economically vulnerable communities. This empirical research revealed that flood vulnerability is mainly defined and interpreted by government actors in terms of geographical factors such as altitude and proximity to the river(s). However, socio-economic factors are not inherently and sufficiently integrated into existing flood resilience strategies. Current flood resilience strategies implemented by the municipality are generic and

applied uniformly across the city, rather than tailored to the specific needs of vulnerable communities that may require additional support. Existing flood risk management strategies often overlook the integration of socio-economic considerations. In particular, current approaches lack specific protocols tailored to the needs of vulnerable groups. There is no clear framework or playbook for directly incorporating and addressing the unique challenges faced by these communities in flood risk management. This gap highlights the need for a more holistic approach that combines both geographical and socio-economic factors to effectively mitigate flood risks for all segments of the population. In particular, the city of Dordrecht has recognised the need to incorporate social factors in order to create more inclusive and engaging strategies. As a result, areas for improvement were identified, particularly in the development of specific protocols for vulnerable communities. By addressing these gaps, Dordrecht can improve its flood risk management practices to ensure they are more equitable and effective, ultimately promoting resilience across all sectors of the population.

Perceptions and challenges of flood governance (RQ3)

Previously, the governmental, institutional perspective was investigated. In answering sub-questions three on the other hand, the perceptions of non-state actors, including residents and community leaders, were researched. These findings reveal significant challenges in current flood governance approaches. These perceptions indicate an apparent gap between perceived and actual flood risks, between governmental, scientific risk awareness and community risk awareness, particularly in socioeconomically vulnerable neighbourhoods such as Krispijn and De Staart.

From the perspective of the residents of Krispijn, flood risk often takes a back seat to more immediate socioeconomic challenges. Many community members face financial constraints and limited educational opportunities, which can make it difficult to prioritise flood preparedness. Language barriers and the transient nature of housing for some migrant families further complicate efforts to build consistent awareness and engagement around flood risk. These factors contribute to a sense that flood preparedness is less urgent than other pressing daily concerns. Despite living in a flood-prone area, many residents express a lack of awareness and a sense of detachment from the potential dangers of flooding. In De Staart, the perception of the community is strongly influenced by its geographical elevation, which gives a sense of security and a misconception of being unaffected by flood risks. Residents trust the existing flood infrastructure and often see their neighbourhood as a safe haven during flood events. However, this perceived safety can lead to complacency, with residents not fully accepting the responsibility of being a shelter for evacuees. Communication gaps further complicate the situation, with inhabitants feeling inadequately informed about flood safety and emergency protocols.

Both neighbourhoods highlight the need for more inclusive and effective communication strategies that take into account specific socioeconomic and geographical contexts. Current efforts are not sufficiently tailored to the needs of vulnerable groups, such as migrants and the elderly, who may face language barriers or lack access to digital communication channels. Both neighbourhoods highlight the need for more inclusive and effective communication strategies that take into account specific socioeconomic and geographical contexts. Despite these challenges, there is general trust in government efforts, but this trust is undermined by the lack of targeted risk communication strategies. Residents express a need for better and more detailed

information in order to feel adequately prepared and more actively involved. The findings underscore the urgency of implementing community and context-specific strategies that leverage institutional support to enhance community resilience and preparedness.

Dordrecht-specific recommendations to improve flood governance (RQ4)

To improve flood governance and support flood resilience in vulnerable neighbourhoods, several general guidelines are proposed that are targeted to the identified governance gaps:

Context-sensitive diversification of FRM strategies:
Conduct localised flood risk assessments that take into account both geographical and socio-economic factors. Develop detailed flood risk maps to guide specific infrastructure improvements and evacuation protocols tailored to the unique needs of each community.
Linking and aligning strategies:
Improve coordination and communication between governmental and non-governmental actors. Promote interdepartmental and cross-sectoral collaboration to integrate community needs into local planning and ensure coherent emergency response strategies.
Engage and involve private actors in FRM:
Develop inclusive platforms for community engagement, including multilingual workshops and training sessions. These efforts will enable residents to meaningfully contribute to FRM processes, overcoming both language and economic barriers.
Stimulate public debate on FRM:
Initiate public dialogues and use various communication platforms to engage different segments of the community. This approach will align flood resilience measures with the ethical and social expectations of the community and promote a better understanding of flood risks and the role that residents can play during floods.

And certain other, more targeted and actionable, recommendations – inspired by international cases – were explored and proposed based on Dordrecht's current campaign and priorities:
Risk communication strategy:
Multi-modal approaches that ensure comprehensive outreach to all segments of the community are investigated. This strategy should include visual aids, audio messages and direct interactions. Door-to-door campaigns and community forums will directly engage residents, especially in vulnerable neighbourhoods, and allow for the distribution of printed materials and discussions on emergency procedures. Multimodal communication channels should use digital platforms, face-to-face interactions and print media. Visual aids and audio messages placed in public areas can address different language and literacy needs. Engaging the community network through partnerships with local leaders and NGOs is essential for effective information dissemination. In addition, training key community figures will help to maintain up-to-date communication practices. Finally, an integrated climate risk communication strategy should be developed to promote consistent messaging on all climate adaptation issues, including flood risk and heat stress. This approach will ensure overall community preparedness and resilience.
Evacuation strategy:
In order to improve flood management and support flood resilience in vulnerable neighbourhoods in Dordrecht, several key strategies are recommended. These include the implementation of annual evacuation drills and targeted training programmes in targeted

neighbourhoods in cooperation with the community centres or with relevant organisations to ensure that vulnerable groups understand and can effectively respond to flood risks. Establishing a clear framework that outlines the roles and responsibilities of stakeholders, along with the creation of a local emergency management committee, engaging community leaders, will help integrate community needs into evacuation planning. Ensuring accessible transport and retrofitting shelters to accommodate all residents, especially those with disabilities and mobility issues, is critical. In addition, engaging the community through forums and workshops, collaborating with local organisations will further enhance resilience. Together, these measures are aiming to assist the planning of an inclusive and practical evacuation strategy tailored to the specific needs of Dordrecht.

By integrating these strategies, elaborated in detail previously (section E.2), Dordrecht can significantly improve its flood resilience framework, ensuring that the community is not only better prepared for emergencies, but also actively involved in shaping resilience initiatives. This approach, based on empirical research and informed by international best practice, provides insights for policy makers, urban planners and the academic community.

Main research question

In response to the main research question - what flood governance strategies are government actors developing and implementing to increase resilience to climate-induced fluvial flooding in vulnerable neighbourhoods in the Netherlands - the findings indicate a complex and evolving approach. Government actors have developed multi-dimensional strategies that are adaptive and comprehensive, addressing both immediate and long-term flood impacts through infrastructure development, community preparedness programmes, and strategic planning involving different, mainly governmental stakeholders. The flood management strategies implemented in Dordrecht exemplify a progressive understanding of resilience that integrates technical, environmental, and certain social dimensions. These strategies use a combination of structural measures (such as dikes and flood barriers) and non-structural measures (including general public awareness campaigns and community preparedness initiatives) to mitigate flood impacts and build long-term resilience. The Multi-Layered Safety (MLS) strategy, which combines direct flood protection, resilient spatial planning and crisis management, is central to this approach.

Despite these efforts, the research highlights significant areas for improvement, particularly in terms of community engagement and the inclusion of socioeconomic considerations. Current strategies often fail to address the specific needs of vulnerable groups, such as migrants and the elderly, who may face language barriers and have limited access to digital communication channels. This gap underscores the need for continuous refinement of flood resilience frameworks to better incorporate local socioeconomic realities and encourage greater community participation. Ultimately, the key takeaway is that improving the inclusiveness and impact of these strategies could make a significant contribution to building more resilient vulnerable communities in the face of climate change.

F.2 Broader recommendations

Reflecting on the findings of the flood resilience study, and while the reseach primarily focuses on the case of Dordrecht in the Netherlands, the following recommendations and insights are drawn from the broader findings of the research an can be applied to other contexts, such as Greece, which served as my initial research motivation. These recommendations aim to provide versatile strategies for improving flood resilience in different regions.

Recommendations on enhancing resilience in different contexts

What this research reveals, on a broader level, is that strengthening and investing in the preparedness phase of flood resilience is critical to developing a robust flood risks management (FRM) strategy. This approach involves strengthening the preparation of both the institutional frameworks and community's capacity to ensure an inclusive way of addressing flood risk.

More specifically, to achieve effective flood resilience, dual focus is recommended: implementing top-down initiatives to provide essential resources, policies, and infrastructure, and promoting bottom-up efforts to leverage local knowledge, community engagement, and individual preparedness. Encouraging collaboration between institutions and communities will help develop adaptable, sustainable, and effective flood resilience measures that are culturally relevant and broadly accepted. In addition, flood resilience strategies need to be adapted to both the geographical, climatic and the socioeconomic conditions of different regions. In Greece, for example, the diverse geographic landscape requires different approaches for different physical conditions (coastal or inland areas), while also its socioeconomically diverse landscape necessitates the meaningful involvement of local communities in the flood resilience planning. Using local knowledge ensures that strategies are both culturally and contextually relevant, increasing their effectiveness and acceptance. Involving community members in the decision-making process fosters a sense of ownership and responsibility for flood resilience measures.

Furthermore, addressing socioeconomic vulnerability is also crucial. Public awareness campaigns are essential to educate residents about flood risks and preparedness measures. These campaigns should be inclusive and accessible to all communities, including those with language barriers. Incorporating flood education into educational events and community programmes can instil a culture of preparedness from an early age, ensuring that future generations are better equipped to deal with flood events. Furthermore, poverty and low levels of education have a significant impact on a community's ability to respond to and recover from floods. Economic support initiatives can help low-income communities invest in flood prevention and recovery measures, while targeted education programmes can improve the resilience of vulnerable populations. Moreover, health and mobility vulnerabilities of the community must be considered in developing comprehensive flood resilience strategies. Flood response plans should include provisions for health services, especially for vulnerable groups such as the elderly, children, and those with pre-existing conditions. Finally, demographic factors, including the presence of elderly residents, children, and migrants, influence a community's ability to evacuate and access emergency services. Support services tailored to these groups, such as mobility aids and translation services, are crucial for effective flood resilience.

In conclusion, adapting the findings of the Dordrecht flood resilience study to different contexts, such as Greece, highlights the importance of customized, community-driven strategies that address a broad spectrum of vulnerabilities. By tailoring flood resilience measures to specific regional characteristics and involving local communities in the planning process, we can create

more effective and sustainable solutions. Moreover, the importance of memory transferability from generation to generation and the change of people's risk perception and acceptance are crucial and challenging factors. These aspects, coupled with the lessons learned from Dordrecht's case, are applicable to other contexts, ensuring that future generations are not only aware of the risks but are also better prepared to handle them. Comprehensive public awareness and targeted support for socio-economic, health, and demographic vulnerabilities are essential components of a robust flood resilience strategy. Ultimately, these recommendations aim to foster resilient communities capable of withstanding and recovering from flood events, ensuring safety and well-being for all residents.

Limitations of this thesis

While this thesis provides in-depth insights into flood resilience strategies in two neighbourhoods in Dordrecht, its findings may not fully represent the broader range of flood resilience challenges. Future research should include a wider variety of contexts to increase generalisability. In addition, the thesis relies primarily on qualitative data, which provides depth but may lack the breadth required for broader applicability. The integration of quantitative data and the use of mixed methods approaches may provide a more comprehensive understanding.

Further research

To further improve the effectiveness of flood resilience strategies tailored to socioeconomically vulnerable communities, additional research is needed in several key areas. Longer-term studies to test and evaluate the effectiveness of risk communication strategies are essential, with a particular focus on optimising these practices for socioeconomically disadvantaged groups. This approach will ensure that communication methods are truly inclusive and effective. In parallel, assessing the potential of emerging technologies such as artificial intelligence (AI) could improve real-time community engagement and would be worth investigating. These technologies have the potential to revolutionise the way communities interact with flood resilience measures. Furthermore, detailed cross-case analyses of flood resilience strategies in socioeconomically vulnerable communities in different international contexts, with the culture being one of the interesting influencing factors. Such study would help to identify transferable practices and innovative approaches. These studies can provide valuable insights that could be adapted to improve the flood resilience framework in Dordrecht's vulnerable urban areas. By pursuing these research avenues, we can significantly contribute to the development of more robust and inclusive flood management practices, ultimately improving the resilience of vulnerable urban areas to climate-induced flooding.

E. Reflection

Reflecting on the journey of my thesis entitled 'Building flood resilience: A case study on climate-driven flooding in vulnerable neighbourhoods', I look at the alignment of my project with my Master's programme, Management in the Built Environment, and my Master's programme, MSc Architecture, Urbanism, and Building Sciences (AUBS), at Delft University of Technology. This reflection aims to provide a comprehensive view of the research and design process, integrate feedback from mentors, and outline future directions.

Relation to the Master's course and programme

My thesis closely relates to the Management in the Built Environment track and the broader scope of the MSc AUBS by focusing on the governance of flood resilience—a crucial aspect of urban management and sustainability. The project underscores the importance of integrating socioeconomic factors into urban resilience governance, resonating with the track's emphasis on creating inclusive and equitable human habitats. By examining governance strategies in Dordrecht, particularly in vulnerable neighbourhoods such as Krispijn and De Staart, the research intersects with the urbanism call for adaptive and resilient urban landscapes.

Implications of the research for design/recommendations

The qualitative research, underpinned by semi-structured interviews and policy analysis, highlighted the complexities of flood management and the nuanced socio-economic vulnerabilities of communities. These findings guided the formulation of tailored recommendations to improve flood resilience. The iterative process of design-thinking - balancing academic literature with empirical evidence - enabled the development of practical, informed solutions that not only aim to mitigate flood risk, but also address the socio-spatial intricacies of urban vulnerability.

Evaluation of approach and methodology

The choice of a qualitative case study approach proved instrumental in capturing the depth and diversity of perspectives on flood resilience governance. This method facilitated a detailed examination of the interplay between policy, local authority approach and community perceptions through the lived realities of vulnerability. While this approach provided rich insights, it also highlighted the challenges of generalising findings beyond the specific context of Dordrecht. Feedback from the mentors was instrumental in refining the research focus and questions accordingly, ensuring that the study remained feasible and aligned with the overarching goals of understanding and improving flood resilience governance in vulnerable urban areas and the scope of the MSc thesis project.

Academic and societal value

This thesis contributes academically by filling a gap in the literature on flood resilience governance, with a particular focus on socially vulnerable communities. Societally, it provides actionable recommendations for local authorities and policy makers in Dordrecht and similar urban contexts, advocating for more inclusive, participatory approaches to flood governance.

Reflecting feedback and learning

The feedback received from the mentors throughout this journey was instrumental in shaping the research direction and enhancing the academic rigour of the project. It encouraged critical evaluation of methods and interpretation of data. By translating this feedback into the work, I developed a deeper understanding of the complexities of flood governance and the critical role

of community engagement and vulnerability assessment in building resilience. This process has been a profound learning experience, reinforcing the importance of adaptability, critical thinking and the ethical considerations inherent in research focused on vulnerable populations.

Looking ahead

The final phase of the graduation period, my focus will be on refining the thesis based on feedback from the supervisors, sharpening my conclusions and improving the recommendations to ensure that they are practical and actionable for communities like Krispijn and De Staart. This will involve a deeper analysis of the data, revisiting interpretations and integrating new findings to solidify the academic and practical implications of this research. Additionally, I will focus on presenting my findings in a clear and compelling manner, optimising the content for impact and readability, and rigorously preparing for the defence in order to confidently articulate the value and relevance of my research. This extensive preparation aims to achieve the highest potential performance of the thesis and make a meaningful contribution to the field of flood resilience governance.

Personal reflection

Study goals

In preparing for my dissertation, my main focus was on mastering the existing literature and refining my skills in research design and data collection. I aimed to become proficient in the selection and implementation of research methods, to set specific targets for the effectiveness of data collection, and to become familiar with data analysis tools and techniques. Meeting project deadlines, actively seeking and incorporating feedback, and improving my presentation skills were also high priorities. Maintaining a healthy work-life balance, setting a clear target date for submission of the dissertation, and discussing it productively with fellow students outside of my scheduled supervisions has also provided useful guidance and reflection. Overall, I appreciated the value of iteration along the way in improving the quality of my work, with the aim of producing a well-structured, coherent and insightful dissertation.

Reflective questions

What were the most challenging aspects of this research?

How did I address these challenges? and

What might I do differently in future projects?

One of the most challenging aspects of this research was engaging and communicating effectively with the various stakeholders involved, especially in socioeconomically disadvantaged neighbourhoods such as Krispijn and De Staart. Ensuring that all voices were heard and accurately represented in the study required considerable effort due to varying levels of accessibility, interest and trust in the research process. To address this challenge, I implemented a multi-faceted approach to community engagement that included in-depth semi-structured interviews, community meetings, and regular updates to keep the community involved and informed. This approach helped to build trust and ensure that community members felt that their input was valued in shaping the research outcomes. In future projects, I would prioritise establishing stronger initial links with community leaders and local organisations early in the research process. This could facilitate a smoother entry into communities and help to better align research objectives with community needs.

Another major challenge was managing the large amount of qualitative data generated from interviews and policy analysis. The process of analysing this data was time-consuming and at

times overwhelming. To manage this effectively, I used qualitative data analysis software which helped me to organise and categorise the data efficiently.

Finally, the theoretical framework required constant refinement to align with the evolving understanding of flood resilience and governance dynamics as the research progressed. This iterative process was intellectually demanding and required constant updating of the literature and theoretical constructs. In response, I held regular discussion sessions with my supervisors and peers, which were invaluable in gaining different perspectives and refining the theoretical framework. For future research, I would benefit from setting up a more structured framework for these discussions, using as a brainstorming guide from earlier on in the process.

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G. Appendix

G.1 Theoretical research

Factors contributing to urban resilience

Urban resilience is shaped by a number of elements that affect a city's ability to withstand shocks and stresses and to bounce back (Suárez et al., 2016; Xun & Yuan, 2020; Huang et al., 2021; Cao, 2023). Key factors were selected from the research, concentrating on those most relevant to urban ecosystems from a socio-environmental perspective. The selection process involved enumerating all the factors mentioned in the literature review. The most frequently occurring factors were then selected, and any that were synonymous or directly related to another factor were excluded to avoid duplication. These factors, which contribute to urban resilience, can be broadly grouped into physical, social, economic, environmental and institutional-governance categories and are analysed in Table 1.

Table 1: Factors contributing to urban resilience, own work (2024) adapted from Suárez et al. (2016); Xun & Yuan (2020); Huang et al. (2021); Cao (2023).

Factors	Sub-categories	Variables/ Indicators
Physical	Sustainable infrastructure	Sustainable and well-maintained infrastructure
		Green infrastructure
		Efficient resource management systems
Social	Social cohesion	Strong social networks
		Community engagement
		Trust among residents
	Inclusivity and equity	Addressing social inequalities
		Promoting inclusivity
		Access to resources and opportunities for vulnerable populations
	Education and awareness	Well-informed population
		Education on risks and resilience
		Participation in resilience efforts
Economic	Diversified economy	Economic diversity
		Reduced reliance on a single industry/ sector
	Economic mobility; job opportunities	Range of job opportunities
		Support for entrepreneurship
		Economic mobility
	Financial resources and investment	Public and private financial resources
		Investment in infrastructure, preparedness, and recovery
Environmental	Biodiversity and ecosystem services	Intact ecosystems
		Diverse species range
		Ecosystem services (e.g., flood mitigation and air purification)
	Climate adaptation and mitigation	Measures against climate change impacts
		Renewable energy adoption
		Climate-resilient urban planning
		Water management and urban heat island mitigation

Institutional – Governance	Effective leadership and governance	Strong and accountable leadership
		Transparent and efficient governance
	Integrated planning and risk management	Risk assessment integration into urban planning
		Sector-spanning risk management
	Collaboration and partnerships	Inter-agency and stakeholder collaboration
		Collective action for resilience building

Flood resilience cycle – phases of intervention

(see Table 2, adapted by Wardekker et al., 2020)

Plan/Prepare: Foresight & preparedness

The first stage recognises the value of anticipating and planning for potential disruptions and places a strong emphasis on foresight and preparedness. Awareness of the intricacies of disruption, exposure and vulnerability requires ongoing research and observation. Increased awareness is enabled by information management that prioritises essential slow variables. The basis for successful flood preparedness is adaptability, which is fostered by the ability to learn from the past. This phase also emphasises the importance of communicating risks to the public, preparing communities, and maintaining coordinated planning and teamwork to maintain and restore regulating ecological functions.

Absorb: Absorbing disturbances

The second phase focuses on resilience, diversity, and redundancy in the process of absorbing disruption. Investing in resilient infrastructure increases its ability to withstand and recover from flooding. Adaptive capacity is enhanced by institutional diversity, spatial diversity in urban planning, and diversity of function and response. Redundancy reduces the cascading effects of flooding through compartmentalisation, spare capacity and overlapping functions. This stage emphasises the importance of using planning techniques that reduce the likelihood and impact of flooding on vital operations.

Recover: Recovering from disturbances

The recovery phase focuses on achieving flatness and high flow (high-flux) capacity. Institutional decentralisation and autonomy accelerate the recovery process, while broad stakeholder involvement ensures inclusiveness. Allowing for autonomous change facilitates unique community approaches to recovery. Ensuring the availability of resources, strengthening social and institutional networks, and promoting flexibility in response are integral components of rapid recovery. This phase recognises the interconnectedness of critical sectors and the importance of managing their connectivity during the recovery process.

Adapt: Adaptability & change

The final stage emphasises adaptability and change, highlighting the need for institutional learning, experimentation, and innovation. Developing institutional learning capacity and reflectivity enables adaptation to evolving flood scenarios. Encouraging experimentation and innovation in flood resilience strategies ensures a forward-looking approach. Flexibility, both

institutional and spatial, will be of paramount importance in adapting to evolving flood risks. Implementing flexible measures that can be adjusted based on the evolving nature of flood disturbances enhances long-term adaptability.

Table 2: Flood resilience phases enriched with potential actions, own work (2023) adapted by; Driessen et al. (2016); Driessen et al. (2018); Matczak and Hegger (2020); Wardekker et al., (2020); Takin et al. (2023)

Phase of intervention	**Subphase**	**Strategies**	**Actions**
Plan/Prepare: Foresight & preparedness	Anticipation & Foresight	**Building knowledge**: Develop an understanding of disturbances, exposure, and vulnerability through continuous research and monitoring.	- Construction of dike - Building of dam - Forestation - Construction of flood control basins/ reservoirs - Construction and operation of meteorological observation systems - Preparation of hazard maps - Food & material stockpiling - Emergency drills - Construction of early warning systems - Preparation of emergency kits - Community engagement workshops - Climate resilient building codes - Public-private partnerships - Early warning system enhancement - Green infrastructure implementation
		Information management: Implement systems for monitoring critical slow variables and sharing information to enhance awareness.	
		Capacity to learn: Foster a culture of learning from past experiences, enabling adaptive responses to emerging challenges.	
	Preparedness & Planning	**Public awareness**: Implement educational programs to enhance public awareness, risk communication, and community preparedness.	
		Response & emergency management: Develop robust response plans and emergency management strategies to mitigate the impact of flooding.	
		Homeostasis: Promote the preservation and restoration of regulating ecosystem services through integrated planning and collaboration.	
Absorb: Absorbing disturbances	Robustness & Buffering	**Infrastructure robustness**: Invest in resilient infrastructure to withstand and recover from flood disturbances.	
		Impact and risk reducing planning: Incorporate planning practices that reduce the impact and risk of flooding on critical functions.	
	Diversity	**Functional & response diversity**: Embrace functional and response diversity in critical functions and services to enhance adaptive capacity.	- Rescue efforts - Evacuation plan - First aid treatment - Fire fighting

		Spatial diversity: Foster spatial diversity in urban planning to mitigate the impact of flooding on different areas.	- Monitoring of secondary disaster - Construction of temporary housing - Establishment of tent villages - Industrial rehabilitation planning - Community emergency response training - Ecosystem restoration - Community-based flood monitoring - Sustainable drainage systems - Resilience education: community
		Institutional diversity: Establish diverse institutions and multi-level governance systems to promote flexibility and adaptability.	
	Redundancy	**Overlapping functions**: Ensure overlapping functions and roles to enhance the redundancy of essential services.	
		Spare capacities: Develop and maintain spare capacities and backup resources to respond to flooding events.	
		Compartmentalisation & modularity: Implement compartmentalization and modularity to minimize the cascading effects of flooding.	
Recover: Recovering from disturbances	Flatness	**Institutional decentralization**: Promote institutional decentralization and autonomy to facilitate a faster recovery process.	- Disaster resistant reconstruction - Appropriate land use planning - Livelihood support - Industrial rehabilitation planning - Mental health support programs - Social infrastructure restoration - Financial aid and insurance - Cultural heritage preservation - Community-based recovery plans - Green infrastructure initiatives
		Broad participation: Encourage broad stakeholder engagement and inclusiveness in recovery efforts.	
		Room for autonomous change: Provide space for autonomous changes, allowing communities to recover in unique ways.	
	High-flux	**Availability of resources**: Ensure the availability of resources for rapid recovery.	
		Social & institutional networks: Strengthen social and institutional networks to facilitate resource sharing and support.	
		Flexibility in response: Foster flexibility in response and resourcefulness to manage the connectivity of critical sectors.	
Adapt: Adaptability & change	Learning	**Institutional learning capacity**: Develop institutional learning capacity and reflectivity to adapt to changing flood scenarios.	- Iterative scenario planning - Dynamic risk assessment

		Experimentation & Innovation: Encourage experimentation and innovation in flood resilience strategies.	- Innovation and technology integration - Community engagement and feedback - Adaptive governance frameworks - Training and capacity building - Research and development - Flexible infrastructure planning - Collaboration networks - Adaptive policy framework
	Flexibility	**Institutional flexibility**: Foster institutional flexibility to adapt to evolving flood risks.	
		Flexibility in spatial planning: Incorporate flexibility in spatial planning to accommodate changing flood patterns.	
		Flexibility in measures: Implement flexible measures that can be adjusted based on the evolving nature of flood disturbances.	

Factors leading to urban vulnerability

In urban areas, the vulnerability of a community to flood hazards and the severity of their effects are often manifested in areas lacking basic services, with dilapidated buildings, adverse social conditions, and gender inequalities, as indicated in Table 3 (De Sherbinin et al., 2007; Ruá, 2021). These areas, consisting of their own community, struggle with social mobility and overcoming social exclusion, making them particularly vulnerable to natural hazards as limited access to resources and opportunities hinders their ability to prepare for, respond to, and recover from from disasters, exacerbating their vulnerability.

This observation highlights the critical link between social inequalities and increased susceptibility to natural hazards because communities facing social exclusion and limited opportunities often lack access to risk awareness information and are often less able to implement effective risk reduction measures (De Sherbinin et al., 2007; Batica, 2014; Ruá, 2021). Understanding urban vulnerability is essential to improving the resilience of urban areas, as it helps to design targeted interventions that address specific vulnerabilities and enable cities to better with stand and adapt to a wide range of hazards (Batica, 2014).

A closer examination reveals that urban vulnerability is influenced by multiple factors, each of which contributes to the overall risk profile of a community. In particular, community vulnerability has several dimensions, including physical, sociocultural, economic, environmental, institutional and coping capacity considerations (see Table 3). The key factors contributing to urban vulnerability were identified in the literature review. These were selected by listing each element discussed in my theoretical research regarding the topic. Then, to avoid duplication, the most common factors were selected and those that were directly related to or synonymous with another factor were excluded.

Table 3: Factors contributing to urban vulnerability, own work (2023) adapted from Moreira et al. (2021); Song et al. (2019); De Bruijn et al. (2022).

Factors	Sub-categories	Variables/ Indicators
Physical	Infrastructure & services	Households without sanitation
		Households without safe water

		Households without electricity
	Building & urban characteristics	Building material
		Road network
		Physical conditions of the building
		Building location
	Demographics & urban planning	Population in flood area
		Urban area
		Number of floors
		Building age
		Building type
	Health facilities	Number of hospitals
Social - Cultural	Demographics & social structure	Population density
		Population growth
		Illiteracy rate
		Unemployment rate
		Education level
		Total population
	Vulnerable populations	Female rate
		Elderly rate
		Male rate
		Children rate
		Persons with disabilities
	Family & community dynamics	Family members
		Single parents with young children
		Household headed by females
	Cultural	Cultural heritage
	Health	Household member with illness
		Children mortality
Economic	Income & wealth	Per capita income
		Household income
		Gross domestic product (GDP) per capita
		Population poor
	Housing & property	Rented houses
		Percent of home ownership
	Mobility & infrastructure	Dependency rates
		Own vehicle
		Availability of early warning systems
		Aging infrastructure
Environmental	Natural features & risks	Proximity to water bodies
		Low-lying topography
		Climate change impacts
	Environmental management & degradation	Lack of flood defences
		Environmental degradation
		Erosion
Institutional	Governance & policy	Institutional quality and governance; emergency preparedness and response
		Policy and strategic planning
	Transparency &	Research, data, and information sharing

	community engagement	Community engagement and education
Coping capacity	Disaster readiness & insurance	Early warning system
		Flood insurance
	Experience & capacity	Past flood experience
		Emergency committee

G.2 Empirical research

Flood governance policies

Table 4: Policies on planning vis-a-vis Dordrecht policies, programs, strategy documents (Esteban, 2021)

Dutch (national) policies		**Dordrecht planning policies**
Planning	**Crisis management**	
Spatial Planning Act (1965) 4th National Policy on Spatial Planning (1988) Vierde Nota Ruimteleijke Ordering Extra (VINEX) (1991) Nota Ruimte (National Spatial Strategy) (2004) National Policy Strategy for infrastructure Planning (2012)	Disasters and Major Accidents (1985) Fire Act (1985) Medical Relief during Accidents and Disasters Act (1991) Police Act (1993) Quality Promotion Emergency Management Act (2004) Safety Regions Act (2010)	Room for the River (2003) Stedelijk Waterplan Dordrecht 2003-2007 (2003) Urban Flood Management (2005) Multi-Layer Safety (MLS) approach Waterplan Dordrecht 2009-2015 (2009) MARE Program 2009-2012 (2009) Delta Act on Flood Safety and Freshwater Supply (2012) Delta Decisions (2014)

Flood governance stakeholders

Table 5: Stakeholders and responsibilities – primary & secondary (own work, 2024)

Organization	**Responsibility**	**Policy Area**	**Practical Actions**
Ministry of Justice and Security	Crisis management coordination, evacuation	Public order and Safety	Evacuation procedures, manage crisis centers
Ministry of Infrastructure and Water Management	Management of flood defences, transport infrastructure, drinking water, environment	Flood defence, Transport, Environment	Supervision and management of primary defences
Ministry of Infrastructure and the Environment, Department Zuid-Holland (Rijkswaterstaat)	Primary flood defence funding and national water policy administration	National water management	Set benchmarks for flood defences, policy administration
Ministry of Economic Affairs and Climate	Continuity of utilities and telecommunications	Utilities (electricity, gas, oil), ICT/telecom	Ensuring service provision during floods

Ministry of Agriculture, Nature and Food Quality	Food supply management, animal welfare	Food supply, nature conservation	Distribution and storage of food, animal protection during floods
Ministry of Health, Welfare and Sport	Coordination of healthcare services	Public health	Public health measures in flood situations
Ministry of Defence	Civil authority support	National defence	Specialist assistance in flood events
Ministry of Foreign Affairs	International communication	International relations	Coordination with embassies and international bodies
Ministry of Education, Culture and Science	Protection of cultural heritage, educational institution safety	Cultural heritage, education	Safeguarding educational facilities and cultural sites
Ministry of Finance	Financial transactions	Finance	Maintain economic stability, oversee transactions
Province of Zuid-Holland	Spatial planning and water management integration	Provincial planning	Policy influence on water safety, planning integration
Water board Zuid-Holland Zuid, Hollandse Delta	Dike construction and maintenance	Water management	Dike assessments, maintenance activities
Safety region ZHZ	Coordination of disaster management and public education	Crisis management	Develop disaster response plans, public awareness campaigns
Municipality of Dordrecht	Spatial planning, local disaster response, resident information	Local governance	Spatial development, permits, disaster response management
Emergency Services	Emergency management	Public safety	Provide immediate emergency response
Citizens	Personal flood risk management	Community resilience	Prepare and recover from flood events

Interviews; Findings (interesting quotes)

Urban planner

"We are vulnerable in case of flooding; you have to go to the higher ground or to the roof and then you can be safe." (interviewee II, 2024)

"How can we explain such a complex reality of management and future planning to the broader audience of other people, to school children, to local inhabitants who live there in communities?" (interviewee II, 2024)

"These are not rich people. Many of the communities have socioeconomic problems and are not considered to be represented all the time clearly." (interviewee II, 2024)

“Leverage media attention. On popular media, not scientific, but popular media. Bring it under people's attention.” (interviewee II, 2024)

"I think you know we have all the water management in the Netherlands is in the hands of professionals and it starts. The insuring companies and the local communities they think “Everything is organised so we have no target and we have no job. We can sleep.’ But what do you do? This is very interesting.” (interviewee II, 2024)

Governmental actor (regional scope)

"In Dordrecht, De Staart; it's one of the highest areas outside the dikes, so the risk of flooding is very low. But in Krispijn, there is a serious flood risk if the dikes don't hold." (interviewee III, 2024)

Governmental actor (regional scope)

"We've got a big problem with flooding because we have flooding from the North Sea from the coast and also from inland sections like rivers, and these can also be combined." (interviewee IV, 2024)

"When a flooding occurs between different municipalities or regions; we all want to use help from the military, the defense. We only have one. We all want to use the possibility from the police. We only got one. We all want to go people to higher grounds, but we cannot do it for everyone one-by-one" (interviewee IV, 2024)

"We are trying to organize it in front, but most of the times we will organize it when it's too late, when the crisis is already coming, we try to manage it." (interviewee IV, 2024)

Governmental actors (municipal scope)

"Our most important task is to prevent floods, but we are also responsible for preparing the community for such scenarios." (interviewee V, 2024)

"Communication with the public is crucial; we need to keep everyone informed about what they can do and how they can prepare for flood situations" (interviewee V, 2024)

"There is room for improvement and we’re working on our communication strategies, to make sure they reach everyone, including vulnerable groups." (interviewee V, 2024)

"The challenge is to make people understand the risks without causing unnecessary panic." (interviewee V, 2024)

"We are implementing various measures to ensure that the public is not only aware of the risks but also knows how to respond in emergency situations." (interviewee V, 2024)

"Our approach aims to educate people about the flood risks and ensuring they know the steps to take during such events." (interviewee V, 2024)

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"The engineers are proud of their dike strategies, but we're pushing for more comprehensive preparedness measures."

"It feels like people are trapped when a disaster strikes because everyone thinks the same way about escaping, causing massive traffic and chaos."

"We can be cut off as an island, so it's not just about escaping; it's about being prepared where we are, being self-reliant."

"We integrate technical modeling for early warnings with social science to enhance community engagement and preparedness."
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"We integrate technical modeling for early warnings with social science to enhance community engagement and preparedness." (interviewee VII, 2024)
"The greatest challenge is not just forecasting disasters but ensuring that people heed these warnings and act accordingly." (interviewee VII, 2024)
"Our goal is to make the evacuation plans as comprehensive and socially relevant as possible, ensuring they cater to everyone, including those with mobility difficulties." (interviewee VII, 2024)
"We aim to make evacuation routes well-known and practiced, similar to routine paths like going to school, to ensure they are second nature during emergencies." (interviewee VII, 2024)
"Communication must not only inform but also provide a clear action plan because the absence of action leads to panic." (interviewee VII, 2024)
"We're using innovative approaches to raise awareness, such as incorporating art and community festivals, to educate and prepare the public in an engaging way." (interviewee VII, 2024)

Community leaders
"I often say that when you study this topic, you learn to see things that most people don't notice. For example, you might look at trees and think about their purpose or wonder if the protective dikes could be higher. But most people in the community don't think about these things, as experts are." (interviewee VI, 2024)
“People just don't have the mind-space for that [flood risks]. Also for me as a politician, it's not really nice to say: ‘the island you live on the city is gonna flood. What are you gonna do?’ Like the message itself. And it's also counterproductive because it's linked to climate change and we need to be on the track we are the human race we can be on this planet, we can fix everything." (interviewee VI, 2024)
"I remember that when there was some newspaper that people had to flee to De Staart. And then on Facebook all the comments from the people of De Staart were like: ‘The city never does something for us why would we shelter all those people?’." (interviewee VI, 2024)
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"I hadn't realized until now that evacuating to De Staart might mean residents would need to host displaced families in their homes." (interviewee VIII, 2024)
"In the Netherlands, we all learn about the great flood of 1953 as kids. But nowadays, fewer and fewer people were alive when it happened. It's almost become more of a myth than a present concern." (interviewee VII, 2024)

Community members
“I don’t think of flood risk as a present risk, it's not something I feel nearby in the near future” (interviewee IX, 2024)
"We are all aware that… it would have been better if we bought a house in Arnhem or something because… it's not going to be gone. For Dordrecht, we don't really believe it's going to be fixed." (interviewee IX, 2024) referring to the flood risk of Dordrecht.
"I would feel like a doom thinker… That's something that keeps me from doing it." (interviewee IX, 2024) talking about taking preparation actions against flood event.
"Like, we have the Deltawerke and it kind of stops there for me then, you know?" (interviewee XII, 2024)
"I know I will be safe and everyone would love to help me because I know a lot of people but I also know people living in Krispijn and in other places in Dordrecht who do not have that social network." (interviewee IX, 2024)

“We’re missing awareness, I don't think that we [the people who live in Krispijn] think about this topic. If I want to be honest, I don’t really think about it." (interviewee X, 2024)
"Most of the houses in Turkish and Moroccan families most of the parents bought a house when they came here years and years ago, and now their children live in the houses and they are only here a few months a year and then they go back home." (interviewee XI, 2024)
"Oh yeah, for sure, there’s definitely language problems with the migrants and expats around here, on top of all the money issues." (interviewee X, 2024)
“So if there are more points where we can learn about it, maybe a flyer is hanging or a poster or something like that, because I don't see that in this area [Krispijn].” (interviewee X, 2024)
"I think it was only in the weekly free paper, the ‘krantenpapier’, yeah, for all Dordrecht. But not much there. Maybe last week or the week before they had something about it. But it’s not regular at all." (interviewee XI, 2024)

Table 6: Interviewee quotes/ Findings categorised and connected to the relevant governance areas and vulnerability factors (own work, 2024)

Governance area	Actor	Quote	Vulnerability factor
Context-sensitive diversification of FRM strategies	Urban planner	"These are not rich people. Many of the communities have socioeconomic problems and are not considered to be represented all the time clearly."	Coping capacity & Socioeconomic status
	Governmental actor (regional scope)	"In Dordrecht, De Staart; it's one of the highest areas outside the dikes, so the risk of flooding is very low. But in Krispijn, there is a serious flood risk if the dikes don't hold."	Neighbourhood characteristics
	Governmental actor (municipal scope)	"Our most important task is to prevent floods, but we are also responsible for preparing the community for such scenarios."	Risk perception
	Community leaders	"I often say that when you study this topic, you learn to see things that most people don't notice."	Risk perception
	Community members	"We are all aware that... it would have been better if we bought a house in Arnhem or something because... it's not going to be gone. For Dordrecht, we don't really believe it's going to be fixed."	Risk perception, Tenure
Link and align the strategies	Governmental actor (regional scope)	"When a flooding occurs between different municipalities or regions; we all want to use help from the military, the defense. We only have one. We all want to use the possibility from the police. We only got one. We all want to go people to higher grounds, but we cannot do it for everyone one-by-one"	Neighbourhood characteristics

	Governmental actor (municipal scope)	"Communication with the public is crucial; we need to keep everyone informed about what they can do and how they can prepare for flood situations"	Risk perception
	Community leaders	"In the Netherlands, we all learn about the great flood of 1953 as kids. But nowadays, fewer and fewer people were alive when it happened. It's almost become more of a myth than a present concern."	Risk perception
Involvement of citizens in FRM	Urban planner	"How can we explain such a complex reality of management and future planning to the broader audience of other people, to school children, to local inhabitants who live there in communities?"	Risk perception
	Governmental actor (municipal scope)	"The challenge is to make people understand the risks without causing unnecessary panic."	Risk perception
	Community members	"So if there are more points where we can learn about it, maybe a flyer is hanging or a poster or something like that, because I don't see that in this area [Krispijn]."	Risk perception
Adequate formal and informal rules	Urban planner	"I think you know we have all the water management in the Netherlands is in the hands of professionals and it starts. The insuring companies and the local communities they think "Everything is organised so we have no target and we have no job. We can sleep.' But what do you do? This is very interesting."	Risk perception
	Governmental actor (regional scope)	"We've got a big problem with flooding because we have flooding from the North Sea from the coast and also from inland sections like rivers, and these can also be combined."	Location (neighbourhood) characteristics
	Governmental actor (municipal scope)	"We are implementing various measures to ensure that the public is not only aware of the risks but also knows how to respond in emergency situations."	Risk perception

	Community leaders	"People just don't have the mind-space for that [flood risks]. Also for me as a politician, it's not really nice to say: 'the island you live on the city is gonna flood. What are you gonna do?' Like the message itself. And it's also counterproductive because it's linked to climate change and we need to be on the track we are the human race we can be on this planet, we can fix everything."	Risk perception
	Community members	"I would feel like a doom thinker… That's something that keeps me from doing it."	Risk perception
Broaden the resource base of FRM	Governmental actor (municipal scope)	"We integrate technical modeling for early warnings with social science to enhance community engagement and preparedness."	Risk perception
	Community members	"Oh yeah, for sure, there's definitely language problems with the migrants and expats around here, on top of all the money issues."	Demographic characteristics, Coping capacity & Socioeconomic status
Inclusive societal debate on the basic principles and values of FRM	Urban planner	"Leverage media attention. On popular media, not scientific, but popular media. Bring it under people's attention."	Risk perception
	Governmental actor (regional scope)	"We are trying to organize it in front, but most of the times we will organize it when it's too late, when the crisis is already coming, we try to manage it."	Risk perception
	Governmental actor (municipal scope)	"Our approach aims to educate people about the flood risks and ensuring they know the steps to take during such events."	Risk perception
	Community leaders	"I hadn't realized until now that evacuating to De Staart might mean residents would need to host displaced families in their homes."	Risk perception, Neighbourhood characteristics
	Community members	"We're missing awareness, I don't think that we [the people who live in Krispijn] think about this topic. If I want to be honest, I don't really think about it."	Risk perception

G.3 Human Research Ethics (HREC)

Informed consent

Delft University of Technology
HUMAN RESEARCH ETHICS
INFORMED CONSENT

Participant's information / Opening statement

You are invited to participate in a research study entitled 'Building flood resilience - A case study on climate-driven flooding and vulnerable neighbourhoods'. This study will be conducted by Evangelia Telli, a Master student at TU Delft, in cooperation with the municipality of Dordrecht.

The purpose of this research study is to explore and analyse the governance of flood resilience in urban areas, with a focus on preparedness and evacuation strategies in flood-prone areas. Your participation will take approximately 45 minutes and will include an in-depth interview. The data collected will be used for academic purposes, including publication in the TU Delft repository, informing urban planning policy and educational purposes. During the interview you will be asked about your experiences, decision-making processes and perceptions in relation to flood management.

As with any research activity, there is a risk of data breach. We are committed to protecting the confidentiality of your responses. The interviews will be anonymised to protect your identity and no directly identifiable personal information (PII) will be collected. Any PII collected for administrative purposes, such as consent forms, will be securely stored and accessible only to the research team. We will take all necessary steps to ensure that your information is kept secure and confidential.

Your participation in this study is completely voluntary and you have the right to withdraw at any time without penalty. You may choose not to answer certain questions that you do not feel comfortable answering.

If you have any questions or would like more information about the study, please contact:
Evangelia Telli

Explicit Consent points

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated x/02/2024, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: an audio- and video- recorded interview. Information will be recorded by the MS Teams transcribing tool; audio, video and written notes from the interviewers. The recordings are essential for our final deliverable, therefore will be transcribed as text, and the recordings will be destroyed by the end of this thesis project.	☐	☐
4. I understand that I will be compensated for my participation by helping the students with their research and receiving the final deliverable invitation for the final presentation.	☐	☐
5. I understand that the study will end by the end of June 2024.	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study also involves collecting specific personally identifiable information (PII) such as name, surname and associated personally identifiable research data (PIRD) project and company name with the potential risk of my identity being revealed.	☐	☐
7. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: anonymizing the data.	☐	☐
8. I understand that personal information collected about me that can identify me, such as name, surname, project and company name, will not be shared beyond the study team.	☐	☐
9. I understand that the (identifiable) personal data I provide will be destroyed by the end of this thesis project.	☐	☐
10. I understand that the research team holds the responsibility for the ethical handling of my data, ensuring its confidentiality and integrity throughout the research process.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
11. I understand that after the research study the de-identified information I provide will be used for the researcher's graduation, thesis project at Management in the Built Environment at TU Delft.	☐	☐
12. I am informed that the data collected will be owned by the researcher, and any use of this data for publications or dissemination will adhere to ethical guidelines ensuring my anonymity and privacy.	☐	☐
13. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
14. I agree that my real name can be used for quotes in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
15. I give permission for the de-identified interview script that I provide to be archived in Microsoft Teams drive repository so it can be used for future research and learning.	☐	☐
16. I give permission for my data, once de-identified, to be stored securely by the research team. Access to this data will be limited to individuals directly involved in the research or as explicitly agreed upon for purposes of external review or future research that benefits the public interest.	☐	☐
17. I acknowledge that detailed agreements on the management of my data, including its potential destruction or anonymization post-study, have been communicated to me. These measures are in place to protect my identity and personal information.	☐	☐
18. I understand that access to this MS Teams repository is restricted only to members of the research team.	☐	☐

Signatures

Name of participant	Signature	Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Evangelia Telli		09-01-2024
MSc researcher	Signature	Date

Yawei Chen		09-01-2024
Responsible researcher	Signature	Date

Delft University of Technology
HUMAN RESEARCH ETHICS
CHECKLIST FOR HUMAN RESEARCH
(Version January 2022)

IMPORTANT NOTES ON PREPARING THIS CHECKLIST

1. An HREC application should be submitted for every research study that involves human participants (as Research Subjects) carried out by TU Delft researchers
2. Your HREC application should be submitted and approved **before** potential participants are approached to take part in your study
3. All submissions from Master's Students for their research thesis need approval from the relevant Responsible Researcher
4. The Responsible Researcher must indicate their approval of the completeness and quality of the submission by signing and dating this form OR by providing approval to the corresponding researcher via email (included as a PDF with the full HREC submission)
5. There are various aspects of human research compliance which fall outside of the remit of the HREC, but which must be in place to obtain HREC approval. These often require input from internal or external experts such as Faculty Data Stewards, Faculty HSE advisors, the TU Delft Privacy Team or external Medical research partners.
6. You can find detailed guidance on completing your HREC application here
7. Please note that incomplete submissions (whether in terms of documentation or the information provided therein) will be returned for completion **prior to any assessment**
8. If you have any feedback on any aspect of the HREC approval tools and/or process you can leave your comments here

Applicant Information

PROJECT TITLE:	Building flood resilience – A case study on climate-driven flooding and vulnerable neighborhoods
Research period: *Over what period of time will this specific part of the research take place*	September 2023 – June 2024
Faculty:	Architecture and the Built Environment (Bouwkunde)
Department:	Management in the Built Environment (MBE)
Type of the research project: *(Bachelor's, Master's, DreamTeam, PhD, PostDoc, Senior Researcher, Organisational etc.)*	Master's
Funder of research: *(EU, NWO, TUD, other – in which case please elaborate)*	-
Name of Corresponding Researcher: *(If different from the Responsible Researcher)*	Evangelia Telli
E-mail Corresponding Researcher: *(If different from the Responsible Researcher)*	e.telli@student.tudelft.nl
Position of Corresponding Researcher: *(Masters, DreamTeam, PhD, PostDoc, Assistant/ Associate/ Full Professor)*	Masters
Name of Responsible Researcher: ***Note:** all student work must have a named Responsible Researcher to approve, sign and submit this application*	Yawei Chen
E-mail of Responsible Researcher: *Please ensure that an institutional email address (**no Gmail, Yahoo, etc.**) is used for all project documentation/ communications including Informed Consent materials*	y.chen@tudelft.nl
Position of Responsible Researcher : *(PhD, PostDoc, Associate/ Assistant/ Full Professor)*	Assistant Professor

Research Overview

***NOTE:** You can find more guidance on completing this checklist here*

a) Please summarise your research very briefly (100-200 words)
What are you looking into, who is involved, how many participants there will be, how they will be recruited and what are they expected to do?

Add your text here – (please avoid jargon and abbrevations)
The research examines flood resilience governance strategies in response to the growing problem of urban flooding, exacerbated by climate change. The significant increase in natural hazard events in the current century is highlighted. The research critically examines the comprehensive flood management process, including the preparedness, response, recovery and adaptation phases, and the collaborative roles of governments, local authorities and communities. It aims to reduce the impact on people, property and the environment through the implementation of resilient strategies. The study highlights the shortcomings of current flood management and argues for a detailed study of the socio-spatial elements of vulnerability. Lastly, the literature review concludes with an emphasis on the need for tailored strategies for vulnerable urban areas, and provides actionable recommendations to enhance flood resilience governance. The case study focuses on the pre-flood phase and examines evacuation strategies developed with community input to increase resilience in vulnerable

Dutch neighbourhoods affected by climate-induced flooding. The city of Dordrecht, and more specifically the area of De Staart, will be used as a case study. Qualitative research methods, including in-depth, semi-strucutred interviews, are used to gather insights that would be useful for policy makers, urban planners and community members.

a) **If your application is an additional project** related to an existing approved HREC submission, please provide a brief explanation including the existing relevant HREC submission number/s.

Add your text here – (please avoid jargon and abbrevations)
-

b) **If your application is a simple extension of, or amendment to,** an existing approved HREC submission, you can simply submit an HREC Amendment Form as a submission through LabServant.

Risk Assessment and Mitigation Plan

NOTE: *You can find more guidance on completing this checklist here*

Please complete the following table in full for all points to which your answer is "yes". Bear in mind that the vast majority of projects involving human participants as Research Subjects also involve the collection of **Personally Identifiable Information (PII)** and/or **Personally Identifiable Research Data (PIRD)** which may pose potential risks to participants as detailed in Section G: Data Processing and Privacy below.

To ensure alighment between your risk assessment, data management and what you agree with your Research Subjects you can use the last two columns in the table below to refer to specific points in your Data Management Plan (DMP) and Informed Consent Form (ICF) – **but this is not compulsory**.

It's worth noting that **you're much more likely to need to resubmit your application if you neglect to identify potential risks**, than if you identify a potential risk and demonstrate how you will mitigate it. If necessary, the HREC will always work with you and colleagues in the Privacy Team and Data Management Services to see how, if at all possible, your research can be conducted.

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
A: Partners and collaboration						
1. Will the research be carried out in collaboration with additional organisational partners such as: • One or more collaborating research and/or commercial organisations • Either a research, or a work experience internship provider[1] [1] *If yes, please include the graduation agreement in this application*	x					
2. Is this research dependent on a Data Transfer or Processing Agreement with a collaborating partner or third party supplier? *If yes please provide a copy of the signed DTA/DPA*		x				
3. Has this research been approved by another (external) research ethics committee (e.g.: HREC and/or MREC/METC)? *If yes, please provide a copy of the approval (if possible) and summarise any key points in your Risk Management section below*		x				
B: Location						

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
4. Will the research take place in a country or countries, other than the Netherlands, within the EU?		x				
5. Will the research take place in a country or countries outside the EU?		x				
6. Will the research take place in a place/region or of higher risk – including known dangerous locations (in any country) or locations with non-democratic regimes?		x				
C: Participants						
7. Will the study involve participants who **may** be vulnerable and possibly (legally) unable to give informed consent? (e.g., children below the legal age for giving consent, people with learning difficulties, people living in care or nursing homes,).		x				
8. Will the study involve participants who **may** be vulnerable under specific circumstances and in specific contexts, such as victims and witnesses of violence, including domestic violence; sex workers; members of minority groups, refugees, irregular migrants or dissidents?		x				
9. Are the participants, outside the context of the research, in a dependent or subordinate position to the investigator (such as own children, own students or employees of either TU Delft and/or a collaborating partner organisation)? *It is essential that you safeguard against possible adverse consequences of this situation (such as allowing a student's failure to participate to your satisfaction to affect your evaluation of their coursework).*		x				
10. Is there a high possibility of re-identification for your participants? (e.g., do they have a very specialist job of which there are only a small number in a given country, are they members of a small community, or employees from a partner company collaborating in the research? Or are they one of only a handful of (expert) participants in the study?	x		Moderate risk of re-identification due to purposive sampling of flood resilience experts and snowball sampling of local community members, potentially involving a limited and interconnected pool of participants.	Data anonymisation, access restrictions, informed consent, prudent data sharing, compliance with privacy laws, community-based privacy protection		
D: Recruiting Participants						
11. Will your participants be recruited through your own, professional, channels such as conference attendance lists, or through specific network/s such as self-help groups		x				
12. Will the participants be recruited or accessed in the longer term by a (legal or customary) gatekeeper? (e.g., an adult professional working with children; a community leader or family member who has this customary role – within or outside the EU; the data producer of a long-term cohort study)	x		Participants may be accessed or recruited through the influence or involvement of a gatekeeper, such as the municipality of Dordrecht, during your internship while researching the case study. The municipality could act as a customary gatekeeper, using its	Use multiple recruitment channels beyond those suggested by the community. Define objective criteria for the selection of participants. Be transparent about the community's role. Ensure the informed consent of all participants. Implement strict data protection		

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
			network and influence to suggest participants for the research.	measures. Monitor and adjust the recruitment process on an ongoing basis.		
13. Will you be recruiting your participants through a crowd-sourcing service and/or involve a third party data-gathering service, such as a survey platform?		x				
14. Will you be offering any financial, or other, remuneration to participants, and might this induce or bias participation?		x				
E: Subject Matter *Research related to medical questions/health may require special attention. See also the website of the CCMO before contacting the HREC.*						
15. Will your research involve any of the following: • Medical research and/or clinical trials • Invasive sampling and/or medical imaging • Medical and *In Vitro Diagnostic Medical* Devices Research		x				
16. Will drugs, placebos, or other substances (e.g., drinks, foods, food or drink constituents, dietary supplements) be administered to the study participants? *If yes see here to determine whether medical ethical approval is required*		x				
17. Will blood or tissue samples be obtained from participants? *If yes see here to determine whether medical ethical approval is required*		x				
18. Does the study risk causing psychological stress or anxiety beyond that normally encountered by the participants in their life outside research?		x				
19. Will the study involve discussion of personal sensitive data which could put participants at increased legal, financial, reputational, security or other risk? (e.g., financial data, location data, data relating to children or other vulnerable groups) *Definitions of sensitive personal data, and special cases are provided on the TUD Privacy Team website.*	x		Includes discussion of sensitive personal data as it involves in-depth interviews with key stakeholders and community groups within vulnerable communities (financial data etc.).	The study will ensure confidentiality and protection of participants by obtaining informed consent, anonymising identities, handling sensitive information confidentially, and maintaining transparency with participants about research findings and their contributions.		
20. Will the study involve disclosing commercially or professionally sensitive, or confidential information? (e.g., relating to decision-making processes or business strategies which might, for example, be of interest to competitors)		x				
21. Has your study been identified by the TU Delft Privacy Team as requiring a Data Processing Impact Assessment (DPIA)? *If yes please attach the advice/ approval from the Privacy Team to this application*		x				
22. Does your research investigate causes or areas of conflict?		x				

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
If yes please confirm that your fieldwork has been discussed with the appropriate safety/security advisors and approved by your Department/Faculty.						
23. Does your research involve observing illegal activities or data processed or provided by authorities responsible for preventing, investigating, detecting or prosecuting criminal offences *If so please confirm that your work has been discussed with the appropriate legal advisors and approved by your Department/Faculty.*		x				
F: Research Methods						
24. Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g., covert observation of people in non-public places).		x				
25. Will the study involve actively deceiving the participants? (For example, will participants be deliberately falsely informed, will information be withheld from them or will they be misled in such a way that they are likely to object or show unease when debriefed about the study).		x				
26. Is pain or more than mild discomfort likely to result from the study? And/or could your research activity cause an accident involving (non-) participants?		x				
27. Will the experiment involve the use of devices that are not 'CE' certified? *Only, if 'yes': continue with the following questions:*		x				
• Was the device built in-house?						
• Was it inspected by a safety expert at TU Delft? *If yes, please provide a signed device report*						
• If it was not built in-house and not CE-certified, was it inspected by some other, qualified authority in safety and approved? *If yes, please provide records of the inspection*						
28. Will your research involve face-to-face encounters with your participants and if so how will you assess and address Covid considerations?	x		The possibility of transmitting or contracting COVID-19 during personal interactions, especially in enclosed spaces or when social distancing measures are not adequately maintained.	Offering remote interviews as an option will address several key risks associated with face-to-face meetings during the COVID-19 pandemic, but should not be the only means as it may exclude participants.		
29. Will your research involve **either:** a) "big data", combined datasets, new data-gathering or new data-merging techniques which might lead to re-identification of your participants **and/or** b) artificial intelligence or algorithm training where, for example biased datasets could lead to biased outcomes?		x				

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
G: Data Processing and Privacy						
30. Will the research involve collecting, processing and/or storing any directly identifiable PII (Personally Identifiable Information) including name or email address that will be used for administrative purposes only? (eg: obtaining Informed Consent or disbursing remuneration)	x		It involves the collection of personally identifiable information (PII), such as names or email addresses, for administrative purposes. This is evident in the process of obtaining informed consent from participants prior to data collection.	Implement strict data access controls, anonymise personal data, use secure data storage, conduct regular data audits, and establish clear data retention and destruction policies. In addition, the informed consent process must be thorough and all procedures should comply with relevant data protection laws.		
31. Will the research involve collecting, processing and/or storing any directly or indirectly identifiable PIRD (Personally Identifiable Research Data) including videos, pictures, IP address, gender, age etc and **what other Personal Research Data** (including personal or professional views) will you be collecting?	x		It includes the collection of personally identifiable research data (PIRD) using qualitative methods, but does not specify the type of data (such as videos, pictures, IP address, gender, age). The data will include perspectives and experiences related to flood management, ensuring a wide range of perspectives and access to key informants.			
32. Will this research involve collecting data from the internet, social media and/or publicly available datasets which have been originally contributed by human participants		x				
33. Will your research findings be published in one or more forms in the public domain, as e.g., Masters thesis, journal publication, conference presentation or wider public dissemination?	x		The research results will be publicly available, allowing anyone with access to TU Delft's repository to view the dissertation. This will broaden the audience beyond academic circles to potentially have a greater impact, including policy makers, practitioners and the general public.	Anonymisation and careful coding to prevent individual participants from being identified by the general public.		
34. Will your research data be archived for re-use and/or teaching in an open, private or semi-open archive?		x				

H: More on Informed Consent and Data Management

NOTE: *You can find guidance and templates for preparing your Informed Consent materials) here*

Your research involves human participants as Research Subjects if you are recruiting them or actively involving or influencing, manipulating or directing them in any way in your research activities. This means you must seek informed consent and agree/ implement appropriate safeguards regardless of whether you are collecting any PIRD.

Where you are also collecting PIRD, and using Informed Consent as the legal basis for your research, you need to also make sure that your IC materials are clear on any related risks and the mitigating measures you will take – including through responsible data management.

Got a comment on this checklist or the HREC process? You can leave your comments here

Signature/s

Please note that by signing this checklist list as the sole, or Responsible, researcher you are providing approval of the completeness and quality of the submission, as well as confirming alignment between GDPR, Data Management and Informed Consent requirements.

Name of Corresponding Researcher (if different from the Responsible Researcher) (print)
Evangelia Telli

Signature of Corresponding Researcher:

Date: 09-01-2024

Name of Responsible Researcher (print)
Yawei Chen

Signature (or upload consent by mail) Responsible Researcher:

Date: 18-03-2024

Data management plan

Plan Overview

A Data Management Plan created using DMPonline

Title: BK MSc project: Building flood resilience - A case study on climate-driven flooding and vulnerable neighbourhoods

Creator: Evangelia Telli

Affiliation: Delft University of Technology

Template: TU Delft Data Management Plan template (2021)

Project abstract:

This research explores the complex area of flood resilience governance strategies in the face of escalating urban flooding, exacerbated by climate change. It investigates all the various phases of flood resilience governance, recognising the expected increase in natural hazard events in the twenty-first century. The study emphasises the crucial distinction between hazards and disasters, challenging dominant research trends that emphasise technical and financial dimensions over vulnerability and exposure. The research is comprehensive in its examination of flood management processes, encompassing preparedness, response, recovery and adaptation, and examines the collaborative efforts of governments, local authorities and communities. It addresses a range of tasks, from risk assessment to community engagement, and seeks to mitigate impacts on people, property, and the environment through resilient strategies. Despite progress in flood governance, the study reveals limitations in local policy interventions and calls for a nuanced examination of socio- spatial aspects of vulnerability. Focusing with the case study on the pre-flood/preparedness phase, the research examines a specific facet of flood governance - the evacuation strategy developed in consultation with communities to increase resilience in vulnerable Dutch neighbourhoods facing climate-induced flooding. Using Dordrecht, the Netherlands, and De Staart in particular, as a case study, the research uses qualitative methods, including interviews and focus groups, to provide valuable insights – on how to 'build' flood governance strategies that addresses challenges and expands opportunities of vulnerable neighbourhoods in the context of flood risk – for policy makers, urban planners and communities. The study concludes by highlighting the importance of tailor-made strategies for vulnerable urban areas and offers practical recommendations for strengthening flood resilience governance.

The research questions are:

main RQ:***What flood governance strategies do governmental actors develop and implement to enhance resilience against climate-change-induced fluvial flooding in vulnerable neighbourhoods in the Netherlands?***

sub-RQs:

Which governamental actors are involved in flood resilience strategies, and what specific strategies have been implemented to address flood resilience?

How have vulnerabilities to flooding been recognised and articulated by governmental actors, particularly in socioeconomically vulnerable communities, such as Krispijn and De Staart?

What are the perceptions of non-governmental actors regarding the flood governance strategies and actions in Krispijn and De Staart (Dordrecht), and what barriers or challenges have been highlighted?

Considering the current strategies and the perceptions of both governmental and non-governmental stakeholders, how can flood governance be improved or refined to better support flood resilience in vulnerable neighbourhoods?

The research method involves a qualitative approach, using interviews and focus groups, centered on a case study in Dordrecht, the Netherlands, specifically the De Staart neighborhood. This aims to provide insights for policymakers, urban planners, and communities, concluding with recommendations for enhancing flood resilience governance in vulnerable urban areas.

ID: 142348

Start date: 11-09-2023

End date: 30-06-2024

Last modified: 05-02-2024

BK MSc project: Building flood resilience - A case study on climate-driven flooding and vulnerable neighbourhoods

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Administrative questions

Name of data management support staff consulted during the preparation of this plan.

My faculty Data Steward, Janine Strandberg, has reviewed this DMP on 30.01.2024.

Date of consultation with support staff.

2024-01-20

Data description and collection or re-use of existing data

Provide a general description of the type of data you will be working with, including any re-used data:

Type of data	File format(s)	How will data be collected (for re-used data: source and terms of use)?	Purpose of processing	Storage location	Who will have access to the data
Personally Identifiable Information (PII): participants' name, email or mobile phone, gender, age, income range, nationality, (company name).	.pdf, .xlsx	(1) Contact information of interviewees, received by professional and academic network (though my internship organisation and TU Delft). (2) The personal, profile characteristics (gender, age, income range, nationality) will be collected by the interviewees themselves during the interview process (if desirable).	For both administrative (1) and research (2) purposes: (1) obtaining informed consent and communicating with participants (2) to draw conclusions and fulfill research's purpose	Project storage	MSc student: Evangelia Telli
Audio-recordings of interviews with all the various stakeholders	.mp3	Interviews are conducted both during visits to the internship organisation in municipality of Dordrecht, on-site visits at De Staart neighbourhood and via online meetings, using the academic version of MS Teams. Audio-recordings are made on an external device or on MS Teams software, before being moved to Project Storage	Capturing the opinions on flood resilience governance for the vulnerable neighbourhoods from participants; various stakeholders on the topic (academic experts, local authorities, community leaders, residents).	External recording device (temporary storage) + Project Storage (primary storage) + OneDrive	Same as above
Anonymous transcriptions of interviews	.txt	Anonymous transcription created manually based on audio-recordings. Transcriptions automatically made by MS Teams tool, coded by the interviewer. Participants are asked to review the transcriptions of their interview before transcript is finalised.	Privacy-preserving data on flood resilience governance from participants; various stakeholders on the topic (academic experts, local authorities, community leaders, residents).	Project Storage + OneDrive	MSc student: Evangelia Telli + educational supervisor: Yawei Chen + organisation supervisor: Ellen Kelder
Anonymised data on opinion on flood resilience governance in vulnerable neighbourhoods + city, occupation	.csv	Data obtained from coding anonymised transcriptions using Atlas TI. software. TU Delft has a campus licence for employees.	Privacy-preserving data on opinions on flood resilience governance from participants; various stakeholders on the topic (academic experts, local authorities, community leaders, residents).	Project Storage + OneDrive	Same as above
Signed informed consent forms	.pdf	Signatures received by the interviewees themselves, in order to participate in the interviewing process.	For administrative purposes: obtaining informed consent in order to ethically conduct interviews.	Project storage	MSc student: Evangelia Telli
Report/ Thesis	.pdf	Serves as record of the process as well as documentation	Long-term documentation	Project Storage + OneDrive	MSc student: Evangelia Telli + educational supervisor: Yawei Chen + organisation supervisor: Ellen Kelder

0. How much data storage will you require during the project lifetime?

- 250 GB - 5 TB

Documentation and data quality

What documentation will accompany data?

- Data will be deposited in a data repository at the end of the project (see section V) and data discoverability and re-usability will be ensured by adhering to the repository's metadata standards
- Data dictionary explaining the variables used
- README file or other documentation explaining how data is organised
- Methodology of data collection

Supporting material (anonymised transcripts and datasets with coded responses) will be deposited in a public online data repository alongside a documentation file (README), indicating where to find the associated publications, as well as detailed information about what is being shared, i.e., a description of files, methodological information, data-specific information, and sharing and access information.

Additionally, the dataset will be accompanied by a data dictionary explaining variable names, measurement units, allowed values, and definitions of values in the dataset. The OSF guide will be used to create the data dictionary (https://help.osf.io/article/217-how- to-make-a-data-dictionary).

The dataset will also be accompanied by a copy of the informed consent form used during this research, and the questions included in the semi-structured interviews. The online survey questions will also be included

Storage and backup during research process

Where will the data (and code, if applicable) be stored and backed-up during the project lifetime?

- Another storage system - please explain below, including provided security measures
- Project Storage at TU Delft
- OneDrive

Project Storage: Primary research data storage. Only TU Delft team members (Master student and supervisors) have access. Survey and interview data will be stored in separate folders, and within the interview folder, there are separate folders for audio-recordings and anonymous transcriptions. Informed consent forms and contact information are encrypted separately from research data to minimise risk of re-identification.

OneDrive: Used as secondary storage in addition to Project Storage, mainly for convenience when working with data analysis or report writing. Master student and supervisors have access.

External recording device: Used as a temporary storage location for recorded on-site interviews. Interviews will be deleted from device as soon as they are moved to Project Storage.

Legal and ethical requirements, codes of conduct

Does your research involve human subjects or 3rd party datasets collected from human participants?

- Yes

8A. Will you work with personal data? (information about an identified or identifiable natural person)

If you are not sure which option to select, first ask your Faculty Data Steward for advice. You can also check with the privacy website . If you would like to contact the privacy team: privacy-tud@tudelft.nl, please bring your DMP.

- Yes

The research data will be anonymised, but processing of personal data is required for conducting the research project (distributing the informed consent docs and the transcripts to the participants).

8B. Will you work with any other types of confidential or classified data or code as listed below? (tick all that apply)

If you are not sure which option to select, ask your Faculty Data Steward for advice.

- Yes, politically-sensitive data (e.g. research commissioned by public authorities, research in social issues)
- Yes, data which could lead to reputation/brand damage (e.g. animal research, climate change, personal data)

9. How will ownership of the data and intellectual property rights to the data be managed?

For projects involving commercially-sensitive research or research involving third parties, seek advice of your Faculty Contract Manager when answering this question. If this is not the case, you can use the example below.

The datasets underlying the published papers won't be publicly released, as I'm not obliged as MSc student to do so. During the active phase of research, the project leader from TU Delft will oversee the access rights to data (and other outputs), as well as any requests for access from external parties. Rights on the achieved results lie with the student.

Which personal data will you process? Tick all that apply

- Telephone numbers
- Data collected in Informed Consent form (names and email addresses)
- Signed consent forms
- Special categories of personal data (specify which): race, ethnicity, criminal offence data, political beliefs, union membership, religion, sex life, health data, biometric or genetic data
- Gender, date of birth and/or age
- Email addresses and/or other addresses for digital communication
- Names and addresses

Please list the categories of data subjects

Interview participants are various stakeholders on the topic of flood resilience governance in vulnerable communities/ neighbourhoods (academic experts, local authorities, community leaders, residents) in urban area of Dordrecht, and more specifically De Staart.

Will you be sharing personal data with individuals/organisations outside of the EEA (European Economic Area)?

- No

What is the legal ground for personal data processing?

- Informed consent

Please describe the informed consent procedure you will follow:

Interviews: All interview participants will be asked for their written consent for taking part in the study and for data processing before the start of the interview. Interviewees will also be allowed to review the anonymous transcriptions from their interviews before they are finalised and used for analysis.

Where will you store the signed consent forms?

- Same storage solutions as explained in question 6

15. Does the processing of the personal data result in a high risk to the data subjects?

If the processing of the personal data results in a high risk to the data subjects, it is required to perform a Data Protection Impact Assessment (DPIA). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data during your research (check all that apply).
If two or more of the options listed below apply, you will have to complete the DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to receive support with DPIA.
If only one of the options listed below applies, your project might need a DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to get advice as to whether DPIA is necessary.
If you have any additional comments, please add them in the box below.

- Data concerning vulnerable data subjects
- Sensitive personal data

Audio-recordings are not themselves sensitive personal data, but I am asking for the participants' financial situation: income range. Therefore, I have consulted the **Privacy Team** (privacy-tud@tudelft.nl) regarding additional considerations for privacy and security, and we have concluded that a **DPIA is not necessary**.

Did the privacy team advise you to perform a DPIA?

No, we had a meeting and we concluded that there is no need for me to perform a DPIA.

Please include below the outcome of the DPIA, what measures did you take?

Waiting for their response.

Where will you store the DPIA documents (document on data processing features and document on risk assessment)?

- Same storage solutions as explained in question 6

What will happen with personal research data after the end of the research project?

- Personal research data will be destroyed after the end of the research project
- Anonymised or aggregated data will be shared with others

How long will (pseudonymised) personal data be stored for?

- Other - please state the duration and explain the

rationale below Data is anonymised, and thus

pseudonymised personal data is not stored.

What is the purpose of sharing personal data?

- Other - please explain below

Data is anonymised, and thus pseudonymised personal data is not stored.

Will your study participants be asked for their consent for data sharing?

- Yes, in consent form - please explain below what you will do with data from participants who did not consent to data sharing

Although data will be anonymised, all participants will be asked for their consent for data to be shared anonymously with open access in an online data repository. Participants who do not consent to data sharing will not be included in the research project.

Data sharing and long-term preservation

Apart from personal data mentioned in question 22, will any other data be publicly shared?

- I do not work with any data other than personal data

How will you share research data (and code), including the one mentioned in question 22?

- My data will be shared in a different way - please explain below
- All anonymised or aggregated data, and/or all other non-personal data will be uploaded to 4TU.ResearchData with public access

TU Delft Educational repository, with the MSc thesis

How much of your data will be shared in a research data repository?

- 100 GB - 1 TB

When will the data (or code) be shared?

- As soon as corresponding results (papers, theses, reports) are published

Under what licence will be the data/code released?

- CC BY

Data management responsibilities and resources

Is TU Delft the lead institution for this project?

- Yes, leading the collaboration - please provide details of the type of collaboration and the involved parties below Graduation internship plan in an organisation.

Leading party: TU Delft
Internship organisation involved: municipality of Dordrecht.

If you leave TU Delft (or are unavailable), who is going to be responsible for the data resulting from this project?

Thesis supervisor, Yawei Chen of Urban Development Management: Y.Chen@tudelft.nl

What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?

4TU.ResearchData is able to archive 1TB of data per researcher per year free of charge for all TU Delft researchers. I do not expect to exceed this; therefore, there are no additional long-term preservation costs.

Signatures:

Evangelia Telli

MSc. researcher

Yawei Chen

Responsible researcher

G.4 Interview protocols

As part of my master's thesis, I'm planning to conduct 12 in-depth, semi-structured interviews with experts and government actors in the field of flood management and community leaders from the two focus urban areas in Dordrecht, Krispijn and De Staart.

Methodology

Responsibilities - Practicalities

For each interview, certain responsibilities and measures were taken. Apart from guiding the discussion, I made two recordings of the interview and took notes of the main findings.

Sending out consent forms and interview questions

Before each interview, we plan to send the informed consent to the interviewee, together with the questions, so that the interviewee can prepare for the interview.

Research framework

The main research question is:

For the interviews I'll use the following framework (see Figure 1 below), which I concluded form the literature review. The framework is made up of three main factors: Resilient flood management strategies, neighbourhood vulnerability factors and last but not least the multi-stakeholder perception (institutional and community).

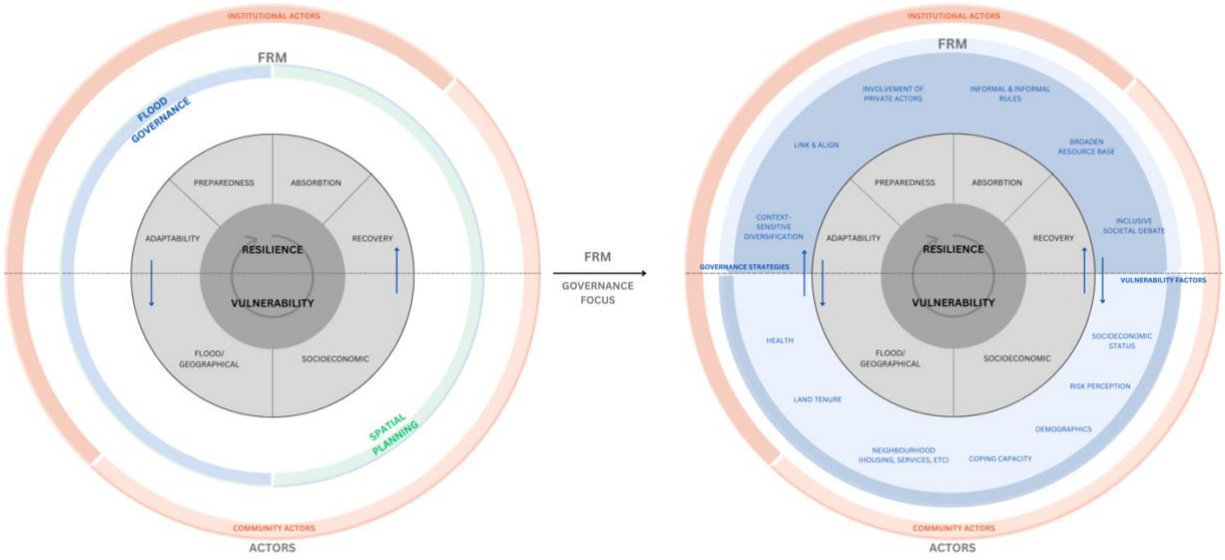

Figure 1: Theoretical framework (own work, 2024)

Main interview themes

Operationalisation variables of the discussion were arranged beforehand for all different stakeholders participating in my research. Specific broader topics and themes deriving from the literature review and the theoretical framework formed the core of the interview discussion (see Table 4 below).

Table 4: Main themes and variables of discussion in the semi-structured interviews per stakeholder group (own work, 2024)

Stakeholder group	Main themes	Sub-themes	Explanation
Authorities: Local, Provincial, National	1. Adaptability and local tailoring 2. Coordination and governance	- Environmental factors - Interdependency - Multi-level governance	Policies and actions are tailored to local environmental contexts; coordination across various governance levels is assessed.
Urban Planners & Architects	1. Community-centric design 2. Integrated development strategies	- Incorporating local knowledge - Stakeholder engagement - Regulatory framework	Design practices that reflect local needs and knowledge; integration of urban development with broader FRM strategies.
NGOs & Organisations	1. Advocacy and inclusive governance 2. Resource mobilization	- Community representation - Decentralized decision-making - Diverse funding - Economic tools	Advocacy roles for community representation in governance; strategies to diversify funding and utilize economic tools for FRM.
Community Members/Residents	1. Participatory resilience 2. Policy interaction and legitimacy	- Personal experiences and perspectives - Self-efficacy and action - Inclusive debate - Social equity	Residents' experiences with flood risks; their involvement in FRM policy debates and advocacy for equitable practices.
Researchers/Academics	1. Policy development support 2. Socioeconomic resilience analysis	- Research informing policy - Analytical perspective on needs - Advocacy for evidence-based governance	How research informs policy-making; empirical analysis of socioeconomic resilience and advocacy for evidence-based governance.

Language of interviews

All interviews were conducted in English.

Introduction

Experts

My name is Eva Telli, a master's student at the Delft University of Technology, currently finalizing my thesis in the Management in the Built Environment track. My research focuses on flood governance strategies in socioeconomically vulnerable neighborhoods, particularly in the Dutch urban contexts of Dordrecht. The aim is to assess the effectiveness of government-initiated flood resilience strategies, not only in mitigating immediate flood risks but also in addressing deeper socioeconomic vulnerabilities that exacerbate a community's exposure to floods.

I am gathering insights into the flood resilience governance strategies, through qualitative research methods, including 2 case studies in Dordrecht and in-depth interviews with stakeholders; ranging from institutional actors to community members. From our discussion today, I would really appreciate your (international) insights on flood resilience governance and even more specifically how we can better integrate socioeconomic factors into flood resilience planning and implementation. Your expertise will help me enrich the practical recommendations of my thesis, which aims to make flood governance more inclusive and effective.

Community leaders

For my thesis I'm working on a research project that focuses on vulnerable neighbourhoods, in Dordrecht in particular, and their resilience to flooding. It focuses on the understanding of urban vulnerabilities as a means to improve community's flood resilience, especially in socio-economically vulnerable neighbourhoods. I'm particularly interested in Krispijn and De Staart neighbourhoods because they face their own unique challenges concerning socio-economic issues but also floodings, one being inside the dikes and on low ground and the other one outside the dikes, but on high ground. I aim to understand these challenges in detail from the perspective of those most affected. I want to find out what's currently being done from the institutional side to protect these areas and what is actually understood and received by the community – community's perception. With the prospect of coming up with improvement recommendations.

Main interview questions

Urban planners

Introduction: background & project

1. Can you tell me a few things about your background and your involvement in the High Ground exhibition in de Staart?

Vision of the project

2. What was the overarching vision of the project and how did you approach it?

Community's characteristics

3. In the context of de Staart, did you identify certain specific needs/ vulnerabilities of the local community?
4. If yes, how did you consider and address their specific needs in your design? Can you provide examples of specific design decisions?

Talking about design decisions, ...

Flood governance strategies

5. Reflecting on your proposal for De Staart in Dordrecht, what key (design) elements do you believe are essential in a flood governance strategy to enhance community resilience?

6. In such projects (within flood and socio-economically vulnerable communities) do you usually align/ get influenced by the city's broader water safety or resilience strategy? Are you in touch/ in close contact with the municipality's vision/ governance strategies?
7. Other similar projects, in vulnerable neighbourhoods: in your opinion, what are the most effective way to engage diverse community stakeholders in the planning process for areas like De Staart?

All this stakeholder-coordination, already brings me more questions regarding the collaboration, especially when the community is also involved…

Stakeholder involvement

8. Do you have any relevant experiences/ projects where the stakeholder involvement was particularly challenging or rewarding (opportunities/challenges), and what you learned from that experience?

Lessons-learned to address/mitigate vulnerability

9. Looking back at past projects, could you share a lesson-learned that you now apply to new projects in similar settings (to mitigate vulnerability and enhance resilience)?

Water board ZHZ

Understanding approach and paradigm of Dutch flood management

1. Can you elaborate on the holistic approach to FRM in the Netherlands and how it integrates considerations of spatial quality, environmental sustainability and community involvement? (as it can very much differ from country to country)

Understanding role and responsibilities

2. Can you outline your main responsibilities of the Waterschap Hollandse Delta, especially in relation to flood risk management and flood resilience?
3. How does your role, as an emergency coordinator, support the Waterschap in addressing resilience in flood governance?

Flood governance strategies

4. What are the key strategies that the Waterschap employs to enhance flood resilience in vulnerable neighborhoods?
5. Could you provide an example of a strategy/ practice that has been particularly effective in mitigating flood risk?

Stakeholder engagement

6. How does the Waterschap engage with various stakeholders, including both other governmental actors and local communities, in developing flood governance measures?
7. What challenges have you faced in involving different stakeholders (and more specifically a vulnerable community), and how have you addressed these challenges?

Learning from experience

8. Based on your past experiences, what lessons can be applied to improve flood governance and resilience in vulnerable areas?

Emergency response and coordination

9. How do you coordinate emergency responses to flood events? and how is this integrated into broader flood resilience planning?
10. Has the Waterschap adapted its emergency response plans to the tailored needs of a more socio- economically vulnerable neighbourhood (less means to react/respond)? If yes, in what ways?

Foresight and preparedness

11. Are there proactive measures being taken by the Waterschap to prepare for future climate change- induced flooding scenarios?
12. In these scenarios, do you, as a water board, take any proactive measures to prepare and support socio-economically vulnerable areas and communities specifically for flooding?

13. How does the Waterschap balance immediate flood response with long-term resilience building in its planning and operations?

Safety region ZHZ

Understanding approach and paradigm of **Dutch FRM**

1. Can you elaborate on the holistic approach, Dutch paradigm to FRM in the Netherlands? (as it can very much differ from country to country)
2. How does it integrate considerations of community characteristics?

Understanding **role and responsibilities**

3. Can you outline your main responsibilities of the Safety region, especially in relation to flood risk management and flood resilience? [Evacuation strategy]
4. In which stage/ layer of FRM are you involved mainly? (which layer and which phase)

Flood governance strategies

5. What are the key strategies that the Safety region employs to enhance flood resilience in vulnerable neighborhoods?
6. Could you provide an example of a strategy/ practice that has been particularly effective in mitigating flood risk?

Stakeholder engagement

7. How does the Safety region engage with various stakeholders, including both other governmental actors and local communities, in developing flood governance measures? How does your role support the other relevant governmental orgs in FRM (Safety region)?
8. What challenges have you faced in involving different stakeholders (and more specifically a vulnerable community), and how have you addressed these challenges?

Evacuation strategy planning

9. Who are the key stakeholders responsible for planning and implementing evacuation strategies in socio-economically disadvantaged and flood-prone neighbourhoods? Do you have any involvement?

10. In your experience, can you describe how these evacuation strategies are developed? Do you have any specific guidelines, best practices or studies in mind that inform these processes?

Learning from experience

11. Does Safety region adapt its FRM plans to the tailored needs of a more socio-economically vulnerable neighbourhood (less means to react/respond)? If yes, in what ways?
12. Based on your past experiences, what lessons can be applied to improve flood governance and resilience in vulnerable areas?

Municipal advisors

General

1. Could you describe the overarching flood governance strategies/ flood governance and management system in Dordrecht?

→ as the various layers or phases of your flood management plan: Key actions taken phase/ layer, and responsibilities among the community/inhabitants.
(prepare, absorb, recover, and adapt)

2. Can you explain the general division of responsibilities: difference between inner- and outer-dike areas for instance?

3. What are the main challenges you face in improving flood resilience in urban areas, particularly in socio-economically deprived neighbourhoods? → and how have you adjusted your approaches to overcome them?

4. How does the municipality engage with such local communities in the planning and implementation of flood resilience measures? Can you give examples of successful community involvement?

Krispijn

5. What specific challenges/ vulnerabilities does Krispijn face regarding flood resilience? what makes Krispijn vulnerable regarding flooding?

6. Considering Krispijn's socio-economic vulnerabilities and evacuation dynamics: have/ how have flood governance strategies been tailored specifically for this area? Are these being addressed through governance strategies?

A good practice: a specific example where a flood governance strategy significantly improved resilience in Krispijn?

De Staart

7. What are the main opportunities/ capacities and challenges/ vulnerabilities of De Staart regarding flooding?

8. How have/ will/ could flood governance strategies been adapted to meet the specific needs of De Staart, particularly concerning its sheltering capacities?

Is/ Will the community of De Staart (be) involved in the development and implementation of flood governance strategies?

Future

9. Looking ahead, do you have any improvements or changes in mind that are planned for Dordrecht's flood management strategies to increase the resilience of vulnerable neighbourhoods further?

Thank you very much for your time!

Community leaders

Introductory question to establish relevance and expertise:

1. Can you share something about your involvement/ role with Het Vogelnest?

Understanding vulnerabilities specific to Krispijn and De Staart:

2. In your experience, what are the main vulnerabilities faced by the communities in Krispijn and De Staart, particularly concerning urban flooding and climate change?

Community engagement and response:

3. How does Het Vogelnest engage with the community in Vogelbuurt to address these vulnerabilities? Can you give examples of initiatives or projects?

Perceptions of vulnerability and resilience:

4. How do residents (in Krispijn and De Staart) perceive their vulnerability to urban flooding? What are their main concerns and hopes for future resilience?

Barriers to effective vulnerability and resilience management:

5. What are the biggest challenges or barriers you've encountered in trying to address these vulnerabilities in Krispijn and De Staart?

Effective strategies and recommendations:

6. Based on your experiences, what strategies or actions do you believe would most effectively enhance resilience against flooding in these areas?

Collaboration and support:

7. How crucial is the role of local authorities, organizations, and the community in building resilience? Can you share an example of successful collaboration?

Leveraging community leaders for engagement:

8. How can community ‘leaders’ like yourself act as catalysts for engaging the community members in resilience-building activities?

Future directions and improvements:

9. Looking forward, what improvements or changes would you like to see in the way Dordrecht, and specifically Krispijn and De Staart, manage their vulnerabilities (in order to enhance resilience)?

International flood experts

Personal intro

1. Could you start by sharing a few things about you, as your role and experience in flood protection and management? → key projects, is the scope of your work international or national?

FRM strategies

2. Have you observed significant changes in FRM strategies over the years in different international contexts?

3. Could you share with me the most successful FM strategies you've come across, nationally or internationally?
4. Do these strategies integrate/ consider socioeconomic factors/vulnerabilities within the communities they are meant to protect? How? → strategies or innovations that you believe that could enhance resilience in socioeconomically diverse settings

Community involvement

5. In your experience, how important is community involvement in the development and implementation of flood management strategies?

Barriers

6. Are there barriers in involving the community? Could you name the most common ones to implementing effective FM strategies in vulnerable neighborhoods?

7. How can these barriers be overcome, and what role do various stakeholders play in this process?

Trends

8. Looking forward, what trends or emerging technologies do you see playing an important role in shaping inclusive flood risk management in urban areas (for inclusion of the vulnerable groups too)?

9. Are you aware of any case study/ city/ country that is a good reference for their risk communication strategy or their evacuation strategy?

G.5 Questionnaires

De Staart neighbourhood

Hallo, bewoners van De Staart! Ik ben Eva, een studente van de TU Delft, bezig met mijn onderzoeksproject en het verzamelen van gedachten over hoe wij, als gemeenschap, elkaar kunnen helpen in tijden van overstromingen, aangezien het gebied van De Staart op hoger gelegen grond ligt. Jouw mening zal helpen om een zorgzame en goed voorbereide De Staart vorm te geven. Al je antwoorden zijn privé en erg belangrijk!

Over jou
Leeftijd:
Nationaliteit:
Geslacht: Man / Vrouw / Anders / Liever niet zeggen
Hoeveel jaar woon je nu op De Staart?
Thuis: Huren of bezitten? Huren / Bezitten

Persoonlijke ervaring [omcirkel je keuze]

Heb je zelf ooit een overstroming of wateroverlast meegemaakt? Ja / Nee

Veilig en klaar blijven [omcirkel je keuze]

Hoe zeker voelt je zich over de veiligheid van uw huis en gezin als er in uw buurt een overstroming zou plaatsvinden? Zeer zeker / Enigszins zeker / Niet zeker

Denk je dat De Staart goed voorbereid is op zo'n scenario? Ja / Misschien / Nee
Als je Misschien of Nee hebt geantwoord:
Wat zou volgens jou kunnen helpen bij de voorbereiding van het gebied om een schuilplaats te worden (in geval van evacuatie)? [geef een kort antwoord].

_____

_____

_____

Wie zou volgens jou de hoofdverantwoordelijkheid moeten dragen voor het gereedmaken van De Staart als opvang/verblijfsgebied en het veilig houden ervan? [omcirkel uw keuze]
Het stadsbestuur
Wij allemaal samen in de gemeenschap.
Zowel het stadsbestuur als de gemeenschap

Heb je vertrouwen in de overstromingsveiligheids- en evacuatieplannen van de stad?
Ja / Niet zeker / Nee
Indien Niet zeker of Nee: Waarom zou je meer vertrouwen hebben in de overstromingsplannen van de stad?

_____

_____

<u>Hosting en helpen</u> [omcirkel je keuze]

Zou je, indien nodig, een gezin uit een door overstromingen getroffen gebied willen opvangen?
Ja / Misschien / Nee
Wat zou je nodig hebben om dit mogelijk te maken? (bijv. steun van de stad, meer informatie):
[schrijf je korte antwoord]

_____

_____

_____

<u>Leren over waterveiligheid en voorbereid zijn op overstromingen</u> [omcirkel uw keuze]

Heb je gehoord van of deelgenomen aan activiteiten of bijeenkomsten over waterveiligheid georganiseerd door de gemeente Dordrecht? Ja / Nee

Zo ja, vond je het nuttig? Ja / Misschien / Nee

Indien ja of misschien: Wat vond je nuttig? [geef een kort antwoord].

_____

_____

_____

Uw gedachten over de sterke punten en behoeften van de gemeenschap [schrijf je korte antwoorden]

Wat zijn volgens jou de sterke punten van De Staart als veilige plek tijdens overstromingen?

_____

_____

_____

Zijn er dingen die jullie missen of die jullie zouden kunnen verbeteren om elkaar en gezinnen uit door overstromingen getroffen gebieden beter te ondersteunen?

_____

_____

_____

De boodschap verspreiden [omcirkel uw keuze]
Heb je het gevoel dat je weet wat je moet doen in geval van een overstroming of evacuatie? Ja / Misschien / Nee
Krijgt je voldoende informatie en betrokkenheid van de gemeente Dordrecht over dat onderwerp? Ja / Nee

Hoe krijgt je het liefst informatie over hoe je zich kunt voorbereiden of hoe je kunt helpen bij overstromingen?
Sociale media / Gemeenschapsvergaderingen / Lokale autoriteiten / Brieven thuis / Andere:

Jouw stem is belangrijk [schrijf je korte antwoord]

Nog andere ideeën, zorgen of suggesties over hoe De Staart een rol kan spelen tijdens overstromingsnoodsituaties?

_____

_____

_____

Bedankt voor het delen van je gedachten! ☺ ☺ ☺

Krispijn neighbourhood

Hallo, inwoner van Krispijn! Ik ben Eva, een studente van de TU Delft die onderzoek doet naar overstromingsrisico's en evacuatiestrategieën. Uw inzichten zijn cruciaal voor het verbeteren van de weerbaarheid van onze gemeenschap tegen overstromingen. Uw antwoorden blijven vertrouwelijk en worden zeer gewaardeerd!

Over jou
Leeftijd:
Nationaliteit:
Geslacht: Man / Vrouw / Anders / Liever niet zeggen
Hoe lang woon je al in Krispijn? (jaren/maanden)
Huis: Huren/eigen

Ervaring met en bewustzijn van overstromingen
Hebt je wel eens te maken gehad met overstromingen of ernstige wateroverlast in Krispijn? Ja / Nee
- Zo ja, geef dan een korte beschrijving van de omvang en de gevolgen voor je en uw eigendom:

_____

_____

Is het overstromingsrisico iets waar je rekening mee houdt als je beslissingen neemt over waar je woont of werkt? Ja, vaak / Misschien, zelden / Nee, bijna nooit

Voorbereid zijn op evacuatie
Bent je op de hoogte van de opvanggebieden, gelegen op hoger gelegen gronden, in Dordrecht (de opvanggebieden in geval van een toekomstige evacuatie)? Ja / Nee
Weet je waar de dichtstbijzijnde veilige hooggelegen plek (bijv. De Staart) is? Ja / Nee
Hoe voorbereid voelt je zich (voor je en uw gezin) op een mogelijke evacuatie? Zeer goed voorbereid / Enigszins goed voorbereid / Niet voorbereid
Ziet je het nut in van het organiseren van evacuatieoefeningen of voorbereidingsbijeenkomsten voor de gemeenschap? Ja/ Nee

Rol van de gemeenschap en de overheid
Wie zou er volgens je primair verantwoordelijk moeten zijn voor het opbouwen van bewustzijn en paraatheid met betrekking tot bijvoorbeeld evacuatieplannen?
Lokale overheid
Gemeenschapsleden en -organisaties
Beide; in nauwe samenwerking
Andere:

Communicatie en informatie
Ontvangt je gewoonlijk informatie over overstromingsrisico's en paraatheidsevenementen? Ja / Nee
Zo ja, hoe?
Sociale media
Gemeenschapsvergaderingen
Lokale autoriteiten
Andere:

Hoe effectief vindt je deze communicatie? Zeer effectief / Enigszins effectief / Niet effectief

Extra opmerkingen (optioneel)
Wat zijn uw grootste zorgen met betrekking tot overstromingsrisico's in Krispijn?

Heb je suggesties of ideeën over hoe we de gemeenschap weerbaarder kunnen maken en beter kunnen voorbereiden op overstromingen?

Bedankt voor jullie deelname! ☺ ☺ ☺

TU Delft
BK Bouwkunde
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Built Environment