TOWARDS FLOOD RESILIENT URBAN AREAS

A MULTIPLE CASE STUDY

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The presented document has been written to finalize my Master Study: 'Environmental and Infrastructure Planning' at the Faculty of Spatial Sciences; University of Groningen. This Master Thesis symbolizes the end of my studies in Groningen, which began with the bachelor 'Sociale Geografie en Planologie'. During this entire period, I learned valuable lessons, gained new insights and made friends for live.

This Master Thesis focuses on water, which is one of the three main subjects of the Master. It was not a difficult choice to write my Master Thesis on a subject related to water, as it has always been part of my interests. With the increasing uncertainties related to climate change, urban flood resilience is a very interesting and relevant topic for the development of urban areas as well as the livability of vulnerable areas.

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Please enjoy reading this Thesis.

Jennifer Brécheteau,

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ABSTRACT

To act on the growing flood vulnerability of cities, urban areas increasingly take part in "Resilient programs". These programs focus on enhancing the flood resilience of urban areas. Given that floods cannot always be prevented, not only a reduction of the flood probability is required, but it also requires a reduction of the potential consequences of a flooding. Where Flood Risk Management (FRM) traditionally focused on reducing the flood probability by using defensive strategies, will more holistic approaches in FRM enhance flood resilience. Multiple scholars argue that having a diverse set of Flood Risk Management Strategies (FRMSs), focusing on (1) flood defense, (2) flood prevention, (3) flood mitigation, (4) flood preparation and (5) flood recovery, would make a city flood resilient. Even though implementation of these five strategies would make an urban area flood resilient, implementation is complex. This complexity lies within the institutional organization of FRM. Insights of the institutional context is needed for implementing the appropriate FRMSs. Getting an understanding of how the Flood Risk Governance Arrangements (FRGAs) enable the transition to flood resilient urban areas has therefore been the main goal of this research. Through a multiple-case study, the FRMSs of urban areas and its FRGAs have been analyzed. Based on this analysis comparisons are made, upon which possibilities for institutional reform can reside. As such, acknowledging the influence of the FRGAs is important when urban areas want to change the FRMSs of the area. Becoming flood resilient will be, for most urban areas, a challenging goal which requires adjustments in the FRGAs of the urban area itself.

Key words: Urban Areas, Resilience, Flood Resilience, Urban Flood Resilience, Flood Risk Management Strategies, Flood Risk Governance Arrangements

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FRM	Flood Risk Management
FRMSs	Flood Risk Management Strategies
FRG	Flood Risk Governance
FRGAs	Flood Risk Governance Arrangements
GHP	Greater Houston Partnership
HCMC	Ho Chi Minh City
RCPF	Resilient City Planning Framework
RHDHV	Royal HaskoningDHV
UNISDR	United Nations Office for Disaster Risk Reduction

CHAPTER 1: INCREASING RISK OF URBAN AREAS

1.1 INTRODUCTION

It has become clear that climate change is real. Even though efforts are made to reduce the rate in which the climate is changing, this major global issue will have impact in every corner of the world. There will be more weather extremes such as longer periods of drought but also higher intensity rainfalls with extended periods of precipitation (Restemeyer et al., 2015). Other effects due to global warming will be a rise in sea level and an increasing river discharges (IPCC, 2007). Coastal cities in low-lying delta areas will especially feel the impacts (IPCC, 2007; Wardekker et al., 2010; Wiering et al., 2017). Projections are that by 2050 over 570 cities in low-lying coastal zones will experience at least 0,5 meters sea level rise, which is pictured in Figure 1 (C40, 2018).

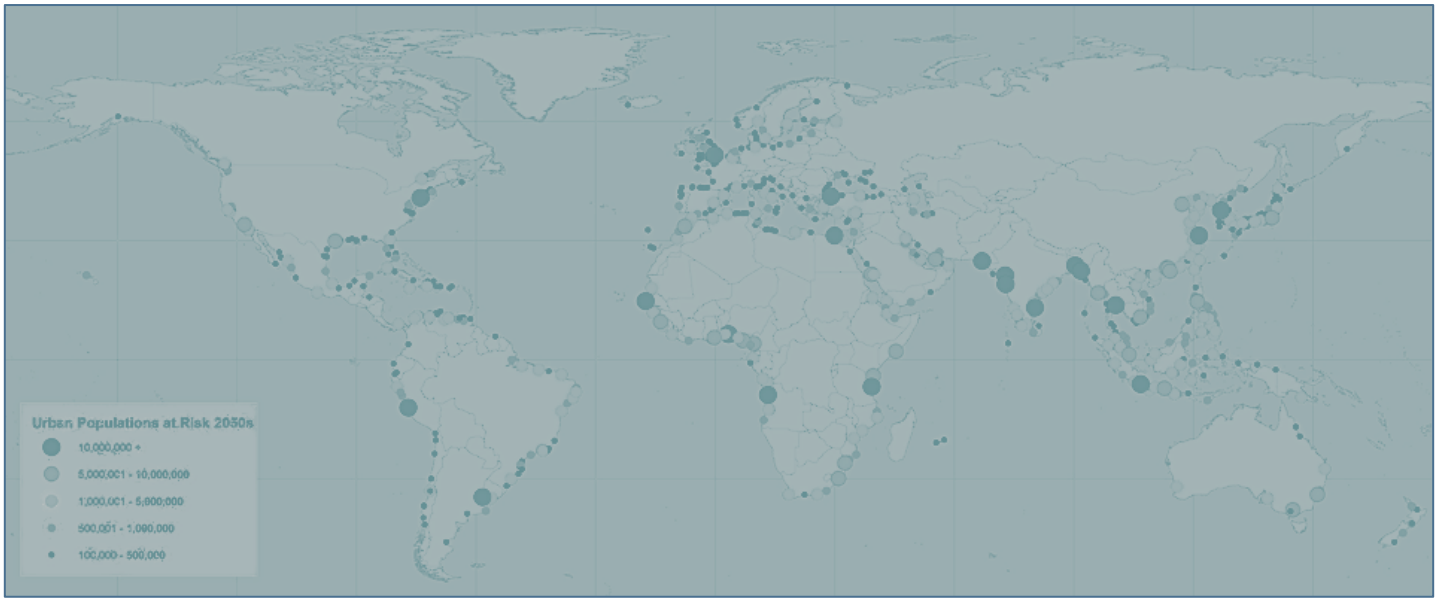


Figure 1: Projection of risk with 0.5 sea level rise (C40 cities, 2018).

Urban areas in these coastal zones are therefore extremely vulnerable. This is due to the high population density and continuous urban development. Expectations are that approximately all future population growth will be in urban areas (Sharifi & Yamagata, 2014). This ongoing urbanization also stimulates economic development in these places which increases the economic vulnerability of the urban areas (Restemeyer et al., 2015).

For these urban areas, mitigation of climate change effects alone is not sufficient anymore, adaptation will be needed as well, since some changes are already occurring (Wardekker et al., 2010; Muller, 2007; Sharifi & Yamagata, 2014). Cities will have to cope with the upcoming challenges that climate change brings and will have to become 'climate proof'. Therefore, while the urban areas are expanding, the cities will also need to find ways to cope with a rise in sea level, increasing river discharges and weather extremes (Wardekker et al., 2010).

Resilience is often considered as a promising concept and multiple programs have already been incorporating it into urban development. Programs aiming to enhance urban resilience are; The Resilient City Planning Framework (RCPF) from the United Nations Office for Disaster Risk Reduction (UNISDR) or the 100 Resilient Cities from the Rockefeller Foundation, which are both international programs. Furthermore, more regional resilience programs exist such as; CATCH an INTERREG North Sea Region Project from the European Union, which also aim to enhance regional resilience. All these programs have the same underlying aim; that mutual understanding and cross-national learning will lead to resilient urban areas (Nadin & Stead, 2012; Jabareen, 2013; Spaans & Waterhout, 2017; Northsearegion, 2018). However, mutual learning based on national policies and planning is uncertain, since this is deeply embedded in local context (Nadin & Stead, 2012). Institutional differences per area can constrain the learning ability which makes it difficult to implement resilience as one concept (Hegger et al., 2014; Wiering et al., 2017).

As mentioned earlier, climate change affects all countries, although it will have different consequences per region. This is due to contextual influences such as economic, spatial, social and physical factors (Jabareen, 2013). Flood Risk Governance (FRG) therefore, asks for different needs per area (Wiering et al., 2017). Developing a resilience strategy calls for tailor-made flood risk management strategies, requiring specific flood risk governance arrangements. A holistic manner of governance is needed for resilience; hence it requires an understanding of the drivers of change within FRG (Wiering et al., 2017).

1.2 PROBLEM DEFINITION

Worldwide the concept of resilience is being embraced within Flood Risk Management (FRM). Through differentiation in Flood Risk Management Strategies (FRMSs) a more resilient urban area would be created (Hegger et al., 2014; Restemeyer et al., 2015). Doing so requires a change within FRG, which is a difficult and complex process. Policy changes as the ones that resilience asks for in FRG are influenced by a variety of driving forces (Wiering et al., 2017). Therefore, detailed knowledge of the conditions needed for such a policy change per area is required (Wiering et al., 2017). In many countries, efforts are being made in transitioning to more flood resilient approaches in FRM, but still lack understanding of what governance arrangements make changes possible (Wiering et al., 2017).

Various research has been done to get a better understanding of the institutional aspect of resilience (Leichenko, 2011). The worldwide aspiration to have flood resilient cities does ask for implementing policies from other countries, yet international comparison of FRG is still lacking. Only multiple comparisons between European countries have been conducted (Hegger et al., 2013; Restemeyer et al., 2015; Wiering et al., 2017, Matczak et al., 2016). To avoid the risk of having recommendations for policy change in FRG that cannot be implemented, there needs to be an understanding of why local policies are the way they are, and which arrangements keep the FRM structure in place (Wiering et al., 2017).

1.3 RESEARCH GOAL AND RESEARCH QUESTIONS

This research will study the Flood Resilience of cities, based on the Flood Risk Governance Arrangements. The study will evaluate and compare how Flood Risk Governance Arrangements enable cities to transition towards a flood resilient urban area. More resilient Flood Risk Management might ask for changes in the Flood Risk Governance Arrangements (Hegger et al., 2014). Lessons could be learned from other cities, but therefore a better understanding of how Flood Risk Governance Arrangements enable cities to differentiate in the Flood Risk Management Strategies is needed. Hence, this research seeks to find an answer to the following main question:

'To what extent do existing Flood Risk Governance Arrangements enable the transition to flood resilience in cities; which lessons can be learned from a comparative research?'

By finding answers to the following sub-questions, an answer will be given to the main question:

1. *How can urban flood resilience be analyzed?*
2. *What is the context of the selected cities?*
3. *How is Flood Risk Management approached in the urban areas and what Flood Risk Management Strategies are used?*
4. *Are the FRGAs organized in such a way that they enable a diversification of FRMSs?*

1.4 THEORETICAL APPROACH

For this research a distinction is made between Flood Risk Governance Arrangements (FRGAs) and Flood Risk Management Strategies (FRMSs) as in Wiering et al (2017). The FRGAs are the institutional configurations needed to handle flood risk. These institutional configurations have an influence on the practical outcomes and diversification of the FRMSs. These arrangements consist of (1) discourse, (2) rules of the game, (3) actors and (4) power and resources and are based on Hegger et al. (2014).

But before analyzing the FRMSs and the FRGAs, the context of the selected cities needs to be explained. This is done based on the urban water framework developed by Brown et al. (2008). This urban water framework evaluates the water infrastructure based on the contextual circumstances of an area such as; geography, demography and the experienced flood risk. This is relevant as the balance between too much and too less water in cities is not only influenced through flood risk management (FRM) but also by its water infrastructure (Dolman & Ogunyoye, 2018). The water infrastructure of an area will also be incorporated in the governance arrangements to make a holistic analysis of urban flood resilience possible. How this is part of the FRGAs will be described in the theoretical framework.

1.5 RESEARCH DESIGN

For answering the main question of this research, an international comparative research has been conducted. Through the use of comparative research, it can be defined how cities develop and implement policies, after which cities might be able to borrow and implement some of the policies (Booth, 2011). This comparison is based on five cases: Zwolle in the Netherlands, Norwich in Great Britain, Semarang in Indonesia, Ho Chi Minh City (HCMC) in Vietnam and Houston in the United States (Figure 2). By analyzing multiple urban areas, insights will be gained in the governance arrangements and how these influence FRM. By using cases that differ considerably from one another, these urban areas will make an interesting comparison (Hegger et al., 2014). These selected cases differ regarding the physical conditions as well as the experienced floods, but also with regard to the strategies and arrangements in place and the economic-, legal- and social context.

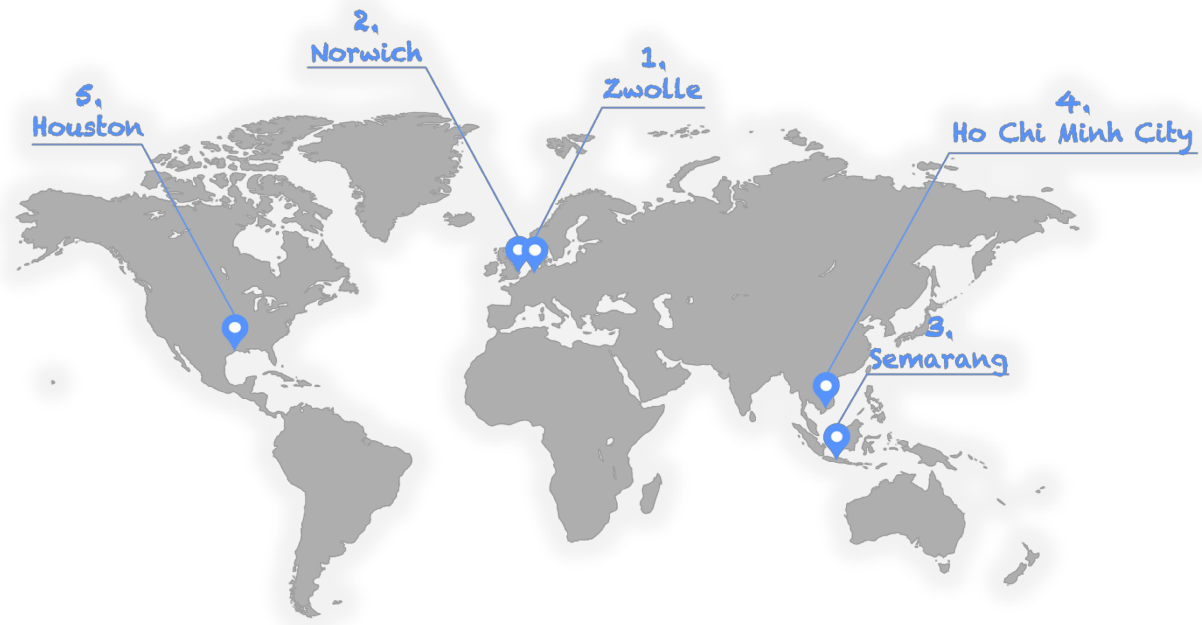


Figure 2: Urban areas of research

1.6 RELEVANCE OF THE RESEARCH

The resilience of societies all over the world is challenged by floods (Wiering et al., 2017), therefore adjustments will be needed. This is also the case for highly urbanized cities in coastal zones or delta regions. These areas are not only very vulnerable due to the growing populations, they also have high economic value. With the increasing uncertainties due to the changing climate, a transition from the traditional way of flood control and risk reduction towards more resilient approaches can be noticed (Restemeyer et al., 2015; Vis et al., 2003). Resilience is seen as a promising concept but implementing this implies policy change. An understanding of the possibilities to change is therefore needed, but according to Wiering et

al. (2017) there is a lack of comparative empirical study to be able to make more general assumptions on how FRGA influences policy change.

By researching multiple urban areas, with their own planning culture, a better understanding will be recognized of the governance arrangements influencing policy change. This will eventually help in the approach to urban resilience in different urban contexts. As such different urban areas will learn from, and make recommendations for each other, based on an understanding as to why established policies exist. This way, recommendations can be made without them being shallow and fit for a specific urban area (Aerts et al., 2012; Wiering et al., 2017). Multiple researchers therefore ask to join in doing research on this complex subject, to enhance the overall flood resilience of urban areas (Farrelly & Brown, 2011; Hegger et al., 2014; Wiering et al., 2017).

1.7 READING GUIDE

In figure 2 an overview is given of the outline of the research. The outline will be structured per research question. This will be done as follows: In chapter one the thesis question and sub questions are introduced. Every chapter will answer one of the sub-questions leading up to the conclusion in chapter 7 where the research question will be answered.

Chapter 2 will answer the first sub-question, through a literature study. Based on the literature study, a conceptual framework will be formed explaining the research approach for analyzing the selected cases. The methodology will be explained in chapter 3.

The second sub-question will be answered in chapter 4 by examining each urban area and defining the urban context and its position in the urban water framework. Chapter 5 will compare the FRMSs of the urban areas, and chapter 6 will analyze and compare the FRGAs. Finally in chapter 7 all the discussed sub-questions will lead to the overall conclusion of the research. This chapter will also include a reflection on the conducted research.

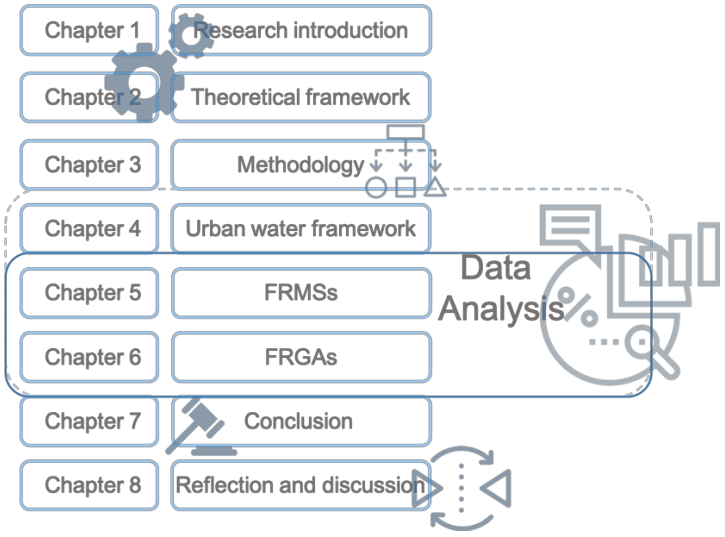


Figure 3: Research overview

CHAPTER 2: GOVERNING URBAN FLOOD RESILIENCE

Throughout the world the vulnerability to flooding is increasing. Factors such as population growth, ongoing urbanization and climate change are the prominent causes. Therefore, there is an ongoing search for improving flood risk management to protect the urbanized areas and its environment (Driessen et al., 2016). In this chapter the theoretical concepts; the urban water framework, Flood Risk Management Strategies and Flood Risk Governance Arrangements, needed for researching urban flood resilience will be explained. Linkages will be made between these relevant concepts by answering the following sub-question: *How can urban flood resilience be analyzed?* After discussing each concept, they will be brought together in the conceptual framework at the end of the chapter.

2.1 URBAN WATER CHALLENGES

Urban areas mainly have to deal with two important water related challenges which differ greatly in nature. First, there has to be a water supply great enough to sustain a city. Second, urban areas need to be protected against water exceedance. The balance between water overrun and water shortage is a very important aspect of how well an urban area can handle water related problems. When cities do not have a well-balanced water infrastructure system, even the smallest disturbances, such as more intense rainfall, can have extreme consequences in such an area (Adger, 2006 in Wong & Brown, 2009). This is greatly determined by the water infrastructure in the urban area (Dolman & Ogunyoye, 2018). A water infrastructure system that is well balanced or resilient, can withstand major disturbances, such as floods, droughts and water degradation, and can even use those disturbances as opportunities for system innovation (Dolman & Ogunyoye, 2018).

WATER INFRASTRUCTURE IN URBAN AREAS

The balance between too much and too little water is regulated by the water infrastructure in place. A better developed water infrastructure will result in a better water balance than in a less developed structure. Brown et al. (2008) developed a framework in which the water infrastructure of urban areas can be categorized in different phases (see Figure 4). In this framework the water infrastructure is being divided in six different phases which urban areas transition through (Brown et al., 2008). These phases are:

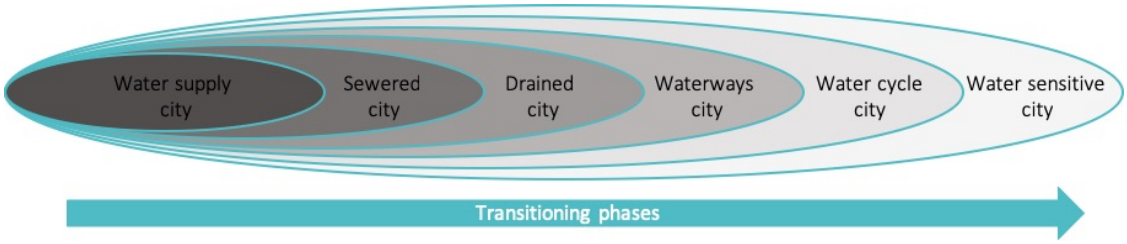


Figure 4: Urban water framework (Based on Brown et al., 2008)

1. In *a water supply city,* the provision of safe and secure water supply is the main objective (Brown et al., 2008). With growing urbanization this can be challenging.
2. *A sewered city* is concerned about the protection of public health, therefore water management has implementation of a separate sewerage system throughout the urban area as a priority (Wong & Brown, 2009).
3. In *a drained city*, flood protection is starting to be of concern. Throughout history drainage has already been done but in a drained city expansion of urban space asks for more attention to a well-organized drainage system and channelization to secure flood protection (Brown et al., 2008; Wong & Brown, 2009).
4. *A waterways city* does in contrast to the previous phases not rely on expanding boundaries of the hydro-social contract but challenges the service functions of the existing infrastructure (Brown et al., 2008). In this phase there is a rise of social amenity and environmental protection (Wong & Brown, 2009).
5. The waterway phases evolved even further in *the water cycle city,* in this phase there is a growing understanding of the limits of natural resources (Brown et al., 2008; Wong & Brown, 2009). This results in more fit-for-purpose developments in water management (Wong & Brown, 2009).
6. *A water sensitive city* is a city resilient to climate change (Wong & Brown, 2009). Dolman & Ogunyoye (2018) describe this city as livable, sustainable and productive, with a balance between the built and natural environment and sustainable use of water. Drinking water supply and wastewater discharge is taken for granted (Dolman & Ogunyoye, 2018), but in an integral and equal way, with water sensitive behavior (Wong & Brown, 2009).

Urban areas evolve through the different stages from being a water supply city to eventually a water sensitive city (Brown et al., 2008; Wong & Brown, 2009). For each of these transition phases there is a different ideological and technological context and a different management paradigm. This means that the urban water framework is being influenced by multiple variables such as: history, geography, socio-political dynamics and ecology (Brown et al., 2008). To be able to analyze city context these variables need to be analyzed, this will be done as followed: geography, demography, flood risk, water infrastructure and resilience program. Each variable mentioned by Brown et al. (2008) is used but another name has been given to some variables. The history variable has been adjusted to the water infrastructure, as this developed throughout the history of the city. The socio-political dynamics are divided in the demography and in the resilience programs, as these programs have to deal with policies development. The flood risk represents to some extent the ecology of the area. The context of the urban areas is analyzed based on these variables, to define their position in the urban water framework.

Although the Figure 4 represents the phases in a linear way, there is no evidence that cities cannot move in the opposite direction within the framework, let alone adapt to other phases when the circumstances of the city change (Brown et al., 2008). But to eventually become a resilient city, more water sensitive thinking is needed at planning level. Therefore, a movement

on the framework towards the right is needed (Brown et al., 2008; Dolman & Ogunyoye, 2018). The urban areas that are still in the first two phases of the urban water framework can be seen as vulnerable systems. This because water supply and sanitation are vital to ensure health and a good quality of life (Dolman & Ogunyoye, 2018).

Becoming a 'water sensitive city', often requires major socio-technical changes. Reaching this desired best-practice, urban water management is a complex process, as it not only requires urban (water) planning to consider the protection and the maintenance of 'multiple' services to benefit the urban water cycle, it also wishes to enhance it (Brown et al., 2008; Sörensen et al., 2016). This water sensitive city requires services such as: security of water supply, protection of public health, protection against floods, waterway protection, recreation, greenhouse neutrality, economic growth and environmental sustainability. By focusing on optimizing individual parts of the water cycle, urban water managers have been trying to reduce this complexity throughout history. But by doing so, other parts of the water cycle were secluded or not taken into consideration (Wong & Brown, 2009), which has had negative effects on the resilience of the area. For example, canalization of rivers might increase the water supply, but it also increases flood risk due to peak water flows. Fortunately, there is an increasing recognition of the inextricable linkage between land use and water management (Wheater & Evans, 2009).

URBAN FLOODING:

In coastal zones and delta areas, water challenges often occur in the form of flooding. That is why urban areas are in need of a well-balanced or resilient water system like in a water sensitive city in order to withstand these disturbances. But the type of flooding that urban water infrastructure needs to deal with can differ in appearance. It is important to know the difference between flood types, as each of them ask for different precautions and measures (Sörensen et al., 2016). This is due to factors such as geography, hydrology and meteorology, which influence the type of floods that occur (Depietri et al., 2012). The impact of a flood can be increased by economic developments within a flood prone area (Depietri et al., 2012). The main types of floods that occur in urban delta areas are (1) 'coastal flooding', (2) 'fluvial flooding' and (3) 'pluvial flooding' (Vojinovic, 2015). The characteristics of these flood types will be explained further on. Another type of flood that can occur is due to groundwater exceedance (see Figure 5). This last type of flood can happen anywhere due to saturation of the soil in a way that it cannot hold water anymore.

1. *Coastal flooding* is caused by heavy storms or due to the failure of coastal protections (Vojinovic, 2015). Cities in coastal zones or delta areas are vulnerable to coastal flooding, as these cities are low lying and therefore easily affected by these floods. A characteristic of coastal flooding is that the water level rises and drops with the tide (Floodsite, 2008). The rising sea level will only increase the vulnerability of these areas even more and might even lead to permanently flooded areas.

2. *Fluvial flooding*, also named riverine flooding is as the name indicates the result of overtopping or breaching of the flood defense of rivers (Vojinovic, 2015). For holistic flood management the upstream and downstream of the river needs to be included in the process, which makes it complex (Sörensen et al., 2016).
3. *Pluvial flooding* often occurs locally. After a short period of intense rainfall this type of flood can occur (Vojinovic, 2015). It is the result of limited drainage capacity or a slow velocity of the infiltration into the ground (JFR, 2011; Vojinovic, 2015). When more extreme weather events occur due to the changing climate the frequency of these events may increase. This will put more pressure on the drainage system of the urban water infrastructure.

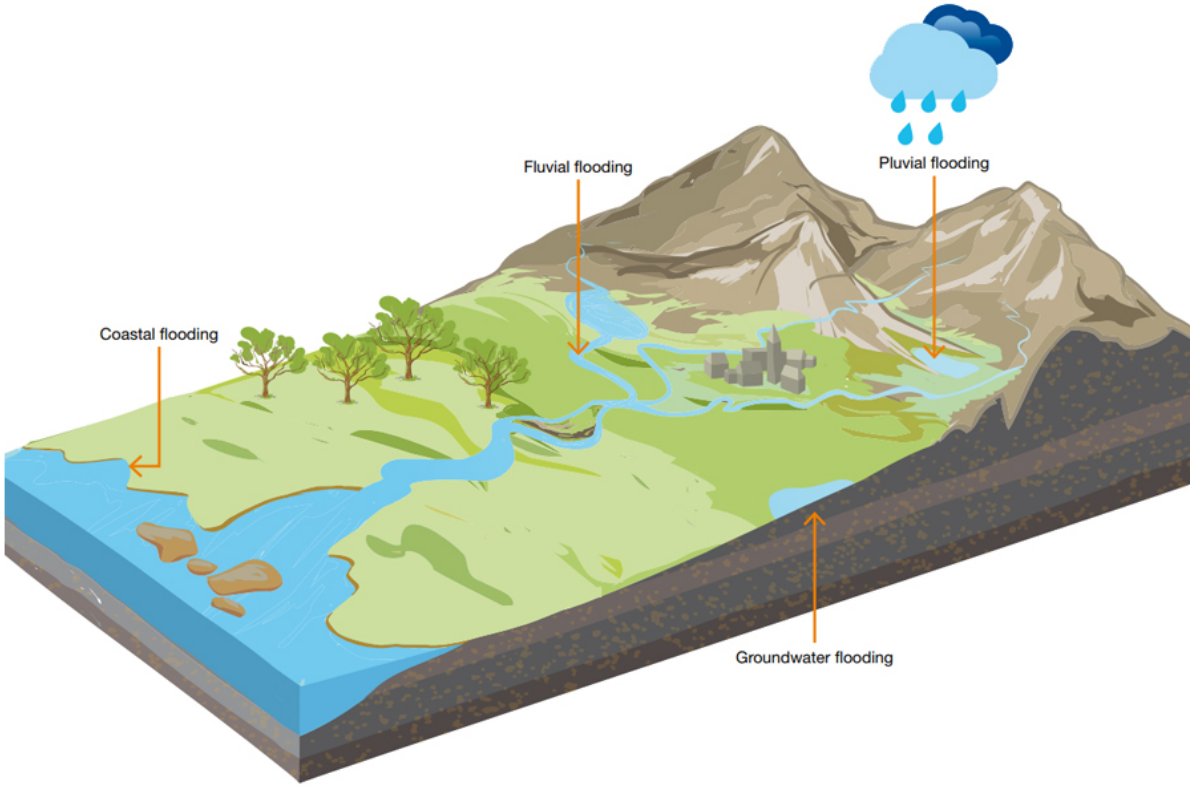


Figure 5: Types of flooding occurring in urban areas (Lambley, 2017)

Although coastal/delta areas are vulnerable to these different types of flooding, they also have favorable conditions for urban and economic development (Vis et al., 2003). These areas therefore have a certain flood risk, which is the flood probability multiplied by the potential damage (Vis et al., 2003). The more development there is, the higher the flood risk of the area. The flood risk that urban areas experience depends upon the types of floods that occur in the area, due to its geography. Next to that it also depends on the level of urbanization in the area, as well as the water infrastructure in place. To be able to understand how flood risk management is organized in an urban area, more profound knowledge of these aspects is needed of each individual urban area. Therefore, chapter four will analyze these aspects and how the water challenges of the proposed cities influence its flood risk management.

2.2 THE TRANSITION TOWARDS FLOOD RESILIENCE

To reduce the flood risk of an area, infrastructural measures such as dams, levees and the canalization of waterways, are often implemented. Consequently, this can also lead to an increase in urbanization in the flood prone areas (Liao, 2014), as these measures often enhance the feeling of safety (Vis et al., 2003). To ensure a certain safety level of the land, dikes and other infrastructural protections need to be constantly renewed and strengthened. This creates a vicious cycle, where economic investments are being made after implementation of new safety measures (Vis et al., 2003).

TRADITIONAL PREDICT AND CONTROL WATER MANAGEMENT

The approach for reducing floods by using hard infrastructure measures can be called 'a flood control strategy' (Vis et al., 2003). For centuries, this was the main strategy used in flood risk management. This management style was regulated through command and control (Schoeman et al., 2014). The focus in this management style strongly relied on maximizing the resource exploitation and had a strong division between the ecosystem and the socio-economic system. Hard infrastructural measures control the water and reduce flood risk. But flood risk is not only the flood hazard itself, it also includes the consequences of flood hazards. Flood risk can therefore also be lowered by minimizing the consequences of a flood event (Vis et al., 2003; Restemeyer et al., 2015). When only focusing on flood control through hard engineering measures, water policy makers generally underestimated the effects of their policy and infrastructural interventions and the consequences these might have later on (Pahl-Wostl, 2007a). Infrastructural measures have a limited capacity to what it can resist. By creating a false sense of security through the strengthening of dikes, the buildup environment becomes more vulnerable as it keeps being developed (McPhee 1989 in Pahl-Wostl, 2007a). Making cities more resilient to upcoming climate change will therefore require other approaches in designing water infrastructure (Sörensen et al., 2016), for example in the form of a water sensitive city (Sörensen et al., 2016; Brown et al., 2009).

With the growing consensus of the complexity and the unpredictability of the world around us, there is an increasing acceptance in addressing problems with a wider perspective (Pahl-Wostl, 2007a; Depietri et al., 2012; Schoeman et al., 2014). Not by managing floods by controlling them, but by being more flexible and adaptive to floods (Sörensen et al., 2016). A transition towards more adaptive management can be perceived (Schoeman et al., 2014; Pahl-Wostl et al., 2011), This transition is characterized by cities strengthening themselves to better cope with climate change (Sörensen et al., 2016). This adaptive management approach asks for the inclusion of aspects such as: the environment and institutional characteristics of the area but also the economic, cultural and technological aspects (Pahl-Wostl, 2007b). By focusing on the consequences of a flooding, the impacts of the flood will be minimized (Vis et al., 2003). A management approach that focuses on this is 'Resilience'. Resilience does not necessarily aim

to reduce the probability of flooding but aims to minimize the consequences of flooding (Restemeyer et al., 2015).

RESILIENT WATER MANAGEMENT

The resilience concept is getting an increasing amount of interest in different kinds of literature, for example literature concerning climate change but also cities (Leichenko, 2011; Restemeyer et al., 2015; Davoudi, 2012). Resilience has its origins within ecology, where the concept has a clear meaning: 'the capacity of a material to bounce back after a shock' (Restemeyer et al., 2015; Davoudi, 2012). But over time the meaning of resilience has evolved into what is called 'evolutionary resilience; where the system has the ability to change structure when a shock has become too much for the original system to cope (Holling, 1996 in Davoudi, 2012). This means that systems have capacity limits which can be passed. If that limit is passed, the system changes into a new form, which once again has a certain resilience capacity (Vale, 2014).

Translating this to 'flood resilience,' three aspects are important: (1) 'robustness,' (2) 'adaptability' and (3) 'transformability' (Davoudi, 2012; Restemeyer et al., 2015). First of all, 'robustness', by being robust an urban area can resist potential flooding (Davoudi, 2012; Restemeyer et al., 2015). With the use of this aspect within resilience, old resistance strategies are not abandoned, as there is still a need for infrastructural flood control within resilience. But for an urban area to be flood resilient, it needs more than only robustness. When the capacity of flood infrastructure is not enough to prevent an area from flooding, adaptability is needed. 'Adaptability' means that within the urban area, adjustments are made to make the city less vulnerable (Restemeyer et al., 2015). Finally, 'transformability' enables an urban area to transform to a new system when the old system is not sufficient anymore. For example, a transformation from predict and control ways of flood management towards more adaptive flood risk management (Restemeyer et al., 2015).

This ability to transform is important in resilience, although Leichenko (2011) mentions that urban areas also need to hold on to their structure and identity after a disturbance. For that, recovery is important, this way cities can go back to functioning as a system. But to prevent that, disturbances such as floods repeat themselves in the same way, adaptability and transformability are needed (Wong & Brown, 2009). For Vale (2014) this is a key aspect of flood resilience; respond immediately to disturbances but make changes over a longer period of time to prevent disturbances from repeating. When urban areas are adapted to floods this will lead to less damage then when it is only built to resist floods (Liao, 2014).

Multiple methods can be used to make sure that an urban area is well adapted to possible floods. Through 'urban flood risk management' the flood risk of an area is assessed (Sörensen et al., 2016). To make a city flood resilient, different flood risk management strategies should be used, adding all three aspects of flood resilience to FRM.

2.3 BROADENING THE STRATEGIES

Floods are highly unpredictable, due to the interaction between the physical and the human system, therefore preparing for such disturbances is difficult (Raadgever et al., 2018). As already mentioned, the use of different strategies can minimize the probability of flooding as well as the consequences that floods have (Raadgever et al., 2018). These 'Flood Risk Management Strategies' (FRMSs) are used to deal with the overall flood risk and can be distinguished from each other by the different focus they have on flood risk (Hegger et al., 2013).

FLOOD RISK MANAGEMENT STRATEGIES

In general, a distinction is made between the probability of flooding, the consequences of flooding and the recovery after floods (Hegger et al., 2014 in Matczak et al., 2015). Within these phases there are five FRMSs that can be distinguished from each other, which are (1) 'defense', (2) 'prevention', (3) 'mitigation', (4) 'preparation' and (5) 'recovery' (Raadgever et al., 2018; Hegger et al., 2013; Matczak et al., 2015). Table 1 gives an overview of the FRMSs and the possible measures representing these strategies. It is argued that diversification, coordination and alignment of these FRMSs will make urban areas more flood resilient (Driessen et al., 2016; Hegger et al., 2013).

Lu & Stead (2013) distinguish the FRM strategies by preparation resilience and performance resilience. The first focuses on the ability to assess and be ready for disturbances. The second focuses on the action after a system failure, which is evolving from one form to another if the current system cannot cope anymore. Matczak et al. (2015), makes a similar distinction but based on the attitude of the strategies. He argues that prevention and defense follow a fail-safe attitude (safe of failing). This fail-safe attitude is the opposite of the mitigation, preparation and recovery strategies, which follow a safe-fail attitude (failing safely). Both of these distinctions are in line with the resilience concept, as the probability of flooding is taken into account together with the consequences. The use of all FRMSs prepares urban areas for flood events in all phases of the disturbance. This way the urban system can fail in a safe way (Matczak et al., 2015; Klijn et al., 2008 in Driessen et al., 2016).

Table 1: FRMSs (Based on Raadgever et al., 2018; Matczak et al., 2015)

Time of strategy use	Strategy	Aim of the strategy	Examples of measures
Before a flood event	Flood risk prevention	Keep people away from water	Zoning and spatial planning
	Flood defense measures	Keep water away from people	Hard infrastructure like dikes and dams
	Flood risk mitigation	Reduce flood risk, as floods do happen	Adjust urban infrastructure, flood storage
During a flood event	Flood preparation and response measures	Reduce flood risk, as floods do happen	Flood warning and forecasting
After a flood event	Flood recovery	Reduce flood risk, as floods do happen	Reconstruction and insurance

Each FRMS has its own focus and approach to reducing flood risk (Raadgever et al., 2018; Hegger et al., 2014). Before a flood event three main strategies can be used. First of all, 'flood risk prevention' aims to reduce the consequences of a flooding by minimizing the exposure to potential flooding through prohibiting or discouraging development in flood prone areas. Secondly, the use of flood defense measures aims to reduce the possibility of flooding through infrastructural flood defense. Finally, the flood risk mitigation strategy, which reduces the consequences of flooding by taking measures within the area at risk, like for example building flood proof through the elevation of buildings. Other strategies are used during a flood event, such as preparation and response measures. These strategies focus on organizing the disaster management, evacuation plans and other management problems during a flood event. After a flood event the flood recovery strategy is used, reconstruction and insurances are tools which provide this strategy to recover from a flood event. (Hegger et al., 2014; Raadgever et al., 2018). Figure 6 gives a visual of the approach of each strategy.

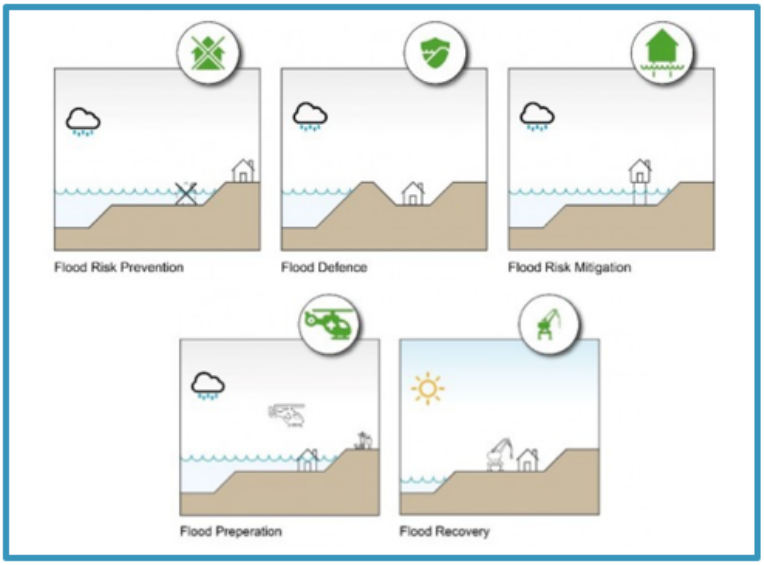


Figure 6: FRMSs (Driessen et al., 2016; Raadgever et al., 2018)

FRM literature is used to explain the timing of the strategy use. But the actual timing of implementing a strategy is not clear-cut. It is rather intuitive, and interlinked with each other (Raadgever et al., 2018). For example; flood preparation strategies such as flood warning systems should already be in place before a flood event in order for it to function. These types of smart technologies already have to be part of the water infrastructure for the strategy to function well.

SMART WATER INFRASTUCTURE

Next to the diversification of FRMSs, an expansion of the water infrastructure framework might be required. This expansion should be based on the use of smart technologies and the growing concept of the smart city (Baron, 2012; De Jong et al., 2015). Although this concept has many definitions (Caragliu et al., 2011; Chourabi et al., 2012; Albino et al., 2015), in this research it will be looked at from the urban planning perspective. From this perspective a 'smart city' is a strategic direction of governments, public agencies and programs to target sustainable and economic development, whilst enhancing the quality of life and the happiness of its citizens (Caragliu et al., 2011; Ballas, 2013 in Albino et al., 2015).

There is a set of factors essential for understanding smart cities. Eight factors can be determined as being influential for the implementation of smart cities which are: technology, organization and management, policy context, the economy, the people, governance, the natural environment, and the built infrastructure (Chourabi et al., 2012). These factors determine to what extent people can use the developed technology and therefore affect the design and implementation of smart city initiatives, (Chourabi et al., 2012). All of these aspects are also important within the urban water framework and could be enhanced when smart technologies are implemented in the urban water framework.

By implementing smart technologies within the urban water framework, new innovations can be made. With technological innovations a more sustainable urban prospect can be reached, which makes urban areas less vulnerable to climate change and related water challenges (Viitanen & Kingston, 2014). A new phase in the urban water framework is therefore considered. This new phase, illustrated in figure 7, would be a 'smart water sensitive city'. This phase is more resilient due to smart technologies being part of the water infrastructure.

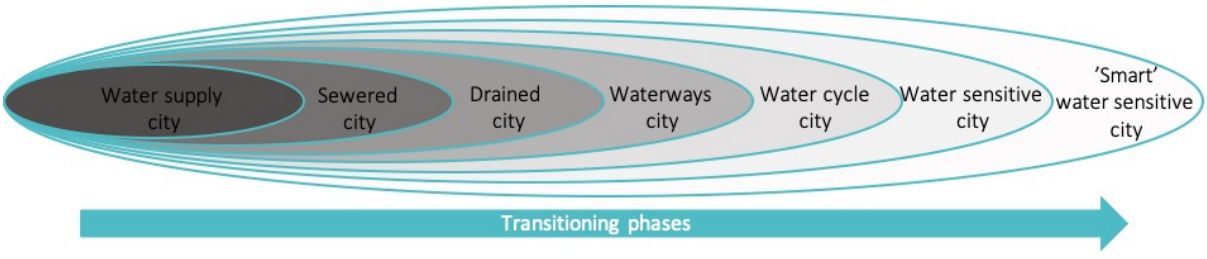


Figure 7: New urban water framework (Altered from: Brown et al., 2008)

Unfortunately, implementation of new strategies faces several barriers. These barriers are largely socio-institutional rather than technical (Sörensen et al., 2016). Therefore, societal transformations have to be made and governance approaches will determine its success (Lu & Stead, 2013). A governance perspective on how FRM is applied is therefore important in order to comprehend the barriers that institutional elements can have on the implementation of new strategies (Lu & Stead, 2013; van den Brink et al., 2011), and society's capability to cope with current and future flood risk (Driessen et al., 2016).

2.4 GOVERNANCE ARRANGEMENTS FOR URBAN FLOOD RESILIENCE

The purpose of governance is to reach a collective goal (Alexander et al., 2016; Renn et al., 2011). In risk governance this goal is to control, reduce or regulate risks (Renn et al., 2011). Within this risk governance, flood risk governance focuses on the specific risk of flooding (Alexander et al., 2016). The success of flood risk governance depends largely on the Flood Risk Governance Arrangements (FRGAs) through which the FRMSs are applied (Hegger et al., 2014). Flood risk governance arrangements can be defined as:

"The institutional constellations resulting from an interplay between the actors and actor coalitions involved in all policy domains relevant for flood risk management; their dominant discourse; formal and informal rules of the game and the power resources base of the actors involved" (Hegger et al., 2013 p.5; 2014 p.4131)

The FRGAs consist of four strongly interrelated dimensions. These are (1) 'the discourse', (2) 'the rules', (3) 'the actors' and (4) 'the resources' (Wiering & Immink, 2006; Hegger et al., 2014; Matczak et al., 2015; Raadgever et al., 2018). The development and implementation of the FRMSs depends upon how these four dimensions coincide (Matczak et al., 2015). Wanting to change the FRMSs therefore involves making changes in the FRGAs, because the FRMSs are embedded within the institutional, legal, economic, social and scientific context of the governance arrangements (Matczak et al., 2015; Lu & Stead, 2013; Driessen et al., 2016).

Policy arrangements are shaped by two overall aspects: by the content of the policy domain and by its organization (Wiering & Immink, 2006; Wiering & Arts, 2006). Within those two aspects the four dimensions can be placed. The discourse can be seen as a part of the content of a policy arrangement. The other three dimensions form the organization of the policy arrangement (Wiering & Arts, 2006). Each dimension will be explained separately in the following sections.

DISCOURSE

The discourse dimension consists of the views and narratives of society and the involved actors (Arts et al., 2006). According to Hegger et al. (2014) this is formed by the values and principles, the path-dependence and the paradigm which are predominant in society. As a paradigm refers

to a set of assumptions that society has about the system and it goals, the prevailing paradigm therefore has an influence on system management (Pahl-Wostl et al., 2011). The discourse is therefore an important determining factor in developing the rules of the game. It determines which actors play a role and to what extent, with regard to the power and resources (Wiering & Arts, 2006).

In this research the discourse dimension will be analyzed based on two components. First the paradigm, which is formed by the water infrastructure phase of an urban area. Throughout history the water infrastructure formed and structured the area in a certain way. Therefore, it is part of the path-dependence of the area. The bigger the gap to a 'smart water sensitive city' on the urban water framework, the bigger the disconnection is between policy ambitions and what can be implemented (Farrelly & Brown, 2011). How strong the path-dependence is, depends on the history of an area (Farrelly & Brown, 2011). Therefore path-dependence is the second aspect in analyzing the discourse dimension. Hegger et al. (2014) also consider policy strategies as being part of the discourse dimension but is left out as the FRMSs already explain the strategy use of urban areas.

RULES OF THE GAME

The rules of the game can be split in to 'hard' and 'soft' institutions (Hegger et al., 2014). Hard institutions are the law and the procedural norms (the formal organizational structures) and the soft institutions are the informal rules and traditions (Gersonius et al., 2016). These soft institutions are difficult to measure and prove, therefore the rules of the game in this research are only based on the hard institutions.

The formal rules and regulations structure the policy process. These determine which role the actors and resources play in the process. On the one hand hard institutions are needed as they give a framework for reaching a common goal. On the other hand, when they are too rigid, these hard institutions can hinder transformation by being bureaucratic and lacking efficacy (Farrelly & Brown, 2011). Rules and regulations are often formed throughout history, this can be called discourse institutionalization. This shows that discourse dimension can influence the rules of the game. A change in discourse can therefore, to some extent, have an effect on the hard institutions (Tatenhove et al., 2000).

ACTORS AND COALITIONS

The third dimension is based on the actors involved in the policy domain and how they interact with each other (Arts et al., 2006). These are not only public actors but also private actors. For example; water authorities, state and local governments, land developers, other professional bodies and academic institutions (Farrelly & Brown, 2011). How these stakeholders interact depends upon the scale of spatial planning (Lu & Stead, 2013). But rather than working independently as has long been done, stakeholders need to interact for better social learning and results (Pahl-Wostl, 2007a). Coalitions can be formed in different forms and constellations

(Hegger et al., 2014). The analysis of the actors and coalitions is therefore based on the following three aspects: public actors, private actors and coalitions.

Unequal power relations can exist between actors. This can be caused by an imbalance in financial or human capital, which can be dynamic over time (Wiering & Arts, 2006). Over time the dynamics can change to a whole new power division. But to make changes in policy, this power division between actors is a very relevant aspect, which needs to be acknowledged.

POWER AND RESOURCES

This dimension can be split in two overall parts, namely 'power' and 'resources'. The power lies with the involved actors and how they divide responsibility. Authority in legitimate forms, as well as acceptance is required for the implementation of new FRMSs (van den Brink et al., 2014). But as mentioned, unequal power relations can exist between actors. This is often the case if one of the actors has more resources than the other (Arts et al., 2006). If that is the case, the one with more power can determine how the overall resources will be divided and used (Arts et al., 2006). This has an influence on the outcome of policy changes. Due to dynamics in time and space this power division can change over time (Wiering & Arts, 2006). 'Authority and power division' is therefore one of the aspects of the power and resources dimension that is analyzed in this research.

There are two kinds of resources which give actors power, financial and human capital (Hegger et al., 2014). The involved actors need to generate and mobilize these two resources. Financial resources are needed to implement types of FRMSs (van den Brink et al., 2014). Without financial resources it will be impossible to make strategy changes. To develop the new strategies human resources are needed, including technical knowledge and former experience (van den Brink et al., 2014). The financial and knowledge capacity are therefore also included in the analyses of the power and resources dimension.

Table 2 gives an overview of the dimensions. It shows the components on which the selected cases will be researched, as explained above.

Table 2: Components of the FRGAs (based on Wiering & Arts, 2006; Hegger et al., 2014)

Discourse	Rules of the game	Actors & Coalitions	Power & Resources
Paradigm/urban transition phase	Rules and regulations	Public actors	Authority & power division
Path-dependence		Private actors	Financial capacity
		Coalitions	Knowledge capacity

To improve urban flood resilience, understanding of the governance arrangements is needed. For example: are the rules equipped to change the FRMSs, are there enough resources to do so and is there a clear division of responsibilities? As Arts et al. (2006) demonstrates, the four dimensions are inextricably connected to one another (figure 8). Changes in one dimension will

therefore cause changes in another dimension. Gaps and barriers within the FRGA can hinder the implementation of resilient strategies (Matczak et al. 2015). Knowledge of the FRGAs and the legal framework is therefore needed (Driessen et al., 2016). By studying the policy arrangements and its development over time, the dynamics between the arrangements can be analyzed (Hegger et al., 2014). This is necessary, as currently governance arrangements in place are often not designed to permit more resilient FRMSs yet (Gersonius et al., 2016; Farrelly & Brown, 2011).

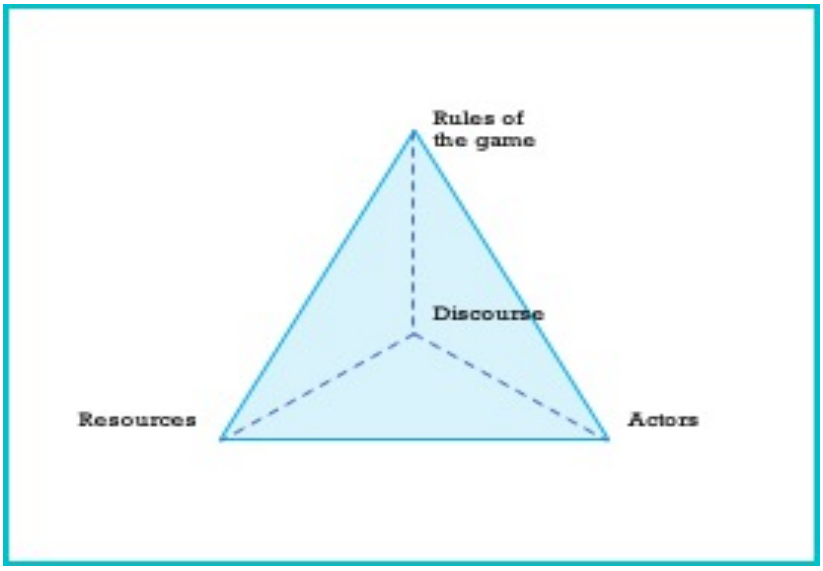


Figure 8: Inextricability of the FRGAs (Based on Arts et al., 2006)

SHAPING NEW FLOOD RISK MANAGEMENT STRATEGIES

The FRGAs shape the FRMSs. For example, changing a discourse, which often is path-dependent, is difficult. But old FRMSs are often based on old habits and know-how, like structural defense methods (Matczak et al., 2015). This combined with urban water infrastructure which has been shaped throughout time, determines in a great way what type of strategies can be applied in the area. The same applies to the resources. If there is a gap between available resources and resources needed, implementation of new strategies will be impossible. Learning from past experience, positive or negative, can help improve plan-making and strategy development for the future (Lu & Stead, 2013). The rules of the game are in a great way the guidance in how developments should take place. But when there is an institutional void or when these rules are fragmented, implementation of strategies will be complicated (Gersonius et al., 2016). For resilience it is important that the governance arrangements are organized in such a way that institutional flexibility is possible (Gersonius et al., 2016).

2.5 CONCEPTUAL FRAMEWORK

The conceptual framework as presented in Figure 9, visualizes the concepts for this research. The three main concepts used are; the urban water framework, FRMSs and FRGAs. There is a growing awareness that the current approaches for limiting flood vulnerability are not sufficient, therefore the transition to urban flood resilience is considered promising. But although this transition to a flood resilient urban area is widely being embraced, it requires changes in FRM. This means widening the set of FRMSs, reducing both the flood probability as well as the consequences of flooding. Consequently, appropriate FRGAs are needed for this diversification of FRMSs. The extent in which the existing FRGAs enable the transition to flood resilient cities, is analyzed in three steps.

STEP 1: ANALYZING THE CONTEXT OF THE CITIES

In step one, the context of the cities is analyzed. The context analyses are based on the city's characteristics: geography, demography, flood risk, water infrastructure and on the city's participation in resilience programs. The geography will describe the size of the urban area and its geographical aspects. The demography explains how densely populated the area is, followed by the flood risk. More densely populated areas often mean a higher flood risk, and the type of flood mostly depends on the geography of the area. The water infrastructure and the resilience programs are also evaluated, which explains the efforts cities make in changing the discourse. Eventually the position of the selected cases in the urban water framework can be defined based on these characteristics.

STEP 2: ANALYZING THE FLOOD RISK MANAGEMENT STRATEGIES

Step two analyses the Flood Risk Management Strategies. The more diversified the FRMSs are, the more flood resilient an urban area is. This step points out which strategies are used in the cities, and which should be better implemented. The individual strategies will be analyzed to explain why and how strategies are used in cities. After evaluating each strategy, the strategy use of cities is visualized in graphs.

STEP 3: ANALYZING THE FLOOD RISK GOVERNANCE ARRANGEMENTS.

The final step of the research approach is analyzing the Flood Risk Governance Arrangements. The FRGAs consist of four dimensions; 'discourse', 'rules of the game', 'actors and coalitions' and 'power and resources'. These dimensions are constructed as discussed in paragraph 2.4. Each dimension is analyzed and explained based on its consisting aspects. This step is finalized with an overview in which the FRGAs of each city can be compared with each other.

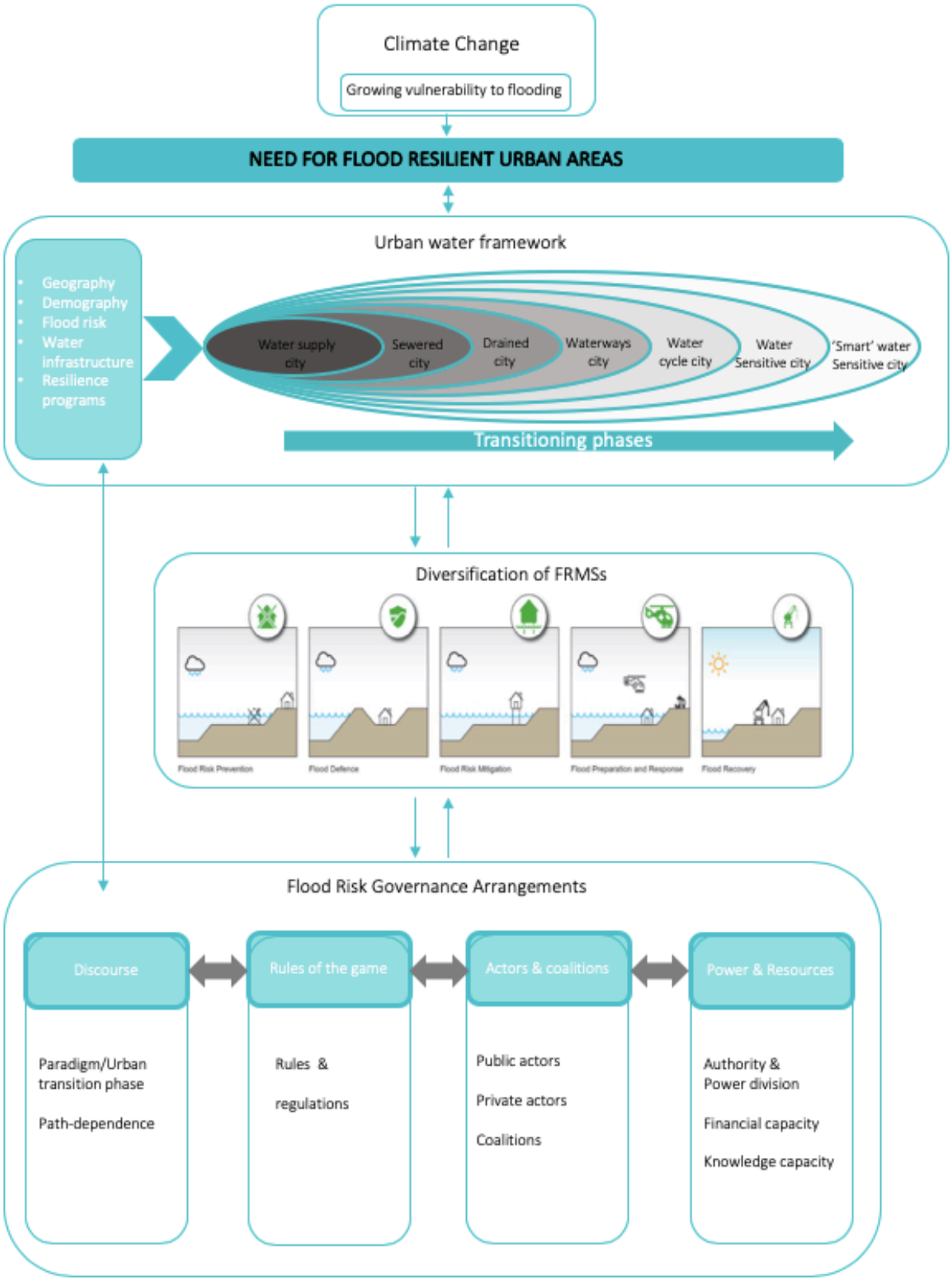


Figure 9: Conceptual framework

CHAPTER 3: METHODOLOGY

Whereas the previous chapter focused on the theoretical aspects of this research, this chapter will focus on the used methodology. First the case study methodology will be explained as well as why this method fits this research. This will be followed by the case selection. After the case selection an explanation follows on how these cases are researched and how the cases will be analyzed. The role of ethical barriers in this research, finalizes this chapter.

3.1 USING A CASE-STUDY METHODOLOGY

Scientific research can be done through experimental and non-experimental research methods (Kothari, 2004). As it is impossible to mimic urban systems in an experiment, social sciences often use non-experimental methods for research, for example, through comparisons or case-studies (Peters, 1998). For analyzing urban areas and their approach towards urban flood resilience, this research uses a case-study methodology.

JUSTIFYING THE CASE-STUDY METHODOLOGY

Case-studies are a form of qualitative research. This qualitative form of research helps emphasizing on the how and the why of processes or events by providing in-depth information (Kothari, 2004). This way multiple perspectives on complex systems such as cities can be explored (Simons, 2014), for example the policies and institutions within cities. A case-study provides detailed information about the real world and the context of the contemporary phenomenon studied (Yin, 2014; Rice, 2010), which is in this case 'urban flood resilience'. Using case-studies therefore fits for this research.

This study aims to compare different cities, to identify if lessons can be learned and if policy transfer is possible. Lesson-learning and policy transfer both refer to the process in which institutional arrangements and policies of one area, are used for the development of institutional arrangements and policies in another area (Dolowitz & Marsh, 1996). Therefore, multiple cases are used, namely five cases from around the globe. According to Yin (2014) this qualifies the research as a multiple case-study. By using five cities, more generalized outcomes of results can be made (Rice, 2010). As multiple analyses will be conducted, this research can be defined as a holistic multiple case-study (Yin, 2014).

CASE SELECTION

While conducting the research the researcher worked as an intern for a consultancy and engineering company: Royal HaskoningDHV (RHDHV). RHDHV is a global company with offices throughout the world. The goal of this company is 'enhancing society'. Being flood resilient contributes to this goal (Royal HaskoningDHV, 2018). The more specific 'urban flood resilience' is an important aspect of flood resilience as a whole and RHDHV wants to enhance this (Royal HaskoningDHV, 2018).

The research consists of five different cases. These cases are: (1) Zwolle, (2) Norwich, (3) Semarang, (4) Ho Chi Minh City, and (5) Houston (see Figure 2). These are all cases in which RHDHV is interested, as all of these urban areas have to deal with water related challenges. RHDHV want to improve the current urban systems in these cities by enhancing its resilience. RHDHV also has offices in most of these cities. Each one of the cases is already making efforts towards floods resilience, as they are all part of resilience programs which focus on enhancing city resilience (100resilient cities, 2018; C40 Cities, 2018; European Union, 2018), RHDHV wants to contribute in this process.

Based on the interest that RHDHV had in specific cases, the case selection was made. Before the company can get involved in these areas, knowledge of current FRMSs and an understanding of the drivers for change within the FRG is required (Wiering et al., 2017). Multiple cases were proposed, such as: Yangon, Houston, Zwolle, Sydney, HCMC, Can Tho, Dan Nang, Chennai, Mumbai, Rotterdam, Semarang and Norwich. The final selection was made based on RHDHV's interest and the availability of relevant participants for these areas, which was the case for the five selected cities. From researcher perspective it was also relevant that enough open non-censured sources available for research, this made that Yangon, Can Tho, Chennai and Mumbai were not selected as cases. Rotterdam and Sydney also met all the case selection requirements but were not chosen due to the amount of research already based on these cities.

3.2 RESEARCH APPROACH

The actual research approach comprises of three steps (Figure 10). Each of these steps is individually executed and represented in a different chapter. Chapter 4 introduces the context of the urban area, which is the first step of the analysis. Through desk research and the use of in-depth interviews, the context of each urban area is explained. Based on the geography, demographics, flood risk, water infrastructure and the resilience programs, the position of the city in the urban water framework of Brown et al. (2008) is explained.

The second step of the approach follows in chapter 5, in which the FRMSs are analyzed and compared between cases. By comparing the used strategies, an overall view can be given to how urban areas are transitioning towards flood resilient use of strategies. With the use of a color scheme (from green to red), a visualization of the interview results was made, representing the degree of importance of the strategies in each urban area (van den Brink et al., 2014; Matczak et al., 2016). This will help to compare the use of FRMSs between the five cases. The researcher performed the rating based on the analyses of the in-depth interviews. High use of a strategy is pictured green and low use of a strategy is red; however, it should be noticed that the importance of a strategy in mind can be different from the implementation in actual practice (Matczak et al., 2016). For each urban area a graph is generated to illustrate its range of FRMSs; the wider the graph, the more strategies are used and vice versa.

The final step in this research is analyzing and comparing the FRGAs. This is done in chapter 6. The in-depth interviews were the basis of the results discussed in this chapter. The analysis of each chapter was based on the relevant codes. Table 6 shows the used codes per chapter. After these steps in the research approach, overall conclusions were made in chapter 7.

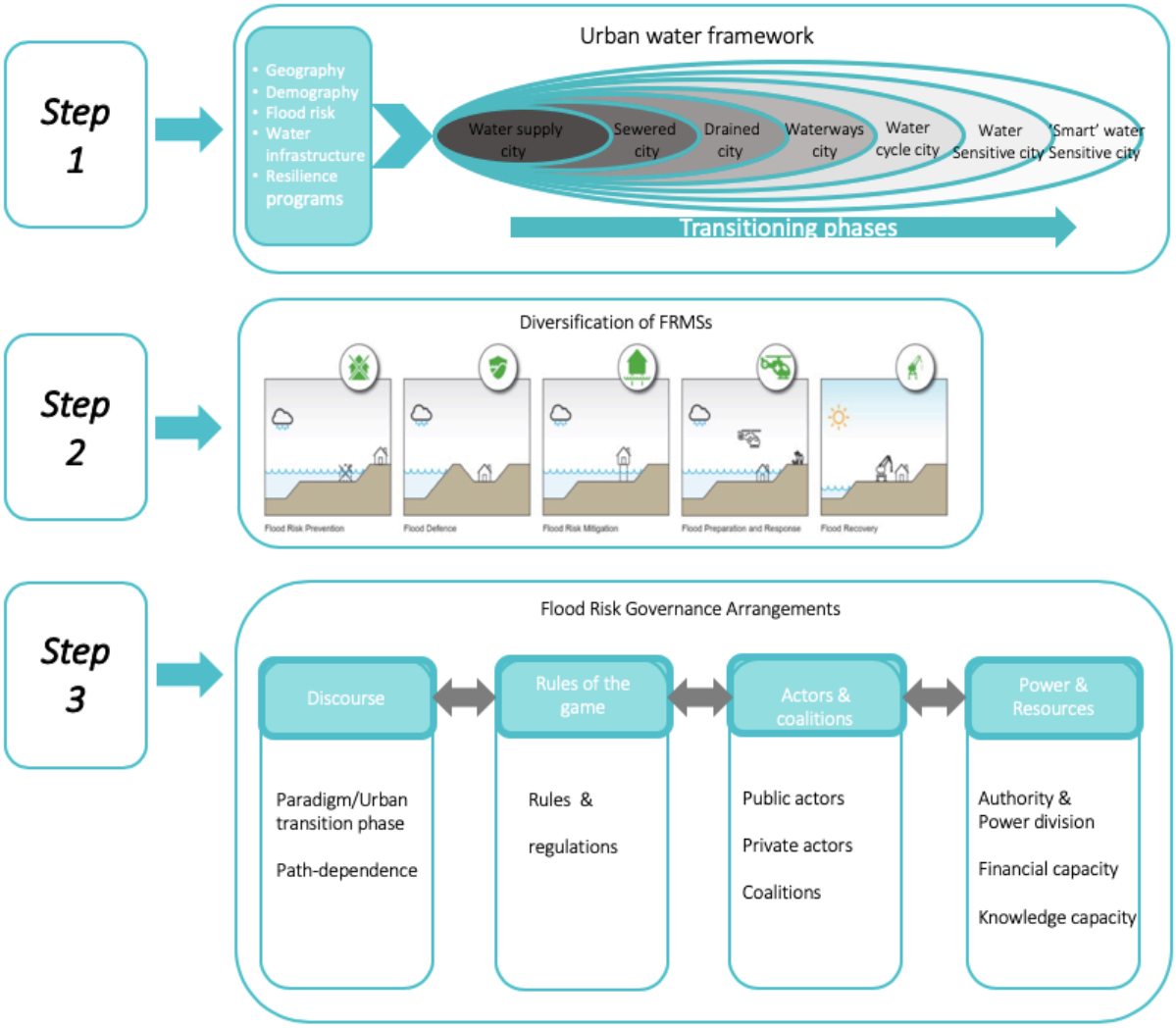


Figure 10: The research approach

3.3 RESEARCH METHODS

Research methods bring logical and structured links between the research questions and the collected data which has to be analyzed (Yin, 2014). Therefore, multiple research methods were used during this research. In table 3, a connection has been made between the used research method, the research question and the relevant concepts per chapter. The following paragraphs will explain the used research methods.

Table 3: Research approach

Chapter	Research question	Research methods used	Theoretical concepts used
2	How can urban flood resilience be analyzed?	Literature study	- Urban water framework - FRMSs - FRGAs
4	What is the context of the selected cities?	Desk research In-depth interviews	Context description: - Urban water framework - Urban flooding
5	How is FRM approached in the urban areas and what FRMSs are used?	In-depth interviews Comparative research	- Flood Risk Management strategies
6	Are the FRGAs organized in such a way that they enable a diversification of FRMSs?	In-depth interviews Comparative research	- Flood Risk Governance Arrangements

LITERATURE STUDY

The first research method used was the literature study. The purpose of a literature study is: identifying the references that are most appropriate for the conducted research (Healey & Healey, 2010). The literature study is therefore not just a summary of concepts, but a critical discussion of the relevant scientific information which eventually forms the theoretical framework. Chapter 2 is based on the interpretations and analysis of the primary sources.

As table 3 shows, is chapter 2 the result of this research method. Through multiple portals such as: Google Scholar, SmartCat and relevant books, relevant literature was gathered. These portals led to lots of articles about resilience and to the more specific flood resilience literature. To not extend too much on all the different aspects of resilience, there has been a focus on the more specific literature by using key words during the search. Key words such as: 'Flood resilience', 'Flood risk management', 'Flood risk management strategies', 'Flood risk governance arrangements', 'Floods/flooding' and 'water infrastructure' were used. For creating the theoretical framework, the most recent literature was used in the literature study. This makes the applied theory the most accurate and therefore better fit for doing research. The sources used were mostly from 2005 and to the present.

DESK RESEARCH

Next to the literature study, desk research was also executed as text analysis in this research. Whereas academic literature study limits itself to scientific research documents, desk research focuses on policy documents and other non-scientific documents. This method was used in chapter 4 to obtain case specific data. Every case has its own context, and to explain this context, websites and documents were analyzed. Table 4 gives an overview of the websites and documents used to acquire the case specific contexts.

Table 4: Documents used for desk research

Cases	Documents	Websites
Zwolle	- Zwolle bij de Hand 2016 - Gemeentelijk rioleringsplan Zwolle	- Zwolle.nl - Overijssel.nl - Oozo.nl - Drinkwaterplatform.nl
Norwich	- The state of Norwich: People, place, economy and wellbeing. - Norwich Urban Fringe Surface Water Drainage Scheme (Norfolk, 2018)	- Worldpopulationreviewer.com - north-norfolk.gov.uk - anglianwater.co.uk
Semarang	- Demography World Urban Areas 2018	- kppip.go.id - Worldatlas.com
HCMC	- Demography World Urban Areas 2018 - The Challenges of water governance in Ho Chi Minh City	- Weeronline.nl - Saigoneer.com - C40cities.org
Houston	- Demography World Urban Areas 2018 - Houston facts 2018	- Houstontx.gov - C40cities.org - Houston.org - Livescience.com

IN-DEPTH INTERVIEWS

The vast majority of the data gathering for this research took place through in-depth interviews. In this research method data collection was accomplished through conversation in the form of interviews (Yin, 2014). During the interviews, case specific participants verbally explain relevant issues, which was recorded by the researcher (Yin, 2014). The participants needed to have insights on the topic (Longhurst, 2010), as the goal of the in-depth interviews was to gather case specific information on FRM and to analyze the existing FRGAs. This required participants to have case specific knowledge and to be experts in the field of water management. Based on these requirements, interviewees were selected. Table 5 gives an overview of the interviewees, their role in the water management field and the case of interest.

Due to long distance, it was not possible to perform all interviews face-to-face. Doing face-to-face interviews was preferred, as it makes them more personal. Elaborating on relevant aspects is easier when interviews are face-to-face, as less effort has to be made to ask follow-up questions (Longhurst, 2010). To limit the consequences of not interviewing face-to-face due to distance, these interviews where held through Skype. This way the interviews were still face-to-face, and non-verbal communication could still be interpreted by the researcher.

During the interviews the researcher made use of an interview guide (Appendix 1). The questions in this guide where open questions, with possible follow-up questions (Gupta et al., 2010). This form of questioning made it possible for the participant to elaborate on the answers. In the questions' technical language and indicator words such as; strong, little, most etc. were avoided as much as possible (Gupta et al., 2010). The use of the interview guide helped the researcher stick to relevant topics during the interview (Gupta et al., 2010). The structure of the guide was based upon the relevant concepts from the theoretical framework (figure 9). Although this structure was useful, the interview guide was adjusted to optimize its relevance to each specific case. Next to altering the interview guide to each specific case, the in-depth interviews did also follow a semi-structured form. This semi-structured form kept the interviews flexible and gave the possibility to dive deeper into specific questions of the interviews (Longhurst, 2010). For each city two interviews were conducted, thus to enhance the quality of the research (Clifford et al., 2010).

During the interviews, sound recordings were made. These recordings made it possible for the researcher to transcribe the interviews literally. The recordings were made in mutual agreement with the interviewees. Before the start of each interview permission was asked to record the interview. With the use of the recordings, transcripts of the interviews were made and coded with the use of Atlas.ti. The transcriptions of the interviews can be found in Appendix 3 till 12.

Table 5: Interviewee overview

Interviewee	Role	Case	Form of interview
1	Leading professional in Urban Flood Resilience at RHDHV	Zwolle	Face-to-face
2	Municipal advisor of civil engineering	Zwolle	Face-to-face
3	Leading professional in Urban Flood Resilience at RHDHV	Norwich	Face-to-face
4	Governance and water strategist at RHDHV	Norwich	Skype
5	Associate director and project manager at RHDHV	Semarang	Skype
6	Flood Resilience Officer for 100 resilient cities	Semarang	Skype
7	Flood resilience consultant at RHDHV	HCMC	Skype
8	Urban delta expert and civil engineer (Next-blue)	HCMC	Face-to-face
9	Urban planner and design graduate (Harvard)	Houston	Skype
10	The Resilience Officer of Houston	Houston	Skype

COMPARATIVE RESEARCH

The goal of this research is to get an understanding of the FRGAs of urban areas and to answer the main question: '*How do Flood Risk Governance Arrangements affect the flood resilience of urban areas, can lessons be learned from other areas?*' In order to find a conclusion, different cities were analyzed in this research and needed to be compared. This is called comparative research. As flooding is not a unique problem, but one in that many cities have to consider, it is relevant to look at other areas and their approaches to flood resilience. Through comparisons cities can learn from past experiences of other cities, which helps to gather an understanding of the problems (Sartori, 1991).

According to Sartori (1991), cities can be compared as they share properties. Shared properties like water challenges and the approach to resilience can be compared. Properties like size and shape cannot be shared. Although these later two are not comparable, they are relevant for the context. Therefore, chapter 4 will outline the context of each urban area, including: geography, demography, flood risk, water infrastructure and the flood resilience programs cities are part of. This will give the context needed to understand the comparisons made in chapter 5 & 6. In chapter 5 the FRMSs of the urban areas are compared. And the comparison of the FRGAs will follow in chapter 6.

3.4 DATA-ANALYSIS

After the data gathering, multiple analyzes were made. This section explains how the collected data was analyzed with the use of Atlas.ti.

After transcribing the conducted interviews all of the transcriptions were coded. Codes can be described as: *"A way of evaluating and organizing data in an effort to understand meanings in a text"* (Cope, 2010 p.441). Coding helps with identifying categories and patterns within the analyzed transcripts. There is no prescribed method for coding (Friese, 2014), therefore the used codes are based on the relevant concepts from the conceptual framework. The used codes can be found in table 6. This code book helped the researcher to structure the coding of interviews. Linking the relevant concepts to parts of the interviews makes it easier to analyze the results. This analysis was done with the use of Atlas.ti (Version 8.2.3). Atlas.ti is a program which provides a researcher with tools to make qualitative data analysis more comprehensible (Friese, 2014).

Table 6: Code book

Chapter	Code Group	Code
4	Context	Geography
		Demography
		(Water) Challenges
		Urban flooding
		Urban water framework
		Resilient programs
5	FRMSs	Defense
		Prevention
		Mitigation
		Preparation & response
		Recovery
6	FRGAs	Discourse
		Rules of the game
		Actors & coalitions
		Power & resources

3.5 ETHICS

During the study the researcher kept in mind that she was an intern at RHDHV. Since the company wants to take a prominent role in the field of flood resilience, this was important to take into consideration. Although this might have influenced the research, this was not the case. Questions about own influence on flood resilience were not asked, only the city's approach to resilience itself. When the company was mentioned, this was for plans that are being developed, which partly explains the wish of a city for implementing new strategies. Interviews with participants from outside the company, the internship was not experienced as limiting. Participants were very willing to share information about city context, strategy use and the governance arrangements of the specific city.

Due to large distance some interviews were conducted through Skype or over the phone. As people tend to elaborate more when talking face to face, the conversations were shorter via Skype or phone. This consequence has been noted by the researcher. Although this approach did not lead to missing answers, sometimes the answers were less detailed than the face to face interviews.

A negative aspect of the use of in-depth interviews was the possibility of forming own interpretations of the given answers. To limit this possibility, the researcher has conducted two interviews for each case. This way both interviews are used as argumentation for the results.

There is quite a substantial difference among the urban areas in this comparison. These differences are in terms of physical conditions, the actual flood risk and the experienced floods. The point of departure also differs considerably with regards to the urban water framework, the FRMSs and the FRGAs. This does not mean that the urban areas cannot be compared, as this was also the case in Hegger et al. (2016). But the context of each urban area needs to be understood. This chapter will focus on answering the following sub-question: '*What is the context of the selected cities?*' This question will be answered by explaining the characteristics of the cases. The characteristics are: the geography, the demography, the flood risk, the water infrastructure and the resilience programs. Based on these characteristics the place in the water infrastructure framework is determined. This is of importance, as it explains the initial choices made within FRG (Wiering et al., 2017), and it forms the basis of the discourse dimension.

4.1 ZWOLLE: A WATER CYCLE CITY

GEOGRAPHY

Zwolle is a city in the Netherlands, a delta country. Zwolle itself is also placed in the midst of this delta, between the rivers IJssel and Vecht (Figure 10).

As the areas surrounding Zwolle lie higher than the city, water will find its way through this urbanized area. The total size of the urban area of Zwolle is 119 square km (Oozo.nl, 2018), of which 805 hectares consists of water in the form of rivers, lakes and other water surfaces.

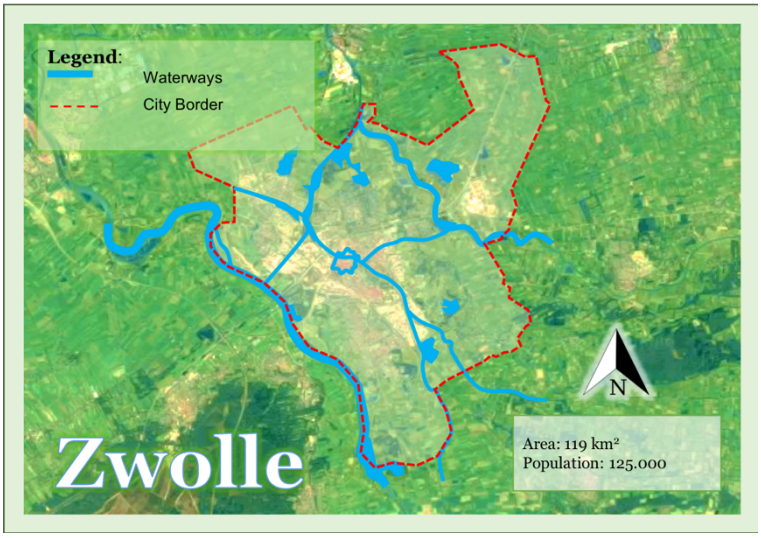


Figure 11: Map of Zwolle

DEMOGRAPHY

Just as the rest of the Netherlands, Zwolle is a densely populated area. At the start of 2017, approximately 125.000 people lived in Zwolle (Zwolle, 2018). Population density therefore is around 1.050 people per square km. It is predicted that the population will continue to increase. Due to the central location of the city of Zwolle, this is also a booming business area. Exact numbers are difficult to give as Zwolle is part of an economic region, including 20

municipalities which partially overlay 4 provinces. (Regio Zwolle, 2017). But there is a growing number of businesses in the city, with a total of 8.782 in 2016 (Zwolle, 2018).

FLOOD RISK

The geographic circumstances together with the demographics of Zwolle make the city vulnerable to floods. The most likely forms in which the floods present themselves in Zwolle is in the form of fluvial flooding or pluvial flooding. Fluvial flooding is due to the multiple rivers that pass the city. Higher intensity in rainfall causes pluvial floods as well.

WATER INFRASTRUCTURE

Although the city is susceptible to flooding, the entire water infrastructure is well in place. Water supply is due to the Dutch 'Drinkwater wet' which is well-established in the Netherlands and therefore also in Zwolle (Drinkwater platform, 2018). There is also a well-established sewerage system, which is maintained on a yearly basis and replaced by the just in time principle to be more sustainable (Gemeente Zwolle, 2016). Projects which concern water mostly incorporate multiple aspects at the same time such as: water safety, improving the livability, waterway traffic improvement, water supply and nature and recreation (Provincie Overijssel, 2018).

RESILIENCE PROGRAMS

Zwolle is making efforts to get to the next phase of the water infrastructure framework by trying to become resilient. By being part of two resilience programs, Zwolle is making steps towards a flood resilient urban area. The first program is CATCH, a resilience program consisting of multiple cities in Europe (Northsearegion, 2018). The objective of this program is to accelerate the redesign of urban water management, so cities can become climate resilient. The program focuses on midsize cities in the North Sea Region of Europe. Projects in the CATCh program are based on the Water Sensitive Cities theory.

The other program is one between various cities within the Netherlands and is called 'City Deal' (City Deal Klimaatadaptatie, 2018). This program focuses on cities within the Netherlands and wants to enhance cities approaches for climate adaptation. Learning, innovating and experimenting are key concepts in this program.

URBAN WATER TRANSITION PHASE

Based on the described characteristics, a position in the urban water framework can be given to Zwolle. This position can be qualified as being in the 'water cycle city' phase, as fit-for purpose solutions are being considered and attention is given to the limits of the natural resources. Further transitions can be noticed towards the 'water sensitive city' phase. By being part of the resilience programs, Zwolle shows ambitions of developing into a livable and

sustainable city with a balance between the built and natural environment. Evan though, water supply and wastewater discharge can be taken for granted, water is used in a sensitive way.

4.2 NORWICH: A DRAINED CITY

GEOGRAPHY

Norwich is a city in Great Britain. Norwich is close to the sea but is not connected with it, although water runs through the city in the form of a river. The river Wensum merges with the river Yare when it has past the urban area of Norwich. The total size of the area is about 39 square km. Therefore, Norwich can be considered as a minor sized city (figure 11).

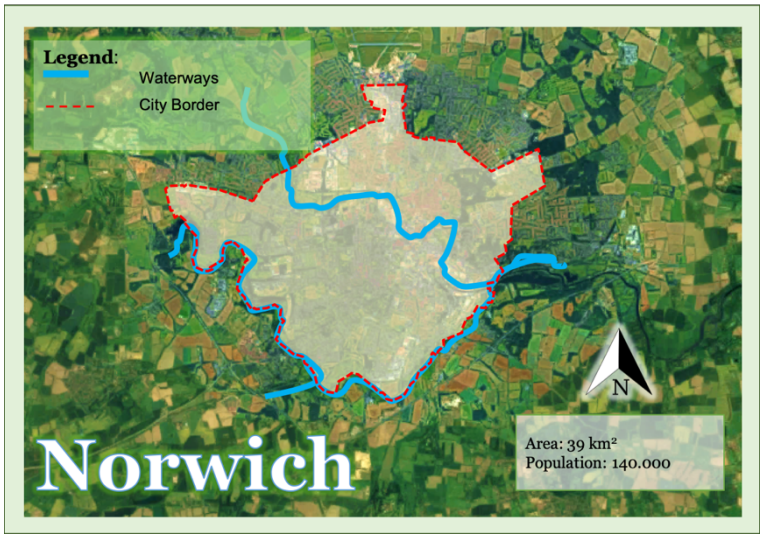


Figure 12: Map of Norwich

DEMOGRAPHY

Although the size of Norwich is not considered large, for its size it has a large population. At the start of 2017 the population size of Norwich was approximately 140.000 inhabitants (Norwich City Council, 2018). This comes done to around 3.600 people per square km.

FLOOD RISK

Just like Zwolle, Norwich, due to its geographic circumstances and demographics is vulnerable to floods. The river that passes the city and runs through the city can cause fluvial types of floods. Next to those types of flooding, high intensity rainfall can cause pluvial floods in Norwich.

WATER INFRASTRUCTURE

The water supply in Norwich is mostly provided by Anglian Water. Besides the water supply provided by Anglian Water, it is to some extent also possible to have a private water supply. About 450 of these private water supplies are in use in the whole district of North Norfolk, which Norwich is part of (North-Norfolk, 2018). Water supply therefore is available in Norwich. Anglian water is also responsible for the water recycling services in the area (Anglian water, 2018). Looking at the water infrastructure of Norwich, most investments are made in the

drainage of the area. In April 2015 a funding of 9.1 million pounds was awarded for surface water infrastructure improvements. In late February 2018 these drainage projects were finalized with a result of almost 10 miles of new carrier pipes and 270 new water chambers being installed (Norfolk, 2018).

RESILIENCE PROGRAMS

Norwich acknowledges that new approaches are needed for the urban area and wants to go beyond the drained city. Therefore, the city joined the CATCH resilient program. This program, as already mentioned, has as objective accelerating the redesign of urban water management in midsized cities. The program is based on the Water Sensitive Cities theory. Just as Zwolle, Norwich is part of this program with multiple other cities in Europe. New projects are put into place to enhance the flood resilience of the area (Northsearegion, 2018).

URBAN WATER TRANSITION PHASE

Based on the described characteristics, a position in the urban water framework can be given to Norwich. This position can be qualified as being in the 'drained city' phase, as most investments are made to improve the drainage of the area. Even though the focus in water management lies on the drainage, by joining the CATCH resilient program Norwich shows that the area wants to transition towards a new phase. This will be in small steps by first transitioning towards the waterway city, but more attention will be given to service functions of the existing infrastructure and environmental protection.

4.3 SEMARANG: A WATER SUPPLY CITY

GEOGRAPHY

Semarang lays in the north of the Indonesian island Java. This urban area is a delta with direct connection to the sea and with numerous rivers running through (figure 12). This delta lies very low, at some points it is at the same level as the sea. The size of the total urban area is of approximately 272 square km (Demographia, 2018).

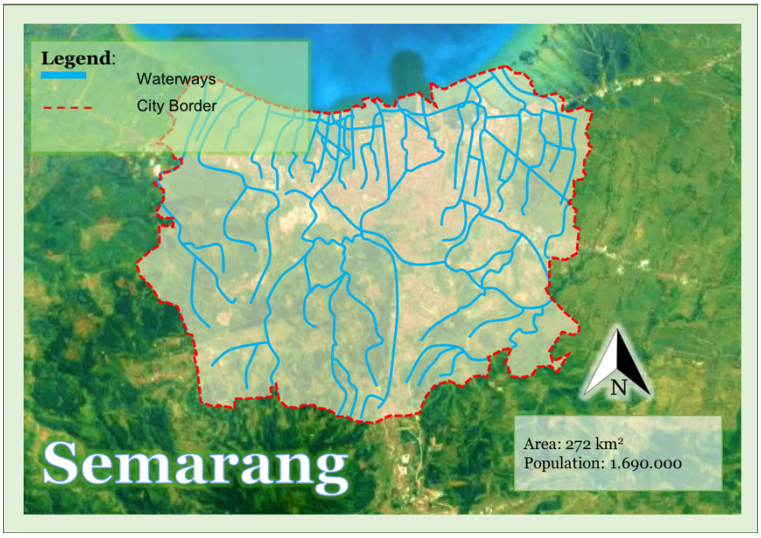


Figure 13: Map of Semarang

DEMOGRAPHY

The total population of Semarang is approximately 1,69 million people (Demographia, 2018). This means that 6.200 people live on the same square km. Semarang is 5th most populated city of Indonesia and is an important shipping port in central Java (World Atlas, 2017).

FLOOD RISK

The delta area in which Semarang is located is very low lying and the area is therefore very vulnerable to flooding. The types of flooding that can occur in this area are coastal flooding due to the sea, fluvial flooding due to all the rivers that run through the area and also pluvial flooding due to high intensity rainfall. Next to the flood risk due to the different types of flooding is the urban area also experiencing subsidence, which increases the flood risk of the urban area.

WATER INFRASTUCTURE

The urban area Semarang still has a long way to go on the water infrastructure framework. For now, it still is in the water supply phase. Water supply is still challenging in this urban area. Many people do not have access to fresh water supply, which leads to uncontrolled groundwater uses. This is also the main reason for the subsidence of the area. Although projects are in place to enhance the current water supply (KPPIP, 2016), there still is a long way to go.

RISILIENCE PROGRAMS

That Semarang is vulnerable is also acknowledged by the city itself. Therefore, the city is taking part in the 100 resilient city program. This program wants to help cities around the world to overcome physical, social and economic challenges in order to become resilient. The Rockefeller Foundation is the pioneer of this program (100 Resilient Cities, 2018). By installing a resilience officer and releasing a Resilience Strategy in 2016, the first efforts towards flood resilience are being made (100 Resilient Cities, 2018). The Resilience strategy of Semarang focuses on six main pillars, of which water is separated in two pillars. One pillar focuses water scarcity and another pillar focuses on disaster such as flooding (100 Resilient Cities, 2016).

URBAN WATER TRANSITION PHASE

Based on the described characteristics, a position in the urban water framework can be given to Semarang. This position can be qualified as being in the ‘water supply’ phase, as having safe and secure fresh water is still not accessible to all inhabitants of Semarang. With the expansion of the city, this keeps being a barrier for transitioning towards a new phase in the urban water framework.

4.4 HO CHI MINH CITY: A WATER SUPPLY AND SEWERED CITY

GEOGRAPHY

Ho Chi Minh City is located in the south of Vietnam. The urban area lies in the delta of the Saigon River, also called the Mekong delta and the city has a connection to the sea (figure 13). The total size of the urban area is about 1.580 square km (Demographia, 2018). With that size HCMC is the biggest city in Vietnam (van Leeuwen et al., 2015).

Figure 14: Map of Ho Chi Minh City

DEMOGRAPHY

The total population of HCMC is approximately 10,69 million people (Demographia, 2018). This means that the population density of the area is 6.800 people per square km. This makes HCMC the most densely populated case of this research. HCMC is a very important hub in Vietnam with high economic activity (van Leeuwen et al., 2015).

FLOOD RISK

Due to the location HCMC is vulnerable to multiple types of flooding. The Saigon River can cause fluvial flooding. Next to the river the sea can cause coastal flooding due to the connection that HCMC has with it. Furthermore, just as in the other cities, high intensity rainfall can also cause flooding in HCMC. These types of flooding especially occur in this urban area during the rainy season, which is from May until October (Weeronline, 2018). During this period the area is also susceptible to hurricanes, which increases the flood risk.

WATER INFRASTRUCTURE

The water supply company SAWACO (Saigon Water Company) is responsible for water distribution, exploitation and treatment in HCMC (van Leeuwen et al., 2015). Most of the water supply originates from the Saigon River, Dong Nai River, groundwater and lastly rain. Although the water supply has increased over the years, the number of households connected to the main water supply is still low. 34% of the households still obtain water from wells and 19% from other small water suppliers (van Leeuwen et al., 2015). As for the sewer system, during French colonization former Saigon was turned in an urban center with the most modern infrastructure and sewer system (Saigoneer, 2015). This system now is outdated and in need of replacement.

RESILIENCE PROGRAM

Just as the other cities HCMC is also part of a resilience program. HCMC is committed to the c40 cities as a resilience program. This program focuses on multiple aspects of resilience, with flood resilience being one of them. HCMC is one of the overall 96 participating megacities (C40 cities, 2018). The C40 program supports cities to share knowledge and collaborate effectively in order to drive sustainable action for approaching climate change (C40 cities, 2018).

URBAN WATER TRANSITION PHASE

Based on the described characteristics, a position in the urban water framework can be given to HCMC. This position for HCMC can be qualified as balancing between the 'water supply city' phase and the 'sewered city' phase, although water supply still is not accessible to all inhabitants of HCMC during French colonization a sewerage system was developed in the city. Over time the city expanded, but the sewerage system did not develop at the same speed as the city. Both, the water supply and the sewerage system, are currently under review in the urban area as it has not been implemented to its best extend yet.

4.5 HOUSTON: A WATERWAY CITY

GEOGRAPHY

The urban area of Houston lies in the South of the United States. Houston has no direct connection to the sea but has a small connection with Galveston bay. There is also a river that runs through the urban area and mouths in Galveston bay (figure 14). The total size of the urban area is approximately 4.841 square km (Demographia, 2018). This makes Houston the largest agglomeration of the research.

Figure 15: Map of Houston

DEMOGRAPHY

Houston counts approximately 6,285 million inhabitants (Demographia, 2018). This comes down to a population density of 1.100 people per square km. Houston is an important economic hub in the United States. It houses the largest export market of the U.S. (GHP, 2018a).

FLOOD RISK

Comparing to the other urban areas, Houston experiences another type of flood risk. This flood risk mostly exists because of the yearly returning hurricane season from June until end of November (Live science, 2018). Occurring hurricanes can cause fluvial, coastal and high intensity rainfall flooding. Although Houston is not directly connected to the sea, water can be pushed upstream in the bay which can cause floods.

WATER INFRASTUCTURE

Water supply, a sewer system and drainage are in place in Houston. When it comes to water infrastructure the main focus lies on the water way function, as Houston houses a great export market, shipment and the waterway function in this city needs to be well established (GHP, 2018b). The functions of existing infrastructure are challenged to serve as optimal as they can.

RESILIENCE PROGRAM

Houston also is part of the resilience program of C40 cities (C40 cities, 2018). Although the urban area is part of this program, it is not very proactive within the program. The city focuses more on enhancing the flood resilience on their own. For example, they have a resilience officer in place (City of Houston, 2018). Even though Houston is not very proactive in the C40 program, the city recently joined the 100 Resilient City program as well (100 Resilient Cities, 2018). Houston joined this resilience program based on a sponsorship from Shell (100 Resilient Cities, 2018).

URBAN WATER TRANSITION PHASE

Based on the described characteristics, a position in the urban water framework can be given to Houston. This position can be qualified as being in the ‘waterways city’ phase, as the city focuses on the service functions of the existing infrastructure. The previous phases are well in place in the urban region of Houston. The city is on the verge of transitioning towards a ‘water cycle city’ as there is a growing understanding of the limits of natural resources, but more fit-for purpose developments still have to be developed. Enhancing the resilient programs of which Houston is part will help develop its water management to the ‘water cycle city’ phase.

CHAPTER 5: THE DIVERSIFICATION OF FLOOD RISK MANAGEMENT STRATEGIES

After analyzing the individual urban areas, a better understanding of the urban context and the (water) challenges has been gained. Each city experiences flood risk and has implemented strategies to decrease this risk. This chapter will analyze and compare the FRMSs in place. This will answer the third sub-question of this research, which is: '*How is Flood Risk Management approached in the urban areas and what FRMSs are used?*' First, the overall strategy usages of the urban areas will be pictured, followed by an analysis of the individual strategies used.

5.1 THE USE OF FLOOD RISK MANAGEMENT STRATEGIES

The results of the interviews made it possible to examine the strategies of each urban area; see table 7 for an overview. The table shows the urban areas and the FRMS used. A resilient city should not use just one dominant strategy, but a more diversified set of strategies which should be well aligned to each other. Based on table 7 it can be concluded that neither one of the urban areas have accomplished that in their FRM. The table shows the focus on strategies or the lack of strategy use.

Table 7: The use of FRMSs per city

		Zwolle	Norwich	Semarang	HCMC	Houston
Before flooding	Defense	High	Medium	Low	High	Medium/high
	Prevention	Medium/high	Medium	Low	Low	Medium/high
	Mitigation	Medium/low	Medium	Medium	Medium	Low
During flooding	Preparation	Medium	Medium	High	Medium/low	Medium
	Response	Medium	Medium	High	Medium/low	Medium
After flooding	Recovery	Not applicable	High	Low	Low	Medium/high

Based on the table, it is not yet possible to call one of these urban areas flood resilient. It can be said that each urban area has a key strategy for dealing with flood risks. This is remarkable since all the cases want to become resilient and therefore need the wide range of strategies. Important to note is that although cities have a focus strategy, this does not imply that the execution/implementation is always successful. The following sections will elaborate on each strategy and its use within the different urban areas.

FLOOD DEFENSE

For Zwolle and HCMC flood defense is the key FRMS, which is mostly due to their history. Zwolle mainly focuses on infrastructural works such as dikes to fight flood risk. Zwolle will keep using the dikes that are in place, but to make the city more livable, value will be added to the dikes by for instance making these dikes greener. A civil engineering advisor of the municipality of

Zwolle explained: "*There has been hundreds of millions invested in the dike reinforcements, […] but to make a livable city there also has to be added value to the dikes."*[1] Zwolle therefore, still has its focus on defense but is trying to broaden the functionality of the dikes.

In some cases, the use of defense strategies can have negative effects on the flood risk of an urban area. This is due to ongoing economic development after implementing hard infrastructure, which increased the flood risk (Depietri et al., 2012). A flood resilient consultant of RHDHV in HCMC explains how this is the case in HCMC: "*Ho Chi Minh City makes a lot of infrastructure investments, for example building new sluice gates […] but what also happens is that the river and rainwater are kept inside the city once the sluice gates are closed."* For HCMC it is therefore very relevant to diversify its FRMSs.

Houston also experiences an increased flood risk due to the implementation of hard infrastructure as flood defense. Inhabitants experience a false sense of security which is created by the defense strategy (Liao, 2014). Lack of maintenance on the defense infrastructure also increases the flood risk of Houston, as the capacity of the infrastructure decreases. This was shown during Harvey when the area of Houston flooded. Which is also explained by the quotation of the urban planner: "*The storm-water infrastructure could have worked, they just are not maintaining it well."* In all three of the mentioned cities, a more holistic approach needs to be considered.

In contrast to the cities that focus strongly on defense, Norwich and especially Semarang need to incorporate more defensive measures. "*The only defense there is are the existing mangroves"*[2] explains associate director and project manager of RHDHV in Indonesia about Semarang.

FLOOD PREVENTION

Table 7 shows that the other two strategies used before flooding receive less attention than the defense strategy; the prevention strategy being one of those two. Zwolle and Houston do make efforts to implement more preventive strategies. Due to the increase in flood events, the awareness rose for the need of change towards prevention. The increasing awareness of the vulnerability of an urban area for flooding can therefore be seen as a window of opportunity, which makes changes in strategies possible.

Hurricane Harvey provided a window of opportunity for the city of Houston to promote change. The rise of awareness directly after the storm was used to push more preventive measures during the rebuilding of the city. "*They have definably been trying to make people up stain from rebuilding, but it is like a mix"* the interviewed urban planner explains. Prevention still is a challenge as willingness is needed as well "*If they are not voluntary than we can't buy them out using federal dollars"* explains the Chief Resilience officer of Houston. The longer it takes to rebuild, the smaller the window of opportunity gets, as people forget and just want their lives to be back to normal.

Zwolle experiences another challenge which makes implementing preventive measures difficult, which is the availability of space. Creativity is needed to implement preventive measures when space is limited, for example reorganizing functions in the built area. As the leading professional in flood resilience of RHDHV in Zwolle states "*For the existing built area, we must consider reorganizing the functions"*[3] therefore, willingness and acceptance are needed "*Not everybody has accepted that idea yet"*[4] states the advisor of civil engineering.

Improvements can be made concerning the prevention strategy for all the cases, especially in HCMC and Semarang. Improvements of strategy use is needed, but as explained, doing so asks for acceptance and willingness to change.

FLOOD MITIGATION

Table 7, shows that the two urban areas who have a low focus on prevention and also to some extent on defense, have more focus on mitigation as a strategy before flooding. This might not be a very striking observation, as these cities flood regularly and therefore are adjusted to living with these floods. Mitigating measures are often small and done by the local people even when there are limited resources, such as elevating the market places on the streets by putting them on poles "*When it starts raining people just elevate their market stands and keep on selling their goods"*[5] tells the urban delta expert and civil engineer. This to minimize the effects of a flood, which is the goal of the mitigation strategy.

Mitigation strategies try to ensure the continuity of the daily activities during a flood event. For cities such as HCMC and Semarang, inhabitants have accepted to a certain extent that they need to live with the flood events. An urban delta expert and civil engineer who lived in HCMC explains how this is the case for HCMC: "*Till certain heights the people are flexible and invent ad hoc solutions to keep the water out."*[6] There are limits, at some point it will not be possible anymore to continue with daily activities during a flood.

The type of flood has an influence on the possibility to use this strategy (Sörensen et al., 2016). Both HCMC and Semarang mostly experience coastal flooding caused by the rising tides. This means that the water rises slowly, and people can see it coming. This gives inhabitants time to react with ad hoc solutions. During a storm or a sudden dike breach, this is not possible. Mitigating measures such as retention areas are therefore needed to mitigate other types of flood risks.

FLOOD PREPARATION

There is only one city which focuses on strategies that are used during a flood event, namely: Semarang. This focus in Semarang can easily be explained: as the city lacks focus on strategies before flooding events, there is a need for response and preparation strategies. One type of preparation strategy is implementing a warning system. Such a warning system enhances the capacity of citizens to prepare and respond to a flood event. In Semarang this type of measure

is being implemented. The resilience officer of Semarang explains how this helps the inhabitants of Semarang "*We have an early warning system for floods […] it develops a capacity within the community to prepare and respond to a flooding.*"

Since technology is growing, connecting new technologies in a smart way to these warning systems can enhance the capacity of the systems even more. Therefore, enhancing the infrastructure with these types of measures will lead to more resilient urban areas. The use of new technologies such as smartphones and other technology increases the range in which people can be reached and warned. People could even become part of this strategy themselves, by passing along relevant information such as high water levels in the streets etc. Progress is being made on these fronts. Multiple cities are already trying to implement such smart technologies. "*Inhabitants of Zwolle now have the possibility to pass along occurring flood sides through a mobile app, which is called the wet-feet map app*"[7] explains the leading professional in flood resilience in Zwolle. Other cities also are exploring the possibilities of this kind of technology and although it is not working to its full capacity yet, it is a start.

FLOOD RESPONSE

Flood response includes responsive measures to flood events such as evacuation. Semarang also has a strong focus on this strategy (table 7). The associate director and project manager of RHDHV in Semarang explains: "*What you see now is mainly response after floods, and not really preventive measures.*"[8] Other cities do have response measures to some extent, for example, emergency plans, but the focus on this strategy could be enhanced as it is of importance to have a quick and optimal response after floods.

The response strategy would also benefit from the implementation of more smart technologies. The associate director and project manager at RHDHV in Indonesia thinks that it would be most ideal if resilience would be part of smart city concept: "*Most ideally would be if it would be integrated as a part of the smart city concept.*"[9] Linking new technologies to the water system could for instance enhance the evacuation. For example, the emergency services could have quicker response blockades on the roads which are quickly visible in their system and a quicker route could be selected. Another example is connecting the hard infrastructure from the defense strategy to the response strategy in a way that sluice gates get closed when alarm systems go off.

FLOOD RECOVERY

Finally, there is the recovery strategy, which is a low priority for most of the cities, even though it is a very important strategy for a resilient city. Because flood resilience includes the possibility of a flood event, the city has to be able to recover from a flood event if they occur. Table 7 shows that Norwich and to a lesser extent Houston, are the only cities that have this strategy implemented, mostly in the form of insurance, so people can insure themselves against flood damage.

In Norwich, people are obligated to have insurance if they live in a flood prone area. An important reason for this obligation is the division of responsibilities in Great Britain, which is not designated for water safety. Implementing strategies therefore becomes a business case, where implementation will only be possible if there is a good return on investment. To make sure people can recover from a possible event, insurance is obligated: "*People can get insurance and are obligated to have insurance when they live in flood prone areas*"[10] noted the governance and water strategist in Norwich. Being dependent of economic benefits for implementing other strategies makes this strategy well implemented, as it gives some compensation for people if a flood event occurs.

During the recovery, there is often a window of opportunity for changes. As this strategy is used after a flood event, change is better accepted, which makes transformation possible. Depending on the severity of the flood, more drastic changes could be made. The FRGA's are often influenced due to a severe event; this gives room to adjust the FRGA's in a way that new FRMSs can be implemented. The question that remains is; could such change also occur without a flood disaster?

5.2 CASE SPECIFIC USE OF FLOOD RISK MANAGEMENT STRATEGIES

As previously discussed, the cities vary in their focus and usage of FRMSs. In this paragraph, the overall strategy use of each individual urban area will be given. For each urban area a graph will show the strategy focus to visualize the FRMSs in place.

ZWOLLE

Graph 1 shows a visual overview of the FRMSs used in Zwolle. Due to its history, there has long been a strong focus on the defensive strategy. Currently a shift can be noticed towards other strategy use, such as preventive measures.

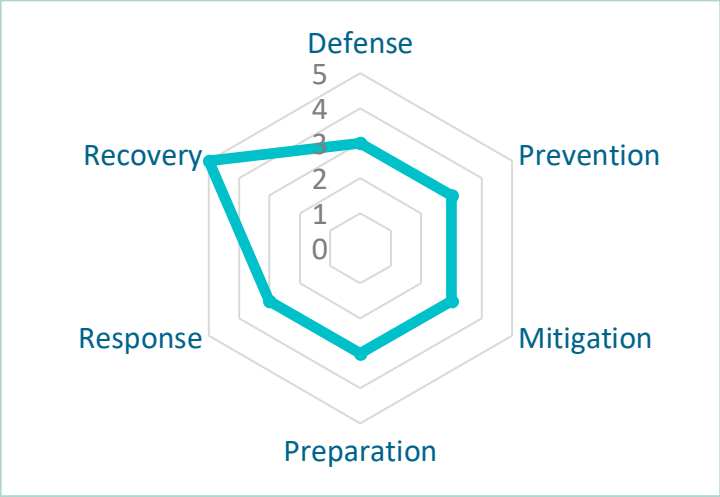
Graph 1: FRMSs use in Zwolle

Compared to the other strategies that can be implemented before flooding, mitigation is still lacking although efforts are being made. The preparation and response strategies are being used but not yet to their full capacity, therefore improvements in strategy use of these two strategies need to be made. Unfortunately, in Zwolle, insurance as part of the recovery strategy is not available. The recovery strategy is therefore still lacking behind. This can lead to complicated situations if the amount of water damage increases due to climate

change. Combining multiple strategies with the water infrastructure could also enhance Zwolle's resilience capacity.

NORWICH

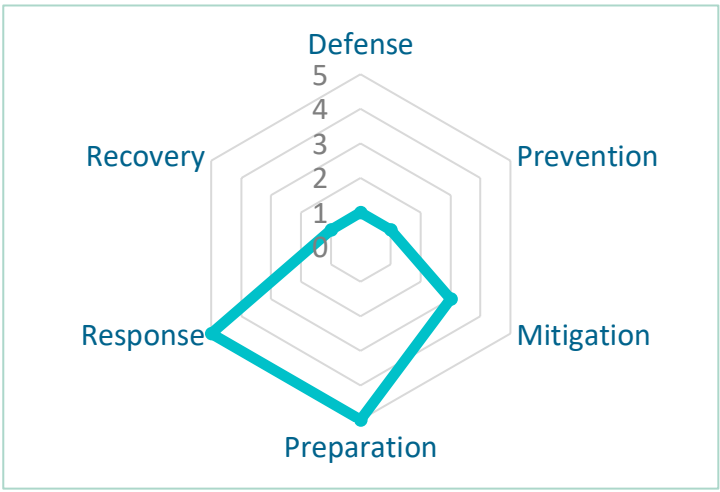
The FRMSs used in Norwich are shown in graph 2. The graph shows that the only strategy Norwich uses to its full extent is the recovery strategy. This is due to a lack of legal responsibility for water safety. The other FRMSs are used, but only when the return on investment is high enough for implementation of the strategy. In Norwich, flood risk management is approached from a very economic perspective. To ensure that citizens are able to recover from a possible flood event, there is a strong focus on the strategy after flooding, more specifically on measures such as insurances. Once again, this is based on economic aspects, as insurances engage in most of the economic activities. By implementing more smart technology, the flood resilience of Norwich can be enhanced. Improving the water infrastructure towards a more 'smart water sensitive city' would in this area not only benefit the flood prone area, but also the region as it will be less vulnerable.



Graph 2: FRMSs use in Norwich

SEMARANG

Semarang's focus mostly lies on both the response and preparation strategy as illustrated in graph 3. This is mostly due to the lack of other strategies. The strategy that is currently used most to limit flood damage before a flood event is mitigation. As this is not enough to keep areas from flooding, response and preparation are of great importance. These strategies are in place to warn people of an occurring flood event and how to respond to it. As for strategies focusing on recovery, these are very limited. An important part of the vulnerability of the urban area lies in the urban water infrastructure. Improving the water infrastructure would be an important part of enhancing the resilience of the area. Although it will be challenging, being



Graph 3: FRMSs use in Semarang

able to by-pass certain phases of the urban water framework would speed up the process of becoming resilient, but this requires commitment and resources.

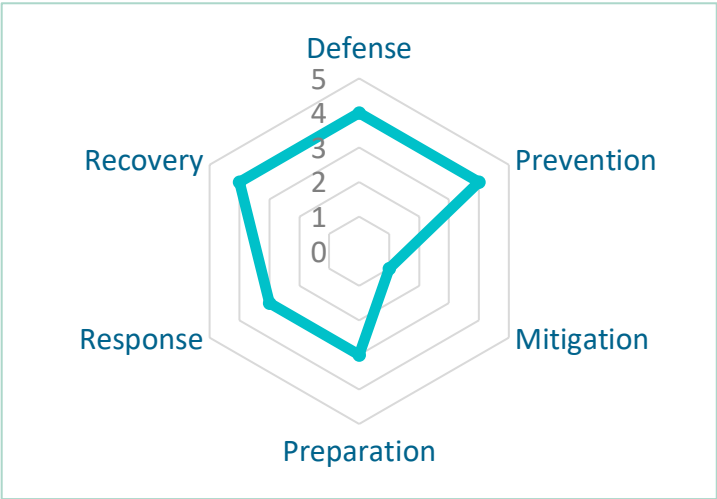
HO CHI MINH CITY

In contrast to Semarang, HCMC does have a very strong focus especially on the defense strategy (Graph 4). In the urban area a lot of hard infrastructure is in place, which also makes people less aware of the actual flood risk in the area. The mitigation strategy used to limit flood damage is also in place. The focus on the other strategies is still lacking. Many improvements still need to be implemented. For example, the flood warnings are not working well. As for the recovery strategy, there is limited insurance. The ones who have insurance are mostly foreign companies that have an office in HCMC. Improving the urban water infrastructure will, to a large extend, be of importance for this urban area to become flood resilient.

Graph 4: FRMSs use in HCMC

HOUSTON

The overview of Houston's use of FRMS is shown in graph 5. It shows that none of the FRMSs are used to their full capacity. This is disturbing especially when considering the hurricanes, which frequently pas this urban area. Strategies before flooding should be well implemented to make sure the area has limited damages. The biggest concern lies with the flood defense strategy where a lack of maintenance has a negative influence on the defense capacity of the hard infrastructure. Since Hurricane Harvey, there has been a rise in awareness. It has been noted that the defense strategy is not working to its full capacity and that other strategies need to be considered. This shows in the shift towards more preventive strategy use since Hurricane Harvey. The city made use of its window of opportunity. Since severe weather events like Harvey do occur regularly, the recovery strategy has been noted as an important strategy. Also, improvements on the urban water infrastructure will help make Houston more resilient.



Graph 5: FRMSs use in Houston

These visualizations show that each city uses the FRMSs differently. The urban areas use a different set of FRMSs and have other focus points. All the FRMSs are present but to a different degree. Diversification of strategies is still needed in all of the urban areas (Matczak et al., 2016). As theory explains, this is due to the FRGAs in a city. The way the FRGAs are organized in a city greatly determines how the city implements the FRMSs. Therefore, the FRGAs of the cities will be analyzed in the next chapter.

CHAPTER 6: ORGANIZING THE FLOOD RISK MANAGEMENT STRATEGIES FOR CHANGE

The implementation of FRMSs in urban areas depends on the overall FRGAs (Matczak et al., 2016). These FRGAs consist of (1) *the actors and coalitions* involved in flood risk management policy domains, (2) *the power and resources* of the involved actors and (3) *the rules of the game* within the current policy (4) *discourse*. In this chapter the FRGAs of the urban areas will be analyzed. This analysis will give an answer to the last sub-question: '*Are the FRGAs organized in such a way that they enable diversification of the FRMSs?*' The analysis will be done based on the data collected during the research. What influences the FRGAs have on the FRMSs will help in understanding the dynamics that FRGAs have on implementing new strategies. Some governance arrangements can have a bigger effect on the implementation than others. First, each governance arrangement will be analyzed individually, followed by an overall impression of the urban FRGAs.

6.1 THE DISCOURSE

The discourse dimension can be built up from multiple aspects, as explained in chapter 2. Table 8 shows the different aspects that make the urban discourse of each city. The following paragraphs will explain why the dimension is constructed in this manner.

Table 8: Build up of the discourse arrangement

	Zwolle	Norwich	Semarang	HCMC	Houston
Paradigm/urban water phase	Water cycle city	Drained city	Water supply city	Water supply/sewered city	Waterway city
Path-dependence	Strong path-dependence based on technical measures	Strong path-dependence based on technical measures	Strong path-dependence based on responding to floods	Strong path-dependence based on defense and mitigation measures	Strong path-dependence based on technical measures

PARADIGM/URBAN WATER PHASE

The paradigm in which the urban areas can be placed, is based on the water infrastructure phase of the urban area (Chapter 4). The water infrastructure phase influences its city's priorities. For example, Semarang and HCMC have different priorities than Houston and Zwolle, since these cities are at opposite ends of the urban water framework.

A lower position on the urban water framework will mean other priorities are concerning the water challenges. For example: Semarang's priorities consist of in providing basic water needs

to its population, therefore ignoring other water challenges such as a sewerage system "*Yes, water supply is troublesome, everybody is just extracting water as they have water shortage"*[11], explains the associate director and project manager at RHDHV in Indonesia. Just as he explains that sewerage system is underdeveloped: *"Well sewerage in Indonesia as a whole is a problem, we don't have a sewerage system"*[12]

In contrast to Semarang, Houston sees water from a completely different perspective, which is a more economic one. A shift can be noticed from this economic perspective to a more holistic view with historical value of water, explains an urban planner "*Historically water was mostly seen as being of economic importance, as it was used for product transportation. Recently more cultural value is given to water, it is seen more as cultural heritage as it has shaped Houston this way".* The paradigm of the area determines to a certain extent the priorities concerning the water challenges. To be able to change the paradigm the path-dependence of the area needs to be considered as well.

PATH-DEPENDENCE

The history of the urban area greatly influences the paradigm of the area and therefore the water infrastructure in place. The path that the area took over time has formed and constructed the area bit by bit. The stronger this historical path has been on forming the urban area, the harder it will be to change the discourse. Therefore, as table 8 shows, all of the urban areas will have difficulties in changing the path, as each of them has a strong path-dependence. Although these paths are not based on the same flood management strategies, shifting to a more diverse set of strategies will require effort in all of the urban areas.

In multiple areas, as mentioned by the interviewees, a shift in thinking is presenting itself. For example, in HCMC a more holistic view to water is being formed, where it is not only a basic need but also seen as a form of leisure: "*Paths are built where people can walk, sit and have coffee. This is an actual change"* according to flood resilience consultant of RHDHV in HCMC. Water is not the enemy anymore, it is more accepted and less resisted.

Changing the path can be difficult but taking advantage of lessons learned from past disasters can be helpful to accomplish some changes. In Houston such a window of opportunity occurred when Hurricane Harvey struck "*There was a silver lining as a result of Harvey. With the recovery money that is going to Houston from the federal government, Houston might be able to fund and implement resilience projects"* explains the resilience officer of Houston. These resilience projects would not only be implementing infrastructural works as has long been the path for Houston, but also by making space for the water. The only problem is that windows of opportunity pass and there is a need to make use of it quickly: *"About 5000 people were interested in buying out of the area […] dollars have not arrived quick enough, so people have decided to stay"* tells the resilience officer of Houston about the buy-out process after Hurricane Harvey. Unfortunately, Houston has a strong path-dependence, the stronger this path-dependence, the more difficult it is to change the course and get into a new paradigm.

6.2 THE RULES OF THE GAME

The rules of the game as an arrangement can be built up from multiple aspects, as explained in chapter 2. As this arrangement is too complex to focus on all the aspects, the most relevant rules and regulations for implementing resilience (table 9) will be explained in the following paragraph.

Table 9: Build up of the rules of the game arrangement

	Zwolle	Norwich	Semarang	HCMC	Houston
Rules and regulations	Resilience as a strategy will be implemented in the "omgevingsvisie"	Flood Water-management Act 2011	Governmental decrees needed for implementing policies	No strict law	No zoning law compared to the rest of the U.S.
	Development of policies to stimulate resilience and some existing policies already enhance resilience	Multiple authorities have permissive powers	Resilience is implemented in the midterm plan of the mayor	All projects need to align with the city masterplan	Development done according to the city plan and development plans
	Norms for protection level	Strict rules for living in flood prone areas	New developments may not aggravate the current situation		Moratoriums can be given to prevent rebuilding in sensitive area's

RULES AND REGULATIONS

A change of strategy has to be enabled by the rules and regulations in place. Without appropriate rules and regulations for resilience, implementation and enforcement of new strategies will be impossible. As the urban areas are working on becoming resilient, all of them need to have rules and regulations that accommodate this goal. It can be said that all of the cities have to put into place some changes in the rules of the game.

The rules of the game for HCMC and Semarang are in need of improvements as well as being enforced. As the urban delta expert and civil engineer explains about HCMC: "*There are lots of rules […] those rules are there but they are just not being lived up to*"[13] So there are rules, but these need to be appropriate for resilience and need to be enforced, otherwise people can just do what they please. Enforcement is also a challenge for Semarang "*In principle is enforcement in Indonesia ten times nothing*"[14] is what associate director and project manager at RHDHV explains about Semarang's inability to enforce the rules of the game.

Houston and Zwolle are both altering the rules and regulations to better accommodate resilient strategies. For Houston this is mostly due to the window of opportunity left by Hurricane

Harvey. In contrast to other cities in the U.S., Houston does not have zoning regulations; building and rebuilding could be done in almost every location. "*I think the only nuance to Houston that gives its planning fame is that it doesn't have zoning. It has a planning department […] but it does not have zoning"* tells the urban planner about Houston. And implementing zoning is not being considered: "*that is just the lifestyle, so I do not think this is going to be a moment where zoning ordinate is going to be adopted"* The city is becoming more aware of its vulnerabilities, the need for land acquisition is being accepted. The Chief resilience officer of Houston is therefore working on increasing rules for developments in flood prone areas.

As for the urban area of Zwolle, to enhance the flood resilience, efforts are being made to implement new strategies into the current rules and regulations. The city wants to ensure that changing the strategies is according to the rules: "*We need to have regulations to guarantee the ability to enforce resilient approaches […] This guarantee, with resilience goals will be in the omgevingsvisie"*[15] Without it being written down, implementation cannot be guaranteed explains leading professional in urban flood resilience at RHDHV.

This leaves Norwich, where the law states that nobody is responsible for a certain level of water security. This makes it difficult to set clear rules and regulations for the involved actors. Therefore, the Water Management Act is put in place in 2011. In this act permissive powers are given to authorities within the water domain which stimulates interactions between these domains. As there is no accountability, there are strict rules for development in flood prone areas: "*Everything is focused on prevention of building in the flood prone areas, this starts with a system which indicates the flood zones"*[16] explains the governance and water strategist of RHDHV in Norwich. Due to this law, it will be very hard for Norwich to implement rules and regulations for more resilience strategies.

6.3 THE ACTORS AND COALITIONS

This arrangement also consists of multiple aspects, as explained in chapter 2. Table 10 shows the different aspects that make this arrangement for each urban area. To implement new FRMSs this arrangement is of importance as the involved actors need to be willing to improve and reform. Next to that there needs to be willingness to interact in order to form coalitions.

Table 10 shows that public actors are well represented in all of the urban areas. This is not surprising since the water domain is mostly seen as a public task. Often a division of responsibility is made between various public actors, based on area size and type of water tasks like water safety or water supply. Even though, such a division between tasks can have negative effects, like segmentation between actors. As for the private actors, it can be noticed that these are limitedly involved in mostly all urban areas. This can be due to the business case that private actors make out of their involvement. Interaction between the different types of actors is needed for social learning and better results for resilience. Therefore, urban areas are starting to acknowledge the need for coalitions, although some make better progress than

others. In the following paragraphs a closer look will be taken to each urban area and their actor and coalition arrangements.

Table 10: Build up of the actors and coalitions arrangement

	Zwolle	Norwich	Semarang	HCMC	Houston
Public actors	- Municipality - Drents Overijsselse Delta - Province	- Norfolk County counsel - Environment agency - LLFA - IDB	- Mayor - Government - Planning agency of the city - Province	- HCMC people's comity - Steering center of flood control - Women's union	- Planning department - Harris county - Harris county flood control district - State - Federal agencies - Armin core of engineers
Private actors	- Vitens - Own initiatives	- Anglian water (semi private) - Insurance companies	- NGO's - Academics	- Foreign companies	- No real participation of private companies
Coalitions	- CATCH - City Deal - Coalition on water system level	- CATCH	- 100 Resilient cities - Eco-shape - City coalitions for building with nature	- C40 cities - Coalitions formed for multiple projects	- C40 cities - 100 Resilient cities

ACTORS AND COALITIONS IN NORWICH

Norwich is a good example of an urban area where segmentation was observed "*There was a lack of coordination and synchronization*"[17] stated the governance and water strategist at RHDHV in Norwich. But he also explains that efforts are being made to improve this, by implementing the Water Management Act. This act has been put into place to improve working in coalitions and to collaborate more with different responsible actors. Although this is a start in involving a diverse set of relevant actors, there is still a lack of private actor involvement. The water company Anglian Water is involved but this company is semi-private, "*Water-companies are privatized since Thatcher but do also have a public role as risk management authority*"[18] explains the governance and water strategist. He also explains that insurance companies who are private are largely influenced by the government "*Until recently, insurance companies had understandings with the government about providing insurances.*"[19] With a lack of involvement of other private companies, the public actors are mainly in charge in deciding the FRMSs in the area. The coalition in the form of CATCH can be considered as a start of coalition building, but this is still on a very small scale.

ACTORS AND COALITIONS IN HOUSTON

The actor involvement of Houston is very comparable to the one in Norwich. There is a wide range of public actors involved in the water domain, from very large-scale public actors to the smaller scale ones. As for the private actors, these only do the bare minimum. To some extent ordinances give them obligations that have to be fulfilled, but little more is accomplished afterwards. The urban planner explains that even this is not always done properly, "*As private developer in Houston there are obligations to, of course, follow all the ordinances for development [...] but if there is something that I want to do I can probably get away with it in Houston. So yes, there is an obligation but from the development perspective, I think you can always find a way to work your way out of it."* For enhancing the resilience of Houston, the city is part of the C40 program. But although Houston is part of this coalition, the city is not very actively involved in this.

ACTORS AND COALITIONS IN SEMARANG

The actors and coalitions arrangement in Semarang mainly consist of public actors. Although mainly public actors are involved, there is a lot of willingness between these actors to form coalitions to improve the resilience of the area. This is shown in the recently formed coalition between multiple areas for a new building with nature project: "*The integrated coastal zone management [...] for which coalition forming on provincial level has been organized, is an essential start to overcome the flood problems"*[20] explains the associate director and project manager at RHDHV in Indonesia. Only a few NGOs are involved as private actors in this area. These NGOs mainly focus on enhancing the resilience of local communities *"There are also NGOs involved in the flood prone areas to help the local communities."*[21] As Semarang is part of the 100 resilient cities program, private actors are being stimulated to become more involved in the city resilience. The associate director and project manager at RHDHV in Indonesia is certain that, being part of a resilience program is additional to Semarang's flood resilience: "*I for sure think that it is an addition, you are in the spotlight not only locally but also on national level. With that you have an advantage even on the capital city."*[22]

ACTORS AND COALITIONS IN HCMC

In HCMC a diverse set of actors is involved. Next to the public actors a diverse set of private actors, (foreign companies) are actively involved in enhancing the water management of the city. "*There are a lot of actors involved, also from foreign countries"*[23] tells the urban delta expert and civil engineer about HCMC. But a downside can also be experienced, as the actors have limited interaction plans do not align with each other. As the urban delta expert explains: "*The foreign companies have influences on the different plans, which makes them not well aligned, which can have negative consequences, such as; a lack of overview which leads to fragmented planmaking."*[24] Coalition forming is therefore important in HCMC, a challenge

which still needs to be overcome, otherwise different plans can have counter effects on each other. It can be said that some progress is being made on forming coalitions.

ACTORS AND COALITIONS IN ZWOLLE

The involved actors in Zwolle seem to be well divided between public and private actors. Multiple levels of public actors are interacting with each other as well as giving private initiatives the opportunity to participate. "*They let private initiatives implement their own measures*"[25] mentions the municipal advisor of civil engineering in Zwolle. The urban area of Zwolle wants the private actors to play a more important role during the development and implementation of resilience strategies. The city considers those private actors as essential for resilience: *"Those are going to play an important role [...] you will need the private sector"*[26] says leading professional in urban flood resilience at RHDHV in Zwolle. This interaction already shows in the different coalitions which has been made, such as CATCH and the City Deal.

6.4 POWER AND RESOURCES

The power and resources arrangement consist of multiple aspects, also explained in chapter 2. In table 11 the different aspects which build up this arrangement are shown. In the following paragraphs an explanation of the build up of this arrangement will be given.

Table 11: Build up of the power and resources arrangement

	Zwolle	Norwich	Semarang	HCMC	Houston
Financial capacity	Available	No state investments unless 1/5 profit ratio	Available through: World bank and foreign investments	Available through: Asian development bank, foreign investments and PPP constructions	Mostly from public money, private investments very limited
Authority & power division	Equal power division and legal authority for enforcing policies	Nobody dedicated as responsible for water security level	Government is responsible but unequal power division and lack of enforcement	Unequal distribution of power and lack of enforcement of policies	Depending on the area who is responsible, but federal state has lots of influence
Knowledge capacity	Lots of knowledge sources	CATCH program stimulates knowledge sharing	- Academics have big influence - 100 RC source of knowledge	- Limited knowledge sources but willingness to learn - Coalitions bring more knowledge	Improvements are made by learning from successful projects

FINANCIAL CAPACITY

Table 11 shows the financial capacity of the urban areas. What seems most remarkable is that most urban areas do not have enough financial capacity and therefore rely on others for investing in FRM. For the city of Houston this is striking, since many private companies are located there, but the city still has to rely on public investments "*No private companies are involved, in fact there has been an ongoing discussion of how the private industry can help in the recovery side"* Tells the chief resilient officer of Houston, who still is involved in this discussion with private companies. The private companies could make more effort, because for them it is also important that the urban area keeps functioning.

As for Norwich, in this urban area investments are only made if the cost benefit ratio is right. Therefore, it could be said that there is enough financial capacity, but only when certain requirements are reached, investments will be made. If not, other ways have to be found to finance FRM projects. The governance and water strategist of RHDHV in Norwich explains it like this: "*In the English context, when you want to invest in flood risk management, a return of investments of 1/5 is needed, otherwise the money goes somewhere else."*[27]

HCMC and Semarang are in a similar situation considering the financial capacity of the cities. Both of these cities depend on financial aid through foreign sources, such as the World Bank, the Asian Development Bank or foreign investment companies. Plan-making and development of FRMSs therefore largely depends on what investments these financial resources see fit. Often money from these sources has already been designated to basic needs projects, such as water supply.

Only the urban area of Zwolle does not seem to have trouble with finding financing capacity to implement new FRMSs. The public parties are very involved in the process of becoming resilient and want to invest, as well as private parties are being involved in this: "*There is a basis funding which comes from traditional water tasks […] but you can also see that the city finds funding possibilities with other new partners."*[28] Explains the leading professional in flood resilience at RHDHV in Zwolle.

AUTHORITY AND POWER DIVISION

In urban areas, the financial capacity of a region largely influences its authority and power division. The ones controlling the financial resources mostly decide what happens with it. As shown in table 11, Zwolle is the only city with a relatively equal division of power. For the other cities who also have les financial resources to rely on, the division of power is unstable. The urban delta expert and civil engineer explains this well: "Y*ou can get bribes, for which eyes are being shut, which makes it difficult for authority to control."*[29]

KNOWLEDGE CAPACITY

Due to formed coalitions, most of the cities have knowledge capacity available on which they can rely on if needed. All of the cities want to improve their flood resilience and are making efforts to extend the knowledge resources the urban areas have. But the financial capacity also plays a role in this, since the ones with the money are often considered to be more influential. Therefore, for example academics are very influential in Semarang, as they were former professors of the ones in charge tells associate director and project manager at RHDHV in Semarang: "*Academics play an important role in advising […] this advice is taken at hart, even if it is not good advice, as it used to be a professor of someone important, which creates a certain prestige.*"[30]

6.5 ORGANIZATION OF THE OVERALL FRGAS IN THE URBAN AREAS

The individual governance arrangements of the urban areas have been combined in table 12. For implementing a more diverse set of FRMSs, the governance arrangements need to be organized in such a way that structural changes are permitted. Carrying out new strategies and aligning those with all other strategies will be more difficult when there is no room for change within the FRGAs.

Table 12: The Flood Risk Governance Arrangements of the cases

	Zwolle	Norwich	Semarang	HCMC	Houston
Discourse	Water cycle city	Drained city	Water supply city	Water supply/sewered city	Waterway city
Rules of the game	In process of change for resilience	Rules for resilience are limited	Need for more fixed rules for resilience	Lack of enforcement makes the rules useless	In process of change for resilience
Actors & coalitions	Lots of actors actively involved	Lots of actors but limited interaction	Mainly public actors involved, some forms of coalitions	Lots of actors but limited interaction	Mainly public actors involved
Power & resources	Stable power division and availability of resources	Stable power division but limited resources	Unequal power division, resources available with foreign aid	Weak power distribution, available resources trough foreign investments	Weak power distribution and lack of financial resources

Based on the previous paragraphs, it can be said that the analyzed urban areas all have a very different set of governance arrangements in place. Not all of these governance arrangements contribute to flood resilience. All of the analyzed urban areas therefore need to make improvements in the governance arrangements to some extent.

Overall, change mostly needs to be made within 'the rules of the game' arrangement. Enforcement of new approaches will only be possible if legislation prescribes it. Changing discourse is hard and therefore will take time. By putting some rules in place, it will already be easier to follow the prescribed path. 'The power and resources' arrangement influence the FRM in a significant way as well, especially the financial capacity. Without money, new projects cannot be implemented. Having a well-balanced financial capacity is important, because otherwise the one with the financial capacity will also have the power to decide.

Based on this, table 12 shows that Zwolle is closest to a set of FRGAs that accompanies the flood resilience goal, but even here improvements need to be made, which mostly concern the rules of the game. For the other urban areas, more challenges lie in the way of flood resilience, considering the FRGAs.

CHAPTER 7 CONCLUSION AND REFLECTION

In this final chapter the results of the previous chapters are summarized in order to answer the main research question. After a short recapitulation of the research approach, the final results of the researched cases are discussed, and strengths and weaknesses are identified. Based on the gained knowledge from these cases the main research question is answered:

'To what extent do existing Flood Risk Governance Arrangements enable the transition to flood resilience in cities; which lessons can be learned from a comparative research?'

Throughout the world, urban areas are becoming aware of their vulnerability to floods and therefore want to improve their flood resilience. However, implementing new approaches for a more flood resilient urban area is complex, as this is determined by not only physical and geographical factors but also by institutional factors. This research shows how these institutional aspects are organized in urban areas and how areas can learn from institutional arrangements of other urban areas. This analysis required a structured research approach which was developed in chapter 2 as an answer to the first sub-question: '*How can urban flood resilience be analyzed?*' The research approach consisted of three steps applied to the five cases: Zwolle, Norwich, Semarang, HCMC and Houston.

The first step in the research approach was defining the position of the urban areas in the urban water framework, which was done based on the second sub-question: '*What is the context of the selected cities?*' The position of the cities on the urban water framework could be derived from the urban characteristics, which then forms the basis for the analysis. The second step in the research approach was to determine which Flood Risk Management Strategies (FRMSs) are used in the urban areas and if improvements in FRMS use are needed. This step answered the third sub-question of the research; '*How is Flood Risk Management approached in the urban areas and what FRMSs are used?*' The third and final step in the research approach answers the final sub-question; '*Are the FRGAs organized in such a way that they enable a diversification of FRMSs?*' The four dimensions of the Flood Risk Governance Arrangements (FRGAs); discourse, rules of the game, actors and coalitions, and power and resources are analyzed for this step. The data collection of this research consisted of ten interviews, each with a water management expert in the case of interest. After answering the main research question, a reflection upon the used theories and methods is made. This chapter ends with recommendations for further research.

7.1 EMPIRICAL SUMMARY AND REFLECTION

The research analyzed five selected cases, to find how the FRGAs enable the transition to flood resilience of urban areas. This section summarizes the concluding findings of the case. Based on the individual results of the cities analyses, strengths and weaknesses are identified. In the

end these strengths and weaknesses are the basis of the lessons that can be learned from this comparative research.

COMPARING THE FLOOD RESILIENCE OF THE CITIES STUDIED

The following sections will describe the overall conclusions of the cities. After each case description, the institutional strengths and weaknesses of the FRGAs are summarized.

ZWOLLE

Zwolle can be called a “water cycle city” based on the model of Brown et al. (2008), as the city has a well-developed water infrastructure in place providing the city with fresh water and a maintained sewerage system. Next to that, Zwolle is continuously working to create a livable city, by understanding the limits of the natural resources and implementing fit-for-purpose solutions. Even though Zwolle is in a relatively mature phase within the urban water framework, the city wants to transition to the next phase: a water sensitive city. Being part of multiple resilience programs is the first step in this transition. A full transition would require a diversified set of FRMSs, as this enhances the flood resilience of a city. Through history Zwolle mainly used defensive strategies as flood protection which, still shows in the path-dependence of the area. Other strategies are used such as prevention, but to a lesser extent. Therefore, Zwolle needs to diversify its FRMSs, particularly the recovery strategy needs attention as this strategy is not used at all. Implementation of more FRMSs depends largely on the FRGAs in place, such as actor involvement and the availability of resources, overall enabling the transition to a flood resilient urban area. Even though, some small alterations in the FRGAs can enhance the process of transitioning to a flood resilient urban area. Zwolle is already working on improving the FRGAs. For example, to secure the implementation of new FRMSs new rules and regulations are being developed, which Zwolle wants to implement in the ‘omgevingsvisie’. Small adjustments in the FRGAs of Zwolle therefore can improve the ability of Zwolle to become resilient, but overall do the FRGAs enable implementation of new strategies. Hence, Zwolle should be capable of becoming flood resilient and a water sensitive city.

NORWICH

Norwich can be considered as being a “drained city” based on the model of Brown et al. (2008), as the existing drainage system is still being developed and large investments are being made to do so. Even though the drainage system is still being improved, Norwich is already making efforts to transition to a new phase in the urban water framework. Participating in the resilience program CATCH, shows that Norwich wants to focus more on the existing infrastructure and environmental protection. Transitioning to a new phase will be a first step in the process of becoming flood resilient, although Norwich has to go through multiple phases before being a water sensitive city. Diversifying the FRMSs use would enhance the possibility of Norwich to transition faster through the different stages of the framework. For now, the diversification of FRMSs in Norwich is limited and mostly focusing on the recovery strategy. Other strategies are

used, but to limited extent, due to the FRGAs in place. The FRGAs in Norwich hinder the diversification of FRMSs, which is mostly caused by the existing rules and regulations. These rules and regulations do not specify who is responsible for a water safety level. With no responsible party, together with the segmentation of involved water management actors, the development of FRMSs is hindered. Implementation of the Flood water management act of 2011 improved the collaboration between actors, however more improvements in terms of rules and regulations are required. Mostly, because the power and resources are influenced by the existing rules and regulations, given that state investments in FRMSs are only made if there is 1/5 return on investment. The FRGAs of Norwich are therefore hindering the transition to a flood resilient urban area, based on the current FRGAs, transitioning will be difficult.

SEMARANG

Semarang is still in the water supply phase of the urban water framework (Brown et al., 2008), since access to fresh water is troubling. With ongoing population growth, providing the city with fresh water will become even more complicated. Therefore, in water management most attention will go to providing the city with water and limited attention will go to the diversification of FRMSs. This shows in current FRMS use, which is foremost based on strategies used during a flood event. Using preparation and response strategies enables people to react to upcoming floods which makes them less vulnerable, but developing more strategies will make the area more resilient. For now, the other strategies are poorly implemented. The discourse of being in a water supply phase hinders developments in FRM, therefore, Semarang has a strong path-dependence. Not only do these FRGAs hinder the transition to a flood resilient city, but the rules and regulations and the power and resources also make implementation of new FRMSs difficult. Improvements in the FRGAs are necessary in order for Semarang to become a flood resilient city, otherwise it will be difficult.

HO CHI MINH CITY

Ho Chi Minh City is on a split considering its position in the urban water framework (Brown et al., 2008), as fresh water supply is not available for all and the sewerage system is underdeveloped. Both these aspects are relevant in HCMC's water management; therefore, the city is in both the water supply and the sewerage city phase. Even though the water infrastructure needs further development the FRMSs in HCMC mostly focus on defensive strategy use. Most investments in FRM are made in infrastructural investments such as sluice gates. Mitigation is also used as FRMS, however to a lesser extent and carried out primarily by the local community. Expansion of FRMSs use is therefore needed but the FRGAs hinder this diversification. HCMC is, just as the other cities, path-dependent with a focus on the defensive strategy use. This path-dependency influences the capacity of HCMC to change, primarily due to the lack of rules and regulations for enhancing its FRMSs use. Lack of rules and regulations together with limited power and resources make the implementation of existing strategies already difficult let alone hinder new developments. Limited actor involvement, mostly based

on public actors, does not enhance this either. Foreign companies do help in forming coalitions and being part of a resilience program helps the city to develop plans for improvements as well. Still, improvements in FRGAs are necessary, as for now the FRGAs hinder the ability of HCMC to transition to a flood resilient urban area.

HOUSTON

Houston is a waterway city, on the verge of transitioning to a water cycle city (Brown et al., 2008). A change in water management with more fit-for-purpose developments is required in order to enable the transition to a water cycle city. For now, the city still focuses on the service functions of the existing infrastructure. Transitioning to the next phase in the urban water framework will need a widening of FRMSs use. Even though various strategies are being used in Houston, there is still room for improvement. Defensive and preventive measures are being taken as well as there are recovery strategies in place, but these strategies can still be improved. The mitigation strategy is poorly used, this strategy can use more attention. The way the strategies are implemented and used is due to the FRGAs in place. First, Houston is path-dependent, mostly relying on their infrastructural measures as flood protection. Second, the lack of zoning law makes that vulnerable areas have been developed. Although, after Hurricane Harvey rebuild of vulnerable areas has been limited, as it has been prevented by newly implemented moratoriums, showing that Houston wants to improve its FRM. The actor involvement in Houston is mostly based on public actors, although Shell recently helped Houston to take part in the 100 Resilient City program. This demonstrates the increasing commitment of private parties to get involved with enhancing city resilience, although greater private involvement is desired. FRM responsibilities are divided between different jurisdiction areas, but the federal state still has lots of influence in FRM in Houston. This is also the case when the resources are concerned. This concludes, the FRGAs in Houston do to some extent enable flood resilience, but some also hinder it. Therefore, improvements in FRGAs are desired.

INSTITUTIONAL STRENGTHS AND WEAKNESSES

Table 13 gives an overview of the strengths and weaknesses of the FRGAs in the cities, which are based on the conducted research. Some general remarks can be made based on this table.

First, it is remarkable to see that each city has a strong path-dependence, which hinders the ability to make changes in the use of FRMSs. This shows the difficulty to alter discourse, given that a great amount of effort is required to fully commit to a new discourse. A second remark is the lack of actor involvement in all the urban areas, except for Zwolle. Even more notable, are the similarities between Semarang's and HCMC's strengths and weaknesses. Both have a strong willingness to learn and improve the urban flood resilience of the area, nevertheless lack resources and equal power division, which would stimulate this development. Overall, based on table 13, possible lessons could be learned from each other.

Table 13: Institutional strengths and weaknesses of the FRGAs in the cities

Zwolle:	
Institutional strengths	1. *Well-developed (maintained) water infrastructure* 2. *Implementing rules and regulations to secure resilience approaches in FRM* 3. *Diverse stakeholder involvement interacting with each other* 4. *Equal/stable power division between stakeholders* 5. *Financial and knowledge resources available*
Institutional weaknesses	1. *Strong path-dependence based on defensive strategies* 2. *High protection level norms make people less aware of the flood risk. Therefore, lack of recovery strategy*
Norwich:	
Institutional strengths	1. *Strict rules for living in flood prone areas, insurance obligation* 2. *Knowledge sharing is stimulated by for example participating in a resilient program* 3. *Stable division of power*
Institutional weaknesses	1. *No one is responsible for maintaining a water safety level* 2. *Strong path-dependence for development of institutions based on the rules and regulations* 3. *Only state investments in FRMSs when 1/5 return on investment, in general lack of financial resources to take measures for all flood risk areas* 4. *Lots of actors involved but limited interaction between involved actors*
Semarang:	
Institutional strengths	1. *Willingness to learn, therefore also part of multiple coalitions*
Institutional weaknesses	1. *Water management mostly has to focus on provision of fresh water* 2. *Strong path-dependence, focusing on response to floods* 3. *Lack of enforcement of rules and regulations in place* 4. *Mostly public actors involved in FRM* 5. *Unequal power division* 6. *Lack of financial and knowledge resources mostly available through foreign investments*
Ho Chi Minh City:	
Institutional strengths	1. *Willingness to learn, therefore also part of multiple coalitions*
Institutional weaknesses	1. *Strong path-dependence based on defensive FRM* 2. *No strict law for FRM* 3. *Mostly public actors involved in FRM* 4. *Unequal power division and lack of enforcement* 5. *Lack of financial and knowledge resources mostly available through foreign investments*
Houston:	
Institutional strengths	1. *Well-developed water infrastructure and at the verge of transitioning further on the urban water framework* 2. *Possibility to give moratoriums to prevent rebuilding in flood sensitive areas* 3. *Learning done based on successful projects*
Institutional weaknesses	1. *Strong path-dependence based on defensive FRM* 2. *No zoning laws* 3. *Mostly public actors involved in FRM* 4. *Federal state lots of influence on the FRM process in the urban area*

POSSIBILITIES FOR INSTITUTIONAL REFORM

In this section the main question of the research will be answered: *'To what extent do existing Flood Risk Governance Arrangements enable the transition to flood resilience in cities; which lessons can be learned from a comparative research?'* First, can be concluded that weaknesses in FRGAs do exist in all of the analyzed urban areas. However, depending on the urban areas strengths can be defined, which do enable the transition to a flood resilient city. Above all, in Zwolle do the FRGAs enable the transition, and although more weaknesses can be defined for Houston also this city has FRGAs that enable the transition. Even though these cities are on their way for flood resilience, lessons can still be learned which will be done based on table 13. Possibilities for institutional reform can be derived from the comparison of the strengths and weaknesses of the urban areas. For Norwich, Semarang and HCMC some more institutional reform will be necessary in order to transition to a flood resilient urban area. The following sections will elaborate on some possibilities for institutional reform per city.

ZWOLLE

The most important lesson which Zwolle can learn is from Norwich, where the flood recovery strategy is well implemented. Being insured for flooding is required when people live in a flood prone area, the rules and regulations are adjusted to make this obligatory in Norwich. Institutional reform for the implementation of a recovery strategy in Zwolle, could be based on Norwich its rules and regulations, adjusted to the local circumstances of Zwolle. Another possible lesson could be learned from Semarang, where people are more aware of flood risk and have to be more self-reliant. Having more awareness of flood risk could reduce the path-dependence of Zwolle relying on flood defense.

NORWICH

For Norwich the weaknesses mostly lay in the actor involvement and the responsibility division. For both aspects Norwich can best learn from Zwolle. In Zwolle water management responsibilities are divided over multiple parties. Therefore, institutional reform could be based on the water management system in Zwolle. Having a clear division of responsibility might also improve the actor involvement, as it would be more clear which parties should be involved in different processes.

SEMARANG & HO CHI MINH CITY

These two urban areas are quite similar considering the strengths and weaknesses in table 13, therefore, possible institutional reform will be relatively the same for both urban areas. First and foremost, these two urban areas need to have a better power division, without this implementation of rules and regulations will not be possible. Even though power division in Norwich and Houston could improve, Semarang and HCMC can learn from all the other analyzed cities to enhance their current power division. After improving the power division,

both areas need to develop rules and regulations for flood resilience, enhancing the diversification of FRMSs. For doing so it's best to learn from the cities which are already have a diverse set of FRMSs in place such as Zwolle and Houston. Rules can be set to prevent people to build in flood prone areas, as is done in Norwich and Houston. How to implement these policies can be learned from Zwolle, as this is one of Zwolle's strengths.

Securing a well-developed water infrastructure system will be the priority of these two cities. This can be done based on examples of already developed water infrastructure in other cities. Besides that, new technological developments should directly be implemented into the urban water infrastructure system, to quicken the development process.

HOUSTON

Having no zoning law is considered as being a weakness in the FRGAs for Houston, as it gives no restrictions for area development and the building of houses. If zoning will not be considered in Houston as it is for other American cities, institutional reforms could be based on Norwich, which has strict regulations for building in flood prone areas. If building has to be done in these flood prone areas, then requirements can be given to these developments. Lessons to enhance actor involvement could be learned from Zwolle, where private actors are also participating in the process to become flood resilient. Lastly, just as Zwolle, Houston can learn from Semarang where people are more aware of the flood risk and are to some extent self-reliant. Becoming less path-dependent is difficult, however, creating more awareness among its inhabitants will improve the preparedness for possible future flooding.

Based on these possibilities for institutional reform Royal HaskoningDHV could develop plans which would stimulate the diversification of FRMSs. While making plans, both the institutional strengths and weaknesses of the urban area need to be considered.

7.2 REFLECTION ON THEORY AND METHOD

The following part reflects on used theory and method. After reflecting on these two aspects the contribution to planning theory is evaluated. The research is finalized by giving recommendations for further research.

THEORETICAL REFLECTION

The theories on which the research is based were all relevant, given that the urban water framework, the FRMSs and the FRGAs all influence each other. Linking these theories enabled greater insights on the implications that FRGAs have on urban water management. By linking these theories, a scientific contribution was made in this research. New theories were added to the suggested research approach by Hegger et al. (2014) which helped optimizing the method of analyzing FRM. This approach was valuable for the research as it made it possible to conduct the analysis in a structured way and link relevant concepts together. Each of the

conducted steps revealed relevant information for possible institutional reform. Another scientific contribution was made by considering a next phase in the urban water framework. Generally, the used theories were relevant for the conducted research, as the analyses consisted of a quick scan based on five case studies. More in-depth research on the specific cases could be suggested, for further research. Despite the research being a quick scan, the researcher was able to analyze five utterly different cities. Even though, these cities all have developed based on strong path-dependence, it still is possible to learn from one another.

METHODOLOGICAL REFLECTION

To deduct generalized conclusions in this research, five contextually different cases were selected. All the selected cases do have risk of flooding but differ in; geographical and demographical aspects as well as in the level of development in the urban water framework. Lessons learned from all these cases are of value, as it shows how the FRGAs can affect the approaches in urban flood resilience. Nevertheless, it should be noted that the FRGAs of urban areas are context dependent. Lessons can be learned, but policies cannot directly be copied from one urban area to another. For implementing FRMSs based on lesson learning, contextual differences need to be considered (Nadin & Stead, 2008).

The data collection of the research is based on semi-structured interviews, which has been relevant for this research. Due to distance it was not possible to conduct each interview face-to-face, which could have resulted in more detailed conversations. Even though, enough results were retrieved on which the results could be based. During the research the researcher was an intern at RHDHV, therefore half of the interviewees were found from within the company. This contributed to the research, as these participants know the background of water management and what approaches are being implemented in the specific urban areas.

CONTRIBUTION TO PLANNING THEORY

Several insights were revealed by conducting this research which contributes to planning theory as well as planning practice. First, based on the scientific relevance, strengths and weaknesses of the FRGAs were revealed. These strengths and weaknesses can be a basis for institutional reform for flood resilient water management in urban areas, as it is of societal relevance that urban areas are becoming flood resilient. To transition to flood resilient areas, institutional reform must be made to change the FRGAs which hinder this transition.

Two main contributions to planning theory were developed in this research. The first was adding a phase to the urban water framework developed by Brown et al. (2008). The proposed framework includes a new phase based on technological development. Urban areas include more and more technology in city design, however, it should also be considered as an enhancement for flood resilience. The second contribution is developing a research approach to analyze the FRGAs and how these enable the transition to flood resilient urban areas. This

research approach includes more aspects than the original one developed by Hegger et al. (2014). Even though for more in-depth research the used research approach in this research could be developed further.

RECOMMENDATIONS FOR FURTHER RESEARCH

This research analyzed five different cases and therefore very case specific details could not be gathered. A first recommendation for further research would therefore be, conducting in-depth research based on individual cases. More detailed knowledge of the FRGAs could enhance the policy transfer methods.

This research showed the importance of the urban water framework in FRM, even though limited amount of research has been done based on this topic. In further research, greater attention should be given to the importance of the water infrastructure. A recommendation would be to develop a better qualification system for analyzing the urban water framework phases of cities. Using the urban water framework with the seventh proposed step should therefore be considered, as technological developments are becoming more and more relevant.

The most relevant recommendations for Royal HaskoningDHV would be using a holistic approach when developing plans for urban flood resilience. This is needed because all aspect within water management are related to each other. For example, developing plans for defensive strategies will also mean that the urban water infrastructure will be influenced. Or focusing more on response strategies will at the same time mean that recovery strategies have to in place.

Independent consultancy and/or engineering firms often need 'triggers' to start a transition in Flood Risk Management, which is also the case for flood resilient approaches in FRM. Major flood events are often seen as the triggers to start such a transition but change in legislation or new technological developments should also be considered as a way to facilitate the transition to flood resilient cities. Royal HaskoningDHV should utilize those possibilities to enhance urban flood resilience.

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APPENDIX

APPENDIX 1

Interview Guide

Goal of the interview:

- Collecting data to compare different governance and funding methods for 5 cities worldwide to deal with (flood) resilience.
- To gain inside on city specifics and their methods on becoming resilient.

Conversation topics:

General	○ Introduction, can you give a short introduction about yourself, background etc.	○ 5 min
City specifics	○ Can you explain what the circumstances are of this specific urban area, geographical, political (*stability)*, socio-cultural and demographic? ○ What is the future goal or ambition for this urban area? ○ What kinds of floods do occur in this area, and how frequent are they occurring? ○ What are other pressing (water) challenges of this urban area? ○ What is essential in governance for flood resilience in this city and why is it the case? How is flood resilience perceived in this city?	○ 15 min

FRMSs	Short explanation about different strategy measures in Flood Risk (Awareness – prevention – mitigation – defense – response)
	
	○ What kinds of measures are taken to prevent flooding? (e.g. not building in flood-prone areas)
	○ What measures are there to defend the area against floods?
	  ○ Are the preventing measures seen as equally important as the defense measures?
	○ As it comes to mitigation, is there an approach in the area to mitigate the possible impacts of floods?
	○ If an actual flood is happening, what would happen then?
	  ○ Are there warning systems?
	  ○ What kind of response measures are taken during flood events?
	  ○ Are people living in the flood-prone area aware of the risks and the response strategies/evacuation plans?
	○ How about afterwards? Is there any kind of insurance for this kind of shocks?
	○ Are the measures that are taken aligned with each other?
	○ Is there in this area a type of measure that is seen as more important than others?
	○ What type of funding is used? (International funding or emergency from national level or regional budget, etc.)
		○ 15 min

FRGAs	○ What is the most pressing value when it comes to water in this urban area? ○ Is there a shift that can be noticed in these values?	○ 30 min

	○ How deeply do you think are old habits or cultural aspects routed in legislation and methods when it comes to protecting against water? ○ Is the current goal for this area to become flood resilient? ○ How do the rules and regulations of the area accompany the goal to become resilient? ○ Are there relevant binding laws that enforce flood resilience? ○ How strong is the policy of authorities? ○ Is this area involved in some sort of project related to flood resilience? ○ Do you see that as some coalition, where they help each other or do they only have the same goal? And what are the goals then? ○ How is the water management domain organized? ○ How are the interactions within this domain and between other domains? Is there interaction possible in their formal and informal methods? ○ What actors get involved in the process; public, private or a combination? ○ How strong is the private sector and are they supporting the authorities in achieving this? ○ How strong is the policy of authorities? Is there law enforcement and control of execution of flood risk policy? ○ If there is interaction with other domains and actors, what kinds of stakeholders are then involved? ○ The actors involved in the process of becoming flood resilience, how are they involved? ○ If they are involved by giving some sort of resource, how is the power balance than between the actors? ○ Who is funding this? At what political level?	
Goal	○ How do you see the perspective for this area to become flood resilient? ○ What about smart cities, is that a goal for this urban area? ○ Do you see a prospect in smart cities and is it connectable to flood resilience?	○ 10 min
Finishing up	○ Explain what is essential for flood resilience and why it is the case ○ If the essentials are missing, is flood resilience than still possible? ○ Is there an aspect of resilience that we did not discuss which could be relevant to the research? ○ Are there some last things you want to add to this interview?	○ 5 min

APPENDIX 2

[1] "Er wordt echt wel voor honderden miljoenen hier aan de dijk verbouwd […] maar voor een liveble city moet meerwaarde gecreëerd worden door in de ruimtelijke ontwikkeling van de dijken."

[2] "Tot nu toe zijn alleen de mangroves er als defense measures."

[3] "Voor bestaande bebouwing moet een herindeling van functies overwogen worden."

[4] "Maar nog niet iedereen heeft dit geaccepteerd"

[5] "Wanneer het begint te regenen, verhogen ze de makrtkraampjes gewoon en gaan door met verkopen"

[6] "Tot op zekere hoogte zijn mensen flexibel en passen ze zich aan door ad hoc oplossingen te bedenken om het water buiten te houden."

[7] "Bewoners krijgen de mogelijkheid om zelf te melden waar wateroverlast is op de nattevoeten kaart via een app op de telefoon"

[8] "Wat je nu vooral ziet is reageren na een overstroming, en niet zo zeer preventief bezig zijn."

[9] "Het zou eigenlijk idealiter zijn als het geintergreerd wordt, als onderdeel van het smart city concept"

[10] "Mensen kunnen en moeten zich verzekeren als ze in een overstromingsgebied wonen."

[11] "Watervoorziening is een probleem, mensen onttrekken daarom ongereguleerd water uit de grond."

[12] "In heel Indonesië is riolering een probleem, er is geen rioleringssysteem."

[13] "Er zijn heel veel regels […] de regels zijn er gewoon, ze worden verder niet nageleefd."

[14] "In principe is handhaving in Indonesië tien keer niks!"

[15] "Om te garanderen dat iets kan worden uitgevoerd moet het in de regelgeving staan […] dit wordt dus gedaan in de omgevingsvisie."

[16] "Er wordt zoveel mogelijk voorkomen dat er gebouwd wordt in overstromingsgevoelige gebieden, door bijvoorbeeld een systeem dat de overstromingsgevoeligheid aangeeft van een gebied."

[17] "Binnen het watermanagement domein was er een gebrek aan coördinatie en synchronisatie."

[18] "Waterbedrijven zijn in de periode van Thatcher geprivatiseerd, maar ze hebben nog steeds ook een publieke rol als flood risk authority."

[19] "Tot voorkort hadden verzekeraars overeenkomsten met de overheid voor het bieden van premies."

[20] "Integrated coastal zone management […] hiervoor worden coalities gevormd met andere provincies, en wordt gezien als essentiële start voor het voorkomen van overstromingsproblematiek."

[21] "NGO's worden ook betrokken in het proces, vooral in lokale gemeenschappen te helpen."

[22] "Ik denk zeker dat dat een toevoeging is, je wordt namelijk in de schijnwerpers geplaatst, niet alleen lokaal maar ook nationaal. Daarmee krijgt Semarang zelfs een voorsprong op de hoofdstad."

[23] "Er zijn vele actoren betrokken, vooral ook buitenlandse bedrijven."

[24] "De buitenlandse bedrijven hebben invloed op veel verschillende plannen, waardoor ze soms niet goed op elkaar aansluiten. Dit kan negatieve gevolgen hebben, bijvoorbeeld door gebrek aan overzicht wat leidt tot gefragmenteerde plannen."

[25] "Eigen initiatieven van bedrijven worden gestimuleerd."

[26] "Zij zullen een belangrijke rol gaan spelen […] het betrekken van private partijen is daarvoor nodig."

[27] "In Engeland komt het er grofweg op neer dat als je wilt investeren in overstromingsbeheer, de kost ratio ongeveer 5 moet zijn, anders gaat het geld ergens anders heen."

[28] "Er is een financieringsbasis uit de traditionele watertaken […] maar je ziet ook dat er nieuwe financieringsmiddelen gevonden worden met partners samen."

[29] "Of je krijgt steekpenningen, waarvoor een oogje wordt dichtgeknepen, dit is vervelend voor handhaving."

[30] "Academici spelen een belangrijke rol in adviseren […] er wordt goed naar dit advies geluisterd hoe goed ook omdat het professoren waren van mensen die nu werken bij de overheid. Dit creëert aanzien."