



A master thesis on

The Governance of Local Climate Adaptation

*Defining governance arrangements to steer effective
flash flood adaptation in Arnhem*

by
Marijn van Geet

The Governance of Local Climate Adaptation: formulating governance arrangements to steer effective flash flood adaptation in Arnhem.

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BY

Marijn van Geet
marijn.van.geet@gmail.com / +31(0) 6 52 38 39 48
Student number: 2414167 (Oldenburg)/ 1861344 (Groningen)

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Supervisor/ 1st assessor: dr. E.M. (Elen-Maarja) Trelle, University of Groningen
e.m.trelle@rug.nl

2nd assessor: dr. M (Maik) Winges, University of Oldenburg
maik.winges@uni-oldenburg.de

Supervisor internship: Ronald Bos, Municipality of Arnhem
ronald.bos@arnhem.nl



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Table of contents

Table of contents	3
Abstract	6
List of figures, tables, maps & boxes	7
1. Introduction	10
Primary research question.	12
Secondary research questions.	12
2. Theory	13
2.1 Defining urban flash flood risk.....	13
Urban flash flood.....	13
Flash flood risk.....	13
Flash flood risk management.....	13
2.2 Growing flash flood risk.....	13
Climate change, increasing flash flood probability.....	13
Socioeconomic development, increasing potential damage.....	15
2.3 Climate adaptation	16
Adaptive capacity	16
2.4 Institutionalism.....	20
New institutionalism.....	20
Institutions and climate adaptation.....	21
Institutions and governance.....	21
2.5 Governance.....	22
Four perspectives on governance.....	23
Governance in the context of flash flood adaptation in the Netherlands.....	24
Governance as a descriptive and normative tool.....	24
Critical side note on governance	25
2.6 Flash flood governance network in the Netherlands.....	26
Key state actors in the flash flood governance network	26

- Municipality	26
Key market actors in the flash flood governance network	29
- Housing associations.....	29
- Insurance companies.....	30
Key civil society actors in the flash flood governance network.....	33
- Residents	33
Other Actors.....	34
The flash flood governance network.....	35
2.7 Syntheses and Conceptual model.....	35
Flash flood adaptation.....	36
Adaptive capacity	36
Institutionalism and governance	36
3. Methodology.....	39
3.1 Case study as a research methodology.....	39
3.2 Research design	40
3.3 Unit of analyses	41
3.4 Data collection framework and techniques	42
Literature research	43
Semi-structured interviews	43
Questionnaire survey.....	44
Geographical information systems (GIS) analysis.....	47
3.5 Data analysis and interpretation	47
3.6 Combining research and internship.....	48
4. Case study on the municipality of Arnhem	49
4.1 Municipality of Arnhem, an introduction to the case.....	49
Relevance of Arnhem as a case	49
4.2 Institutionalism, Institutional context.....	50
Formal institutions.....	51
Informal institutions.....	54
4.3 Adaptive capacity, taking flash flood adaptation measures.....	63
Individual resourcefulness of key flash flood governance actors	64
Act collectively	71
4.4 Governance of flash flood adaptation on local scale.....	72

Interdependencies and interactions in flash flood adaptation governance	72
5. Conclusions/Discussion & Governance Arrangements	83
5.1 Governance of climate adaptation as descriptive tool	83
The influence of the adaptive capacity of key actors on the governance of flash flood adaptation in Arnhem.....	85
The influence of interdependencies and interactions on the governance of flash flood adaptation in Arnhem.....	86
The bottlenecks in the current flash flood adaptation governance context in Arnhem	87
Understanding the complexity of governance of climate adaptation at local scale.....	87
5.2 Governance of local flash flood adaptation as normative tool	88
Governance arrangements to steer effective flash flood adaptation in Arnhem.....	89
6. Reflection.....	93
References	95
Acknowledgements	104
Appendix I.....	External document. Attached to this research
Appendix II	External document. Only available through researcher

Abstract

Climate change results in increasing urban heat stress and growing risk of pluvial and fluvial floods in Dutch cities. Multiple researchers have shown that several types of barriers hamper the adaptation to these growing risks. Climate adaptation governance has shown to stimulate the implementation of adaptation strategies and help overcome these barriers to adaptation. Despite a growing body of literature on adaptation governance, knowledge on local climate adaptation governance remains limited. This thesis adds to the understanding of local climate adaptation governance. A conceptual framework which integrates climate adaptation, adaptive capacity, governance and institutionalism, is used in a case study research to analyze flash flood adaptation governance processes in Arnhem. The preliminary focus of the case study is on the interrelationships between municipality, residents, housing associations and insurers. Governance is used as both a descriptive and normative tool to give insight in the complexity of local adaptation governance processes and to formulate governance arrangements to steer effective flash flood adaptation. The concluding section reflects on how adaptive capacity, institutionalism and governance context influences local flash flood adaptation governance processes in Arnhem and reveals five adaptation governance bottlenecks. Subsequently, seven governance arrangements are formulated to help steering effective adaptation to flash flood risk in Arnhem.

Key words: Local climate adaptation governance, flash flood risk management, institutionalism, adaptive capacity, governance arrangements, Arnhem.

List of figures, tables, maps & boxes

Figure 1:	Annual precipitation in the Netherlands between 1910-2013 (mean of 102 stations).	p.14
Figure 2:	Winter and summer precipitation in de Bilt (the Netherlands). Showing 30 year averages, KNMP'14 scenarios for 2050 and 2085 and the natural variation.	p.15
Figure 3:	Building a conceptual model step one: adaptive capacity including its components in relation to the implementation of adaptation strategies.	p.20
Figure 4:	Building on a conceptual model step two: governance networks are embedded in an institutional context which can be divided into formal and informal institutions.	p.22
Figure 5:	Building a conceptual model step three: a governance network consists of state, market and civil society actors which are interacting due to their interdependency to achieve goals or solve problems.	p.25
Figure 6:	Mutual dependency across the three public components of the sub-national "triangle".	p.28
Figure 7:	Share of different types of claims on the total damage of claims on private building structure- and content insurance between 2000-2013.	p.32
Figure 8:	The Dutch flash flood governance network based on literature research.	p.35
Figure 9:	The conceptual model/theoretical framework.	p.38
Figure 10:	A visualization of the typification of this research.	p.40
Figure 11:	Characteristics of the sample size.	p.46
Figure 12:	Components of the GIS 'toolkit'.	p.47
Figure 13:	Survey results 1, visualizing to what extent residents are aware of their legal responsibilities in processing rainwater and protect owned property against flash flood damage.	p.54
Figure 14:	Survey results 2, indicators determining the attitude of residents towards flash floods and flash flood management.	p.60
Figure 15:	Survey results 4, what respondents see as the best approach to flash flood risk management.	p.62
Figure 16:	Survey results 5, to what extent residents consider different flash flood actors responsible for reducing flash flood risk.	p.62
Figure 17:	Survey results 6, to what extent residents feel responsible for taking flash flood adaptation measures themselves.	p.63
Figure 18:	Survey results 8, the amount of residents that already took flash flood adaptation measures.	p.67
Figure 19:	Survey results 9, the amount of residents which are withheld by lack of one or more types of resourcefulness in taking flash flood adaptation measures.	p.68
Figure 20:	Survey results 10, the financial resourcefulness of residents and to what extent lack of financial resources withholds them from taking flash flood adaptation measures.	p.68
Figure 21:	Survey results 12, the informational resourcefulness of residents.	p.69
Figure 22:	Survey results 14, the technological/human resourcefulness of residents and to what extent lack of technological/human resources withholds them from taking flash flood adaptation measures.	p.70
Figure 23:	The six different relationships between the four key flash flood adaptation actors on local scale.	p.72
Figure 24:	Survey results 16, the extent to which residents feel dependent on the municipality for reducing flash flood risk.	p.75
Figure 25:	Survey results 18, the amount of residents which are familiar with the municipal Action Plan.	p.76

Figure 26:	Survey results 19, the amount of residents which are willing to play an active role on preventing flash floods.	p.77
Figure 27:	Survey results 20, the extent to which tenants feel dependent on their housing association for reducing flash flood risk	p.78
Figure 28:	Survey results 22, the extent to which tenants feel dependent on insurers for reducing flash flood risk.	p.80
Figure 29:	Survey results 24, the amount of residents which are insured against flash flood damage and where they are insured.	p.82
Table 1:	Precipitation extremes in millimeters in de Bilt, today and projected for 2050 according to the KNMI'06 scenarios.	p.15
Table 2:	Adaptation measures aimed at reducing runoff rates, increasing storage capacity and flood proofing on building/parcel, street/neighborhood and city scale.	p.17
Table 3:	Barriers to climate adaptation in the Netherlands	p.19
Table 4:	Expected increase in damage claims as result of extreme downpours on private building structure- and content insurance under the KNMI'14 climate scenarios expressed in percentages.	p.31
Table 5:	The indicators used for testing the quality of this exploratory case study.	p.41
Table 6:	Data on the population of the focus area.	p.45
Table 7:	Guide for determining when to use which measure of association.	p.46
Table 8:	General guidelines for determining the strength of an association based on the outcome of a measure of association test.	p.46
Table 9:	Survey results 3, results of the statistical analyses determining to what extent informal institutional context influences residents to take flash flood adaptation measures I.	p.61
Table 10:	Survey results 7, results of the statistical analyses determining to what extent informal institutional context influences residents to take flash flood adaptation measures II.	p.63
Table 11:	Survey results 11, results of the statistical analyses determining to what extent financial resourcefulness influences residents to take flash flood adaptation measures.	p.68
Table 12:	Survey results 13, results of the statistical analyses determining to what extent informational resourcefulness influences residents to take flash flood adaptation measures.	p.69
Table 13:	Survey results 15, results of the statistical analyses determining to what extent technological/human resourcefulness influences residents to take flash flood adaptation measures.	p.70
Table 14:	Survey results 17, results of the statistical analysis determining to what extent resident's perception on responsibilities of the municipality in flash flood adaptation associates with the resident's sense of interdependency towards the municipality for flash flood adaptation.	p.75
Table 15:	Survey results 21, results of the statistical analysis determining to what extent tenant's perception on responsibilities of housing associations in flash flood adaptation associates with the tenant's sense of interdependency towards housing associations for flash flood adaptation.	p.79
Table 16:	Survey results 23, results of the statistical analysis determining to what extent resident's perception on responsibilities of insurers in flash flood adaptation associates with the resident's sense of interdependency towards insurers for flash flood adaptation.	p.80
Map 1:	The geographical unit of analysis for this case study research	p.42
Map 2:	The planned development in the focus area mentioned in the municipal development strategy for 2020 and 2040.	p.50
Map 3:	The spread of the different sewer systems in the focus area including a description of each system.	p.53
Map 4:	Combining data on surface elevation, built-up land and how this causes flash floods to form and lead to damage.	p.56
Map 5:	Showing the distribution of land possession in the focus area among municipality, housing associations and private home owners.	p.57

Box 1:	Increasing formal responsibility for landowners to process rainwater.	p.89
Box 2:	Redesigning informal institutional contexts using transition management.	p.89
Box 3:	Arguments in favor of building a broad flash flood adaptation governance network.	p.90
Box 4:	An example of how interactions can lead to innovative collaborations.	p.90
Box 5:	Copenhagen utilizing the economy of flash flood adaptation to realize a huge climate adaptation project.	p.91
Box 6:	Why flood proofing is a key strategy in flash flood adaptation.	p.91
Box 7:	An example of a flash flood management platform: Amsterdam Rainproof.	p.92

1. Introduction

During the summer of 2014 several cities throughout the Netherlands were the adornment of people in inflatable boats paddling through the streets. Intense rainfall resulted in urban flash floods because drainage systems proved incapable of processing the high discharges that accumulated in a short period of time. Inundation of urban areas resulted in traffic disruptions, material damage on building structures and content, production standstill and societal disruption throughout the country. Although the downpour events during the summer of 2014 can be considered extreme, flash floods are not rare in Dutch cities. In recent years several cities in the Netherlands have been repeatedly affected by flash floods (RIONED, 2007; Klijn et al., 2010). In the future the risk of flash flood is expected to increase due to climate change (KNMI, 2009) and social economics developments (Botzen et al, 2010). This research aims at formulating governance arrangements to effectively steer adaptation to growing flash flood risk on local scale. The focus of this research will be on the city of Arnhem. This chapter explains and motivates the scope of this research.

Reflecting on the downpours in 2014, meteorological office Meteogroup assigned Arnhem the title of the wettest place in the Netherlands. A preliminary assessment showed that twenty-two locations throughout the city were, in variable degrees, affected by urban flash floods (Gemeente Arnhem, 2015). As a response the municipality started working on an Action Plan to make the city better rainproof (Gemeente Arnhem, 2014). Because the traditional technical approach of increasing the discharge capacity by upgrading the sewage dimensions is financially unrealistic, the Action Plan focuses on measures that can be taken above ground (CPC, 2014; Gemeente Arnhem, 2015). Above ground the legal responsibilities for rainwater collection, rainwater discharge and flood protection are divided among several public and private actors. The Dutch Water Act 2009 appoints the municipality as the governmental body responsible for urban drainage and storm water collection in the public domain (Mols & Schut, 2012). Landowners bear primary responsibility for processing rainwater that falls on their parcel. This creates interdependency between public and private actors in successfully adapting to growing flash flood risk. This interdependency is reinforced by a withdrawing government and an economic crisis making climate adaptation increasingly dependent on investments by private actors (CPC, 2014). Despite this shared responsibility a study by Runhaar et al (2012) confirms that in the Netherlands, the development and implementation of adaptation measures rests on the shoulders public authorities. Private actor's involvement in local adaptation is limited. Encouraging the involvement of public parties in climate adaptation governance is a key step in solving the bottleneck that is currently hampering climate adaptation (Uittenbroek et al ,2013).

The body of literature on climate adaptation in cities has grown significantly the past years due to multiple national and international research programs. As a result there is an extensive toolbox available describing a wide variety of both structural and non-structural measures for reducing urban flash floods risk (MWH, 2012). Despite the attention from academics, climate adaptation generally does not receive much attention from urban planners in the Netherlands (Runhaar et al, 2012). Although many cities have the ambition to integrate climate adaptation in their policy, measures usually stay limited to pilots and demonstration projects (CPC, 2014). Reasons for this are: lack of sense of urgency, lack of problem recognition, lack of political will, competition of other planning problems, lack of pressure from citizens or NGO's, denial of

responsibility, inflexibility of urban areas and costs/budget constraints (Runhaar et al, 2012). These barriers make it difficult for Dutch cities to adapt to the growing urban flash flood risk.

The concept of governance is widely acknowledged as a valuable approach in the context of realizing climate adaptation. Bauer et al (2012) states it has been linked to the realm of climate adaptation by a significant amount of scholars. Termeer et al (2012) even argue that it is the most appropriate approach for steering climate adaptation. Kooiman (2003) states that the governance approach is especially appropriate for societal challenges where there is a recognition of interdependencies since it encourage interactions between interdependent public and private actors. Knowledge on governance of climate adaptation at national and regional scale has grown considerably. Research on local city scale, where adaptation strategies are implemented, remains limited (Ward et al, 2013). There is a knowledge gap in 'governance knowledge' which helps in understanding the complex social systems in which climate adaptation occurs (Termeer et al, 2011). Runhaar et al (2012) specifically call for "*more research into the scope of governance arrangements for climate adaptation*" (p787). Governance arrangements are rules, processes and instruments which structure the interaction within a governance network to realize a collective goal (Termeer et al, 2011). Increasing understanding on the governance of local adaptation can stimulate the implementation of adaptation measures which is currently slow (Uittenbroek et al, 2013) and make better use of the potential there is at local level for flash flood risk reduction when civil society, market and state work together (AMPF, 2007). Furthermore the focus on local level can be considered significant because actual adaptation happens at this scale, adaptation is highly dependent on local context (Agrawal, 2010).

This research elaborates on the call by Termeer et al, 2011 and Runhaar et al (2012), above, for more research on the local governance (arrangements) of climate adaptation by researching the governance of adaptation to flash flood risk in Arnhem. The point of departure is that several public and private actors are interdependent in adapting to growing flash flood risk. The aim of this study is to develop a set of governance arrangements to steer flash flood adaptation. Due to the complexity of the Dutch flash flood governance network (Waternet, 2014) this study will focus on four key actors: municipalities, housing association, insurers and residents. This research is done in collaboration with the municipality of Arnhem and complements the Action Plan which is currently being developed by the municipality. Where the Action Plan has a stronger focus on measures that can be taken by the municipality to reduce the impact if heavy downpours, this research puts emphases on long-term collaboration with private actors in flash flood adaptation.

Asselt & Renn (2011) state that governance can be used as both a descriptive tool and normative tool. Governance as a descriptive tool can be used for understanding governance processes. Governance as a normative tool can be used for organizing and managing governance processes (Asselt & Renn, 2011). This dual interpretation of governance is fundamental for this research. Formulating governance arrangements to steer effective climate adaptation to growing flash flood risk in Arnhem relates to the normative aspect of governance and is connected to the societal relevance of this research. Like Arnhem, climate adaptation is hampered in other Dutch cities (Runhaar et al, 2012). Results of the Arnhem case study can be valuable for other Dutch cities struggling with the realization of climate adaptation. But before being able to formulate governance arrangements it is essential to understand the local flash flood adaptation governance context. This relates to the descriptive aspect of governance and is connected to the academic relevance of this research. This research adds to the understanding of the complex social dynamics of local adaptation governance processes. The ultimate goal of formulating flash flood governance arrangements can therefore be considered equivocal. This duality is recognized in the research questions underlying this thesis.

Primary research question

Which governance arrangements are most suitable to steer effective adaptation to growing flash flood risk on the local scale of the city of Arnhem?

Secondary research questions

1. How can governance of flash flood adaptation be conceptualized from a theoretical perspective?
2. How does institutional context influence the governance of flash flood adaptation in Arnhem?
3. How does adaptive capacity of key actors influence the governance of flash flood adaptation in Arnhem?
4. How do existing interactions, and interdependencies influence the governance of flash flood adaptation in Arnhem?
5. What are the bottlenecks in current flash flood adaptation governance context in Arnhem?

2. Theory

2.1 Defining urban flash flood risk

Urban flash flood

An urban flash flood, henceforth referred to as flash flood, is a form of pluvial flooding which occurs when drainage systems (both natural and manmade) are unable to process the sudden high volume of rainwater that is released during an extreme weather event (AMPF, 2007). This type of flood often occurs at much smaller range of spatial and temporal scale than fluvial and coastal floods (Spekkers et al., 2013). Flash floods can result in material damages, traffic disruption and societal disruptions and generally do not cause fatalities. Practice has shown that also minor flash flood events with relatively small flood volumes are able to produce considerable damage over a longer period of time due to their high frequency of occurrence (Freni et al., 2010; Ten Veldhuis, 2011).

Flash flood risk

Flash flood risk can be defined as the product of the *probability* of a flood occurring times its (potential) *consequences* (EC, 2007).

Flash flood risk management

Flash flood risk management can be described as implementing measures which reduce the probability and/or the consequence of a flash flood. Measures assigned at reducing flood probability are often denoted as "structural measures". Measures assigned at reducing potential damage are often denoted as "non-structural measures" (Oosterberg et al, 2005). Structural measures aim at reducing runoff rates (e.g. reducing impermeable surfaces) and increasing storage capacity (e.g. water-butts for temporary rainwater storage). Examples of non-structural measures are flood proofing of buildings, forecasting and warning systems, raising awareness and increasing preparedness.

2.2 Growing flash flood risk

Climate change, increasing flash flood probability

There is widespread consensus among scholars that the emission of anthropogenic greenhouse gases is causing climate change. Climate change is considered to be one of the most pressing issues on

contemporary society. Its adverse effects are expected to increase and exacerbate in the next centuries (PLB, 2013). IPCC (2001) and KNMI (2014) conclude climate change to cause, among other things: sea level rise, higher river discharges, droughts, increasing precipitation, intense showers, increasing temperatures and increasing storms. Within urban areas in the Netherlands climate change is associated with increasing urban heat stress and growing risk of pluvial floods and fluvial floods (PLB, 2009). This research focuses on the growing risk of pluvial floods in urban areas, in this research referred to as urban flash floods. The Dutch Meteorological Institute (KNMI) predicts the future development of rain patterns along four scenarios (table 1). These scenarios are four combinations of two different variables: temperature rise which is divided in “moderate” (G) and “warm”(W) and air draught patterns which is divided in “high values” (H) and “low values” (L). It goes beyond the scope of this research to discuss these scenarios in more detail. For a more comprehensive description this research refers to KNMI (2014).

In general KNMI research on precipitation trend has focused on two variables: the development in the amount of rainfall and the frequency of occurrence of intense downpours. Figure 1 shows that the annual precipitation for the Netherlands between 1910 and 2013 has increased by 26%. For the future KNMI (2014) expects an increase in precipitation in all seasons except for summer (figure 2). The frequency of extreme downpour events is expected to increase in all seasons (KNMI, 2014). In addition to KNMI’s (2014) findings, research by Larsen et al (2008) concludes that the amount of extreme downpour events will still be highest in the summer period. The increase in both quantity of rainfall and frequency of extreme downpours is the direct result of the warming of the atmosphere. Warm air can contain more moisture (IPCC, 2013). The frequency of downpours is expected to increase more in coastal regions in the Netherlands due to influence of the North Sea (KNMI, 2009). It must however be mentioned that changes in local precipitation extremes are highly uncertain due to the small scale nature of the development of intense downpour events. But in general there is clear evidence that both the amount of precipitation and the frequency of extreme precipitation will rise in the future. This means that if no measures are taken flash flood risk will rise in the Netherlands due to increase in probability of occurrence (PLB, 2009).

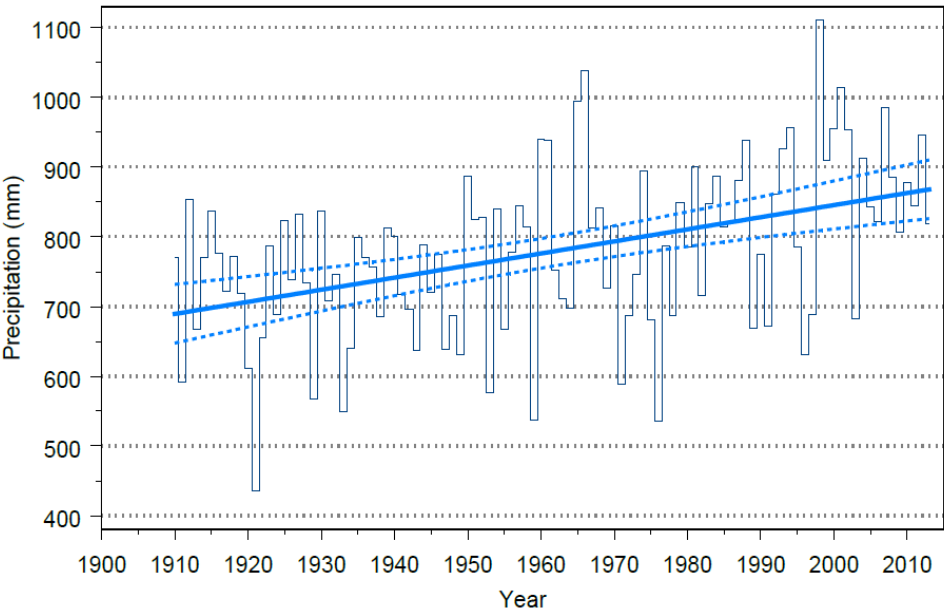


FIGURE 1: ANNUAL PRECIPITATION IN THE NETHERLANDS BETWEEN 1910-2013 (MEAN OF 102 STATIONS). THE STRAIGHT LINE REPRESENTS A LINEAR REGRESSION FIT. THE DASHED LINES GIVE THE 95% CONFIDENCE BANDS, SOURCE: KNMI (2014).

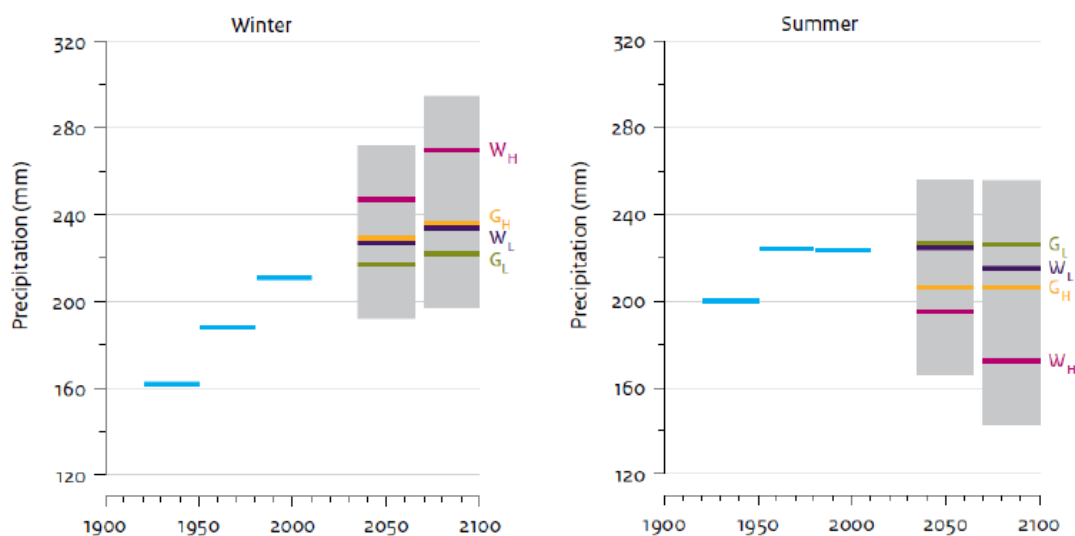


FIGURE 2: WINTER AND SUMMER PRECIPITATION IN DE BILT (NETHERLANDS). SHOWING 30 YEAR AVERAGES IN BLUE, KNMI'14 SCENARIOS FOR 2050 AND 2085 IN FOUR COULOURS AND THE NATURAL VARIATION SHOWN IN GREY, SOURCE: KNMI (2014).

Precipitation period	1 hour					1 day					10 days				
	Present	G	G+	W	W+	Present	G	G+	W	W+	Present	G	G+	W	W+
1 year	14	15	-	17	-	33	36	35	39	36	80	85	81	89	82
10 year	27	30	-	33	-	54	60	57	66	60	114	122	116	130	119
100 year	43	48	-	53	-	79	88	84	98	88	143	154	146	164	150

TABLE 1: PRECIPITATION EXTREMES IN MILLIMETERS IN DE BILT, TODAY AND PROJECTED FOR 2050 ACORDING TO THE KNMP'06 SCENARIOS, SOURCE: PLB (2013).

Socioeconomic development, increasing potential damage

The amount of damage due to weather related hazards is increasing throughout the world (MunichRe, 2006). Multiple researchers have shown that this is mainly the result of socioeconomic development rather than of climate change (Botzen et al, 2010). Urbanization, higher concentration of people and businesses located in areas vulnerable to extreme-weather events, growth in single person households, population growth, increased concentration of population and economic valuable functions and growing wealth are mentioned as trends increasing the potential losses due to extreme weather events (Ward et al, 2008; Botzen et al, 2010). This research aims at formulating governance arrangements which can help to counteract the above described trend of growing flash flood risk.

2.3 Climate adaptation

Measures taken to reduce the effects of climate change can be captured in to two strategies: climate mitigation and climate adaptation. In this context climate mitigation refers to an “*anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks*” (IPCC, 2007, p.878). Climate adaptation can be defined as an “*adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities*” (IPCC, 2007, p.878). Adaptation aims at reducing the vulnerability and enhancing resilience of a system (IPCC, 2007). Research by Adger et al (2005), Swart et al (2009) and IPCC (2013) show that climate adaptation is needed because at current rate climate mitigation is not enough to prevent the adverse effects of climate change from happening. Flash flood risk management can be considered climate adaptation as it is a planned response to moderate harm of increasing and intensifying precipitation patterns. Climate adaptation in the context of flash flood management can be describes as: all measures taken aimed at directly or indirectly reducing flash flood risk.

There is a large body of literature available on concrete adaptation measures that can be implemented to reduce flash flood risk. In general these measures aim at either reducing runoff rates, increasing storage capacity or preventing damage by water ingress. These measures can be divided into measures taken on city scale, street/neighborhood scale or building/parcel scale. Table 2 shows the yield of a literature research on flash flood adaptation measures. Despite the abundance of flash flood risk adaptation measures, implementation lags behind in Dutch cities (CPC, 2014), hinting a lack of adaptive capacity (IPCC, 2007). Runhaar et al (2012) argue this is due to varying barriers that hamper problem recognition and the development of adaptation plans.

Adaptive capacity

Adaptive capacity in the context of climate adaptation determines whether a system is successfully capable of adapting to the adverse effects of climate change (IPCC, 2007). The presence of adaptive capacity has been shown to be a prerequisite for the implementation of adaptation strategies (Brooks & Adger, 2005). The features that influence the ability of the system to adapt can be seen as the determinants of adaptive capacity (Adger, 2003; Smit & Wandel, 2006). Although there is agreement amongst scholars on the broad definition of adaptive capacity, interpretations on how to enhance the adaptive capacity of a system vary (Smit & Wandel, 2006). This paragraph aims at providing an overview of ways the adaptive capacity of a system, in this research being the municipality of Arnhem, can be enhanced. These insights will be used to link the notion *climate adaptation* to the concepts of *governance* and *institutions* which will be introduced later as part of the theoretical framework.

In general the capability of a system to adapt depends on two aspects; the capacity of individuals to adapt (which is determined by the availability of different resources) and the ability to act collectively in the face a certain threat (Adger et al, 2004). The general act of increasing a system’s adaptive capacity can be defined as *capacity development*. Capacity development aims to “*expand the coping range and strengthen the coping capacity of a priority system with respect to certain climate hazards, and thus to build the capacity of the system to adapt to climate change*” (Brooks & Adger, 2005, p.168).

	Reducing runoff rates	Increasing storage capacity	Flood proofing
Building/Parcel	<ul style="list-style-type: none"> • Unpaved gardens (infiltration) 	<ul style="list-style-type: none"> • Green roofs (i.e. plant cover) • Green facades (i.e. plant cover) • Unpaved gardens (water retention) • Water drainage (drainage in gardens, gutters etc.) • Blue roof • Rooftop rainwater harvest: water storage in basement. 	<ul style="list-style-type: none"> • Waterproof building: high thresholds , No crawl spaces, waterproof plaster and membranes on walls, water proof floors • Stop sewage water from entering a home: check valve, stench lock in showers, vent pipe
Street / Neighbourhood	<ul style="list-style-type: none"> • Water permeable pavement. • Lower water tables • Separation of rainwater and sewage water plumbing • Increasing sewage capacity • Drainage systems • Infiltration wells • Infiltration units • Infiltration trenches • Water squares • Infiltration drainage sewage systems • Infiltration transport sewage systems 	<ul style="list-style-type: none"> • Extra green space (increase interception by plants and trees, deciduous tree with big crown are especially suitable for intercepting water). • Water storage facilities open water • Dry pumps • Wadi's 	<ul style="list-style-type: none"> • Adjustment of ground level • Install kerbs to keep water on the street • Build kerbs and use streets to discharge water
City		<ul style="list-style-type: none"> • Water storage in or near city in parks or open water • Dewatering a priori • Water infiltration utilities 	<ul style="list-style-type: none"> • Water discharge system over land

TABLE 2:ADAPTATION MEASURES AIMED AT REDUCING RUNOFF RATES, INCREASING STORAGE CAPACITY AND FLOOD PROOFING ON BUILDING/PARCEL, STREET/NEIGHBOURHOOD AND CITY SCALE, SOURCE: RUNHAAR ET AL (2012); CPC (2014); HVA (2013); RIONED (2014); MWH (2012); WOODS-BALLARD ET AL (2007).

The capacity of individuals to adapt

The capacity of individuals to adapt is dependent on the available financial, informational and technological resources (Smit & Wandel, 2006).

- Financial resourcefulness refers to the monetary budget individuals have available to invest in climate adaptation.
- Informational resourcefulness refers to knowledge individuals possess about the nature and evolution of the climatic hazard faced by society (Brooks & Adger, 2005). Lack of informational resourcefulness could result in unawareness or refusal to accept the risks associated with climate change.
- Technological/human resourcefulness refers to the availability of technologies, expertise, skill and innovations which help to effectively reduce flash flood risk.

Smit et al (2001) have shown the significance of the availability of the above mentioned resources as the ability to adapt is lowest in poor communities where financial resources, information, skills and technology are least available.

The capacity to act collectively

Adger et al (2004) state that societies have inherent capacities to adapt to climate change and that these capacities are dependent of the ability of societies to act collectively. Collective action requires networks and flows of information between both public and private parties (Adger, 2003). This makes adaptation a dynamic societal process within which governance networks and relations between state market and civil society actors play a key role. This illustrates the interdependency between public and private domains to achieve adaptation (Smit & Wandel, 2006). Adaptive capacity is therefore partly determined by governance structures and their institutional contexts to enable and stimulate adaptation (Root et al, 2014). This can relate to both institutional structures (hierarchical, ridged governmental or more fluid, synergetic governance) as well as leading attitudes within these institution (sense of urgency or problem recognition). Understanding and intervening in these institutional contexts and governance structures is therefore an important means of increasing adaptive capacity and realizing adaptation actions (Adger, 2003). Creating synergies between institutions and individuals can stimulate climate adaptation (Adger, 2003) and on the flipside, conflicts can raise barriers that hamper and frustrate adaptation. At local level barriers can take the form of national regulations or economic policies: local level receiving more legal responsibilities because of decentralization and budget cuts are examples of such barriers reducing the urgency for climate adaptation. Runhaar et al (2012) formulates institutional barriers for climate adaptation in the Netherlands (table 3).

The above described factors that enhance adaptive capacity remain quite general for a reason; adaptive capacity is context specific (Smit and Pilifosova, 2003; Adger et al, 2004; Smit & Wandel, 2006; Adger, 2003; Brooks & Adger, 2005). The capacity to adapt varies amongst countries, municipalities, cities, groups and individuals. Furthermore it changes over time (Smit & Wandel, 2006). But also is differs between types of risk. Different types of risks require different types of resources (Adger et al, 2004) and involve different networks of interdependent actors. Also the barriers which have to be addressed will differ between contexts. A capacity building strategy requires to be tailor-made to fit the institutional and governance context. Figure 3 visualizes how this research interpreters adaptive capacity and its relation with the implementation of adaptation measures.

<i>Barriers to problem recognition</i>	<i>Barriers to development of adaptation plans</i>
<p><i>Political/ institutional</i></p> <ul style="list-style-type: none"> • Lack of political will (short-term politics) • No clarity about responsibilities for adaptation/framing adaptation • Consider it to be a private problem • Competition from other planning problems • Institutional fragmentation • Lack of pressure from citizens or NGOs <p><i>Resources</i></p> <ul style="list-style-type: none"> • Budget cuts • Lack of resources (in particular for small municipalities) <p><i>Nature of the problem</i></p> <ul style="list-style-type: none"> • Denial of climate change (climate cynics) • Uncertainties in scientific evidence • Lack of insight into local impacts/difficulties in translating climate change to the local level • Unawareness of the issue 	<p><i>Political/ institutional</i></p> <ul style="list-style-type: none"> • No problem recognition or sense of urgency • Distribution effects (winners/losers) • No clarity about responsibilities for adaptation • Not clear who should finance adaptation (or how) • Institutional fragmentation/complexity • Lack of cooperation from actors within the municipality or outside it/lack of possibilities to steer these internal and external actors • Lack of public or political support • Competition from other planning problems <p><i>Resources</i></p> <ul style="list-style-type: none"> • Lack of insight into possible adaptation measures • Lack of resources (in particular for small municipalities) • High costs/budget constraints <p><i>Nature of the problem</i></p> <ul style="list-style-type: none"> • Inflexibility of urban area and high costs associated with adapting existing buildings and public space • Path dependency (e.g. contracts with project developers that need to be reopened)

TABLE 3: BARRIERS TO CLIMATE ADAPTATION IN THE NETHERLANDS, SOURCE: RUNHAAR ET AL (2012).

Based on the above it is comprehensible why scholars see capacity development as a change management process within governance frameworks (Brooks & Adger, 2005). Termeer et al (2012) motivate that the polycentric, dynamic governance approach is required as opposed to a monocentric, hierarchical government perspective to guide climate adaptation because adaptation occurs in complex and dynamic institutional environments where different state, market and civil society actors are interdependent. Consequently adaption depends upon the involvement of many public and private actors with their own ambitions, interests, beliefs, knowledge and resources (Termeer et al, 2012). Due to this nature of climate adaptation it is best steered with a governance approach (Duit & Galaz, 2008; Koppenjan and Klijn, 2004) making capacity development a gradual process rather than something that occurs instantaneously (Adger et al, 2004). Practice shows that climate adaptation happens in small incremental steps (Termeer et al, 2012), making climate adaptation something that can only develop in a process that requires time and planning.

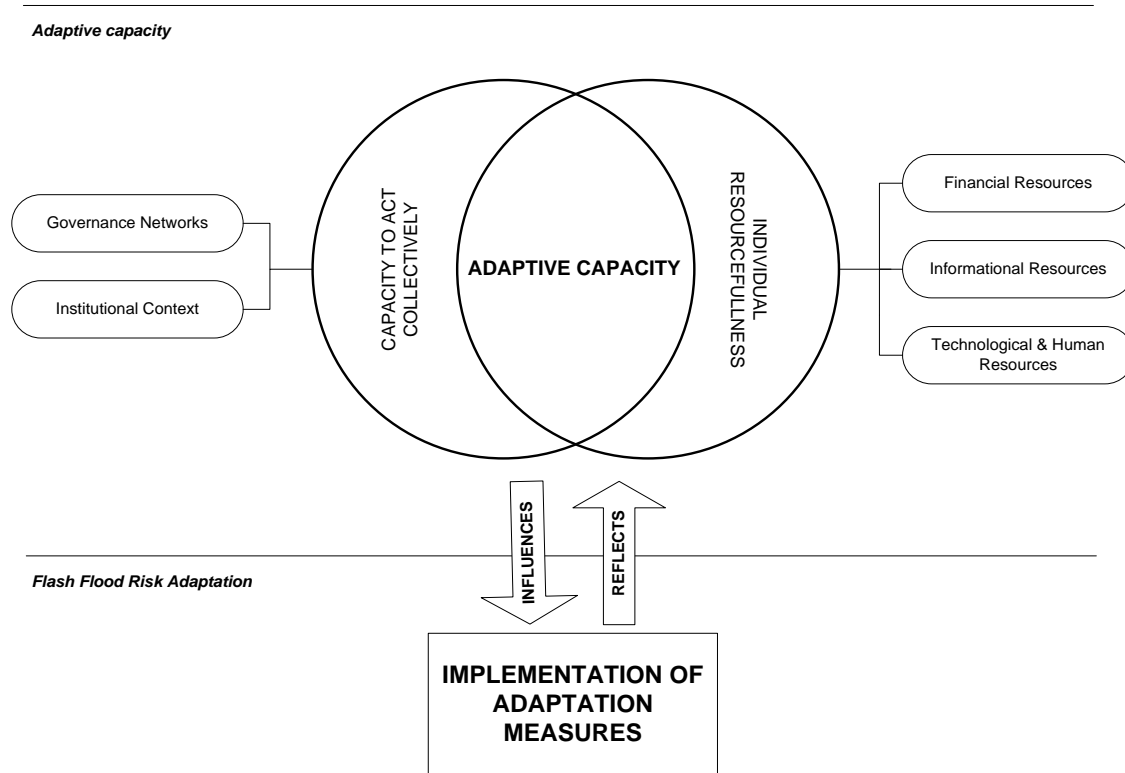


FIGURE 3: BUILDING A CONCEPTUAL MODEL STEP ONE: ADAPTIVE CAPACITY INCLUDING ITS COMPONENTS IN RELATION TO THE IMPLEMENTATION OF ADAPTATION STRATGIES.

2.4 Institutionalism

Institutions shape governance interactions since governance processes are embedded in an institutional context (North, 1990). Institutions are furthermore essential for the evolution and persistence of collective action (Adger, 2003) and therefore for climate adaptation (Root et al, 2014). Consequently, governance of institutions is considered a method to steer climate adaptation (Agrawal, 2010; Funfgeld, 2010). This paragraph elaborates on the notion of institutionalism by first delineating the comprehensive scope of the institutionalism discussion to a focus that fits the approach of this research and then goes into more detail on the relationship between *institutions* and both *climate adaptation* and *governance*, building further on the conceptual model.

New institutionalism

Although institutions can be interpreted in a variety of ways (Kim, 2011), they can generally be divided in formal and informal institutions. Formal institutions include '*state institutions (courts, legislatures, bureaucracies), state enforced rules (constitutions, laws, regulations), and official rules that govern organizations*' and informal institutions are '*socially shared rules, usually unwritten, that are created, communicated, and enforced outside of officially sanctioned channels*' (Helmke & Levitsky, 2004, p.727). Together they form the formal and informal 'rules of the game' (Folke & Boyd (eds.), 2011), which is a much used appellation for institutions. It is said that all planning and decision-making takes place within a specific institutional context (Alexander, 2005).

In addition to the distinction between formal and informal, institutions can be specified along different theoretical perspectives. There are three main theoretical schools of institutionalization theory; historical institutionalism (institutions as historic accretion), rational choice institutionalism (institutional economics with rational actors with fixed preferences) and sociological institutionalism (Alexander, 2005; Hudalah et al, 2010). This research relates to social interpretation of institutionalism, also referred to as *new institutionalism*. This approach to institutionalism states that institutions are ‘not necessarily predetermined but are socially constructed in daily practice’ (Hudalah et al, 2010, p.2257) which means that institutions can also be reconstructed (Kim, 2011). The social construct of informal institutions emerge through the recurrence and solidification of actions through norms, beliefs, perceptions (Buitelaar et al. 2011). These interactions form beliefs, norms and culture that are the micro foundations that build formal institutions such as laws and regulations (Greif, 2006). Due to the changing nature of society and socio-political norms, institutions change constantly (Root et al, 2014). Therefore it is said that institutions generally reflect leading socio-political norms (Root et al, 2014). Due to the socially constructed nature of institutions, institutional contexts differ between countries, regions even and neighborhoods. Because these socio-political norms evolve due to changes in society, institutions change.

Institutions and climate adaptation

Runhaar et al (2012) argue that institutions can be both a facilitator and a limiter of climate adaptation in the Netherlands. Root et al (2014) discuss that there are more scholars working in the field of climate adaptation that acknowledge the stimulating and tempering effect institutions can have on climate adaptation. Institutions can be seen as ‘the rules of the game’ in which adaptation occurs: “*adaptation processes involve the interdependence of agents through their relationships with each other, with the institutions in which they reside, and with the resource base on which they depend*” (Adger, 2003, p. 388). It is hard to generalize how institutions influence adaptation processes because institutional influence is highly dependent on local context (Agrawal, 2010). The influence of institutions on climate adaptation therefore varies between places.

Institutions and governance

For explaining the relation between institutions and governance this research relates to the conceptual perspective of Root et al (2014). They state that there is a dynamic interplay between institutions and governance (Root et al, 2014). Their interpretation of institutions as the formal and informal ‘*rules of the game*’ is in line with what is discussed above. These ‘rules’ are dynamic and change over time by the influence of complex and dynamic governance processes. In turn, these governance processes are embedded in an institutional context (North, 1990). So the relation between institutions and governance can be seen as twofold: on the one hand institutions influence and shape the actions of individuals and organizations in governance processes (figure 4). On the other hand governance networks are spaces of innovation shaping and influencing the institutional context in which they occur (Hall & Thelen, 2009). Climate adaptation is therefore influenced by governance networks as well as the institutional context in which the networks are embedded (Root et al, 2014).

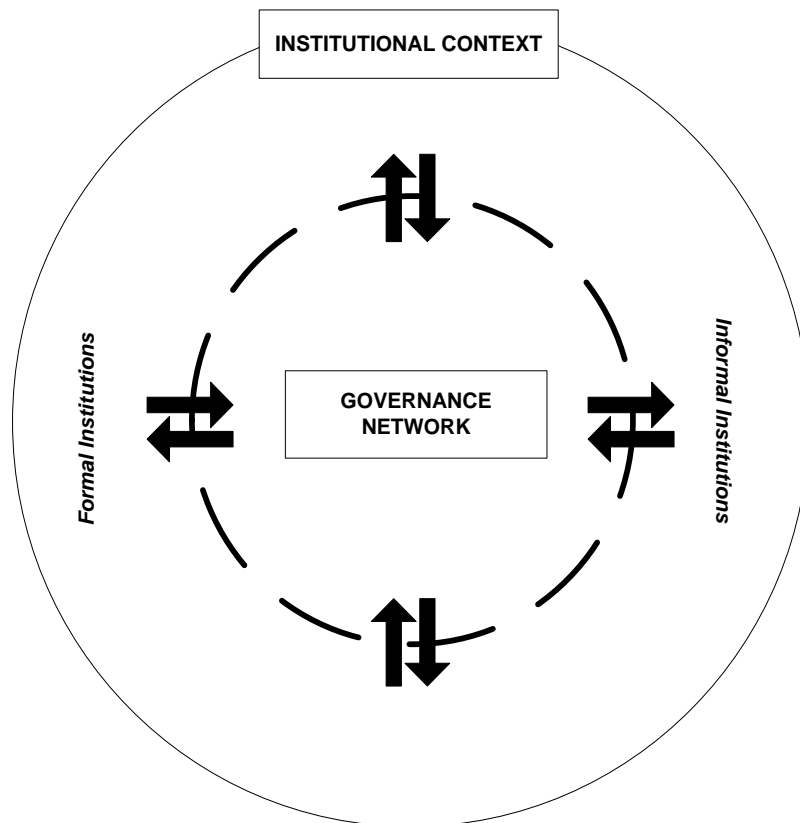


FIGURE 4: BUILDING A CONCEPTUAL MODEL STEP TWO: GOVERNANCE NETWORKS ARE EMBEDDED IN AN INSTITUTIONAL CONTEXT WHICH CAN BE DIVIDED INTO FORMAL AND INFORMAL INSTITUTIONS. THE BLACK ARROWS SHOW THAT INSTITUTIONAL CONTEXTS SHAPE AND INFLUENCE GOVERNANCE NETWORKS AND VICE VERSA GOVERNANCE NETWORKS SHAPE AND INFLUENCE THE INSTITUTIONAL CONTEXT.

2.5 Governance

The notion of governance is of key relevance to this research. Not only because in recent years it has been linked to the realm of climate adaptation by a significant amount of scholars (Bauer et al, 2012); it is even being recognized as the most appropriate approach for steering climate adaptation (Adger et al, 2005; IPCC, 2007; Termeer et al, 2012). It also fits planning contexts, such as flood risk governance (Meer et al., 2013), where interdependency between actors exist (Kooiman, 2003). After a general introduction on governance this paragraph describes four governance perspectives this research relates to. Thereafter it is explained how governance can be put to use as both a descriptive- and normative tool.

Governance is a concept that came into fashion in the 1980's (Stern, 2000). It implies '*a change in the meaning of government, referring to a new process of governing; or a changed condition of ordered rule; or the new method by which society is governed*' (Rhodes, 1996, pp. 652–3). Forester (1999) refers to this change as the change from the traditional paradigm of "planning for the people" to "planning with the people". It speaks to a re-emphasis of the government's role from one of 'command-and-control' to one of service provider, facilitator and partner of the community (Hildebrand, 1997). Government refers to the traditional perspective on decision-making, done by a single stakeholder following a strict hierarchical order (top-down) (Driessen & Vermeulen, 1995) while governance stands for a more integrated planning approach,

where power is divided among multiple actors (also referred to as bottom-up) (Fraser et al., 2006). This is in line with work by Hajer & Wagenaar (2003) who interpret the change from government to governance as the shift from institutions to networks, where stable decision-making processes have become more fluid and boundaries between and within the public and private sectors are becoming blurred (Lamos & Argwal, 2006). This shift goes hand in hand with a change in vocabulary. “*Terms like ‘governance’, ‘institutional capacity’, ‘networks’, ‘complexity’, ‘trust’, ‘deliberation’ and ‘interdependence’ dominate the debate, while terms like ‘the state’, ‘government’, ‘power’ and ‘authority’, ‘loyalty’, ‘sovereignty’, ‘participation’ and ‘interest groups’ have lost their grip on the analytical imagination*” (Hajer & Wagenaar, 2003, p.1).

Governance has gained much popularity (Kooiman, 1999; Rhodes, 1999). As a result governance now knows a wide variety of interpretations. Kooiman (1999) already defines ten and suggests that different definitions and applications of governance are suitable for varying circumstances. Therefore it is appropriate to formulate a specific interpretation of governance which fits the context of this research. This is done by combining insights from the network approach-, social political approach-, multileveled approach-, interactive approach- and risk approach to governance. It is important to realize that these interpretations do not exist separate from each other. These approaches have big overlap but each puts emphasis on a certain aspect of governance.

Four perspectives on governance

- Network governance: Rhodes (1996) advocates this perspective on governance. The network perspective implies that there are multiple steering actors in society. Networks of interdependent actors constitute around social issues where responsibilities are shared (Rhodes, 2000). Interdependency plays a central position in this perspective. The, mostly horizontally oriented, governance networks that form around a problem prove much more effective in solving a problem than traditional hierarchical government structures.

- Social-political or interactive governance is a perspective promoted by Kooiman (2003, et al.2005, et al.2008). Interaction and interdependency are key concepts in this governance approach. Governance is seen as: “*the whole of interactions taken to solve societal problems and to create societal opportunities; including the formulation and application of principles guiding those interactions and care for institutions that enable and control them*” (Kooiman et al. 2005, p. 17). Interdependencies are seen as the trigger for these interactions (Kooiman, 2003). Single actors do not have all the knowledge or resources to make policy work. Therefore interdependency between different societal and political actors exist. These interdependencies are growing ever stronger since societies are becoming more diverse, complex and dynamic (Kooiman, 2003). Governance occurs in a wide variety of networks consisting of actors that can be divided into three main governance arenas: state, market and civil society (Kooiman, 2003; Lamos & Argwal, 2006) (figure 5).

- The multi-level governance perspective is the product of a study on EU cohesion policy and is applied for structuring EU decision-making (Bach, 2005). It describes how decision making competences are shared amongst actors at different levels of government (supranational, national, regional and local) (Marks & Hooghe, 1996). In this multilayered governance structure different tiers have multiple actors with diverging roles who are involved in the process of decision making (Scharpf 1994). Many researches have shown that relation between local, regional, national and international government authorities are significant in determining the scope of climate adaptation responses (Bulkeley, 2010).

- Risk governance translates core principles of governance to risk management. Risk governance embraces a broad picture of risk, it “*deals with the identification, assessment, management and communication of risks in a broad context*” (IRGC, 2007, p.4). This approach fits types of risk that are surrounded by uncertainty, complexity

and/or ambiguity (van Asselt & Renn, 2011) and require coordinated effort amongst a variety of actors from different backgrounds who are interdependent (IRGC, 2005). Flash flood risk can be described as an uncertain, complex and vague type of risk due to its context dependent nature (CPC, 2013), variety of risk perceptions (Maas et al. 2013) and interdependency among a wide variety of actors (Runhaar et al. 2012). Flash flood risk governance draws attention to a diversity of actors, their various roles and relationships, and all the networks emerging from these relationships. It links context to risk governance by effectively engaging stakeholders in risk reduction (IRGC, 2005).

Governance in the context of flash flood adaptation in the Netherlands

The interpretation of governance used in this research builds on the four conceptions described above. Flash flood adaptation governance is defined as:

The totality of interactions between state, market and civil society actors in realizing the collective goal of adapting to growing flash flood risk. Due to interdependencies between different actors, networks emerge around specific flash flood issues. Although these networks are mainly horizontally oriented, local government is interdependent of other governmental bodies from differing layers who play key roles in flash flood risk governance.

Governance as a descriptive and normative tool

The governance perspective can be used as a descriptive tool to provide insight in the roles, responsibilities and positions of relevant actors. Governance can be used to describe relations between different actors involved in a governance issue. Ward et al (2013) state that agreement on the distribution of responsibilities and tasks is a prerequisite for successful collaboration in complex multi-actor settings. Governance as a descriptive tool will be used below to define the flash flood governance network in Dutch cities. Where governance as a descriptive tool aims at formulating and understanding the relations between actors involved in a certain issue, the normative perspective focuses on using these interactions for organizing and managing society (Asselt & Renn, 2011). Governance arrangements can be used as tools to guide governance interactions (Termeer et al, 2012). Governance arrangements can be defined as the "*ensemble of rules, processes, and instruments that structure the interactions between public and/or private entities to realize collective goals for a specific domain or issue*" (Termeer et al, 2011, p. 161).

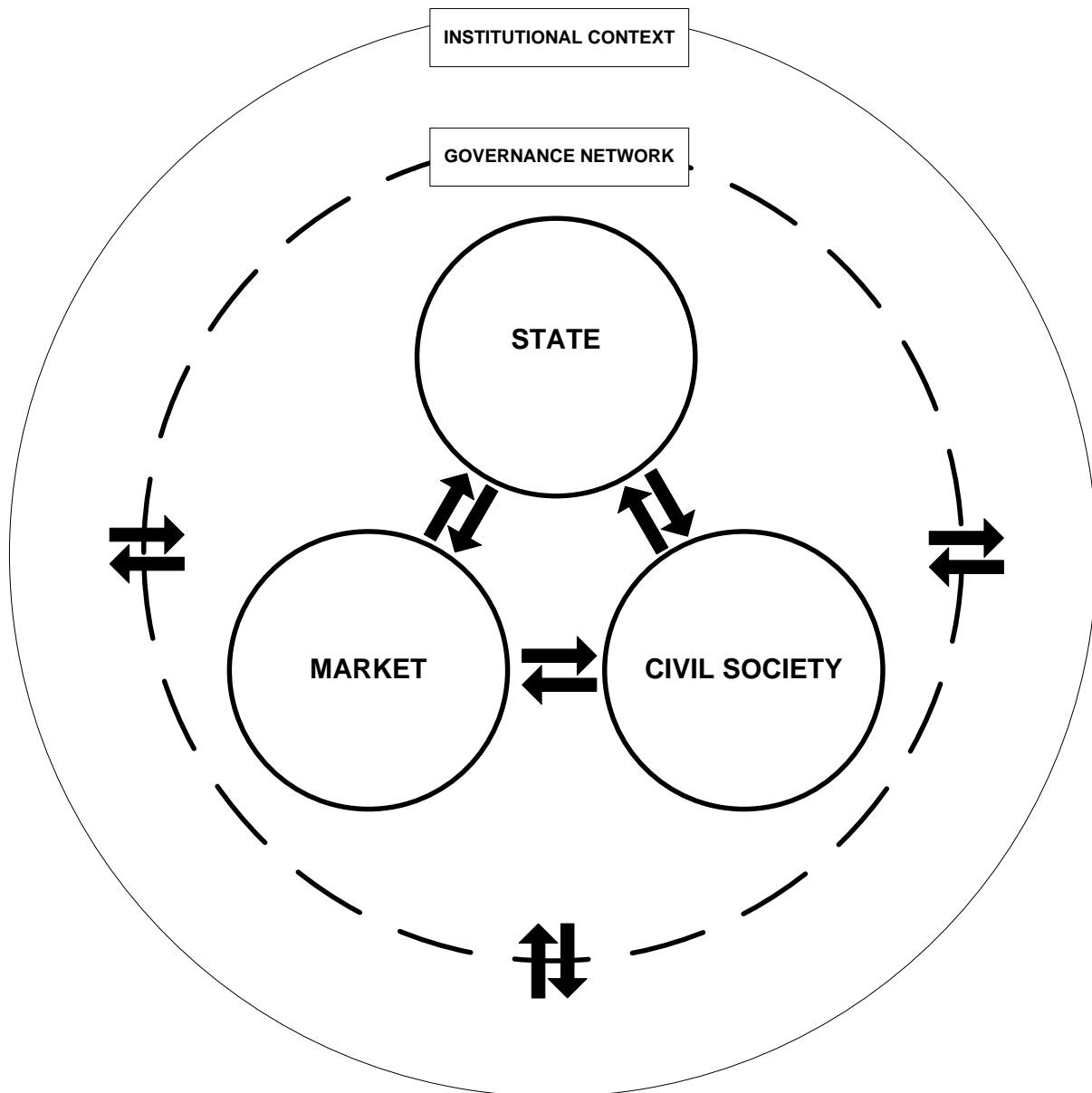


FIGURE 5: BUILDING A CONCEPTUAL MODEL STEP THREE: A GOVERNANCE NETWORK CONSISTS OF STATE, MARKET AND CIVIL SOCIETY ACTORS WHICH ARE INTERACTING DUE TO THEIR INTERDEPENDENCY TO ACHIEVE GOALS OR SOLVE PROBLEMS. THIS GOVERNANCE NETWORK IS EMBEDDED AND INTERACTING WITH ITS INSTITUTIONAL CONTEXT.

Critical side note on governance

Literature provides two critical side notes to the governance approach. The first is motivated by Maas et al (2013) who point out how the shift from government to governance in flood risk management raises legitimacy issues. This makes it crucial to design governance arrangements in such a way that enough legitimacy is built throughout the process. Especially the governance of adaptation to climate change is challenging from a legitimacy perspective (Van Buuren et al, 2014). Climate change is a typical example of an inherent complex and uncertain problem. In such circumstances there are many different opinions on the best course of action. When people value things differently these interpretations should, from a legitimacy perspective, all be taken into consideration. For more detailed discussion on legitimacy and governance this research refers to Maas et al (2013) and van Buuren et al (2014). The second critical note

is formulated by Termeer et al (2013), they states that climate adaptation is a “*wicked problem par excellence*” (p.28) and argue that governance of adaptation is violating the moral principle climate adaptation as a wicked problem by formulating it as a tame one. Termeer et al (2013) warns governance scholars to raise expectations beyond their delivery when they do not acknowledge the inherent uncertainties around climate adaptation.

2.6 Flash flood governance network in the Netherlands

Up to this point the theoretical debate has stayed relatively general by focusing on the overarching concepts related to this research. Along governance, institutionalism and adaptive capacity the contours of the conceptual model have been created. To give the model specific content this paragraph elaborates on the Dutch flash flood governance network. Besides appointing key actors this paragraph gives insight on the institutional context, relation between the governance actors and individual capacity in flash flood adaptation at local level based on literature research. The empirical research will provide more insight in the specific flash flood governance context of Arnhem.

Municipalities, housing associations, residents and insurance can be identified as key actors within the Dutch flash flood governance network on local level. This paragraph discusses the legal responsibilities, roles and interdependencies of each of the main actors based on literature research. Acknowledging that flash flood governance concerns a wider network of actors (Waternet, 2014) this paragraph also refers to actors beyond the four key actors defined in this research to create an extensive overview of the flash flood governance network.

Key state actors in the flash flood governance network

- Municipality

Legal responsibilities

Dutch legislation defines water management in the Netherlands as a multi-levelled game (OECD, 2014). Different governmental layers (state, provinces, regional water authorities and municipalities) have diverging responsibilities. The Water Act (*Waterwet*) ascribes municipalities the responsibility for collecting and processing rainwater (Art. 3.5) and preventing structural groundwater flooding (Art. 3.6). In addition the Environmental Management Act (*Wet milieubeheer*) assigns municipalities responsibility for the collection and discharge of sewage water. Runhaar et al (2012) state that this legal responsibility is a key motivation for municipalities to adapt to growing flash flood risk. The municipal responsibilities are labeled as a duty of care (*zorgplicht*). This municipal duty of care refers to the obligation to make an effort (*inspanningsverplichting*) rather than to achieve a certain standard (*resultaatverplichting*) (Mols & Schut, 2012). Also it is important to note that this municipal duty of care is limited to the public domain. For the discharge of rainwater this means that the municipality is required to create facilities in the public space where private landowners can drain rainwater which they are not able to process on their own parcel (Mols & Schut, 2012). How a municipality fulfills its duty of care should be described in a Municipal Sewage Plan (*Gemeentelijke Rioleringsplan*). The expenses that municipalities make for performing their duty of care is depicted on property owners through a sewage tax (*rioolheffing*). Legislation allows for this sewage tax to be combined or split up in a sewage water tax and a rain- and surface water tax (VNG, 2007).

Article 10.32a Environmental Management Act (Wet milieubeheer) gives municipalities the power to define rules considering the discharge of rainwater. Rules can include:

- Directions for discharging rainwater to a certain utility for the collection and discharge of sewage water.
- Directions for disconnecting the rainwater discharge from sewage water collection and discharge infrastructure.

Ideally the processing of rainwater occurs locally by infiltration or discharge on open water¹. Establishing additional discharge rules should occur in integral deliberation with the province, regional water authorities and other concerned actors².

Role in climate adaptation

Municipalities play a key role in adaptation since adaptation practices occur at local level (Adger, 2001; Termeer et al, 2011). A research amongst all 408 Dutch municipalities shows that around 60% claim to anticipate increasing flash flooding risk due to climate change in their sewage plans (RIONED, 2007). There is a growing sense of urgency amongst municipalities, almost half of the municipalities say to have experienced recurring events of flash flooding, about 30% state that flash floods are occurring more frequently and 40% state that the amount of reports and complaints on flash floods is increasing (RIONED, 2007). Yet most municipalities are not very active in developing adaptation plans (Runhaar et al, 2012) due to different barriers (table 3), a withdrawing government and the economic crisis (CPC, 2014). As a result municipalities experience increasing dependency on private investments for climate adaptation. To stimulate more private investments it is important for municipalities to play a facilitating role (Ruimtelijk Planbureau, 2004; van Rooy 2012).

Next to facilitating private actors in adaptation, municipalities have a legal responsibility in collecting and discharging rainwater that falls in the public domain or which cannot be processed on private owned land. In performing this legal responsibility there is plenty of opportunity to work on raising awareness. Creating multifunctional public water storage, discharging rainwater above ground are examples of this. This research acknowledges the executive role municipalities have but will not further elaborate on it. The municipal Action Plan has a distinct focus on the executive role of the municipality. This research focuses on the municipality's facilitating role.

Uittenbroek et al (2014) describe two main approaches for municipalities to organize climate adaptation: mainstreaming and the dedicated approach. Mainstreaming implies integrating adaptation into existing policy domains such as housing, spatial planning, green or urban development by finding synergies and possibilities for combining resources and couple policy ambitions. The dedicated approach is a more direct approach where climate adaptation is introduced as a distinct policy domain having its own resources and ambitions (Uittenbroek et al, 2014).

Interdependencies

Practice shows that for achieving climate adaptation municipalities are vertically and horizontally dependent on other governmental actors (Burkley, 2010). Holgate (2007) shows that vertically and horizontally oriented networks are important for successful implementation of climate change schemes. Vertical interdependence, in this research referred to as multileveled governance, states that adaptation also implies national, provincial and European actors (Wilson & Piper, 2010; OECD, 2014). This interdependency can be interpreted in two ways. First, different governmental layers are dependent on

¹ Parliamentary Papers II 2005-06, 30 578, nr. 3, p.30.

² Parliamentary Papers II 2005-06, 30 578, nr. 3, p.31.

each other for executing their legal responsibilities (figure 6). Legal responsibility for maintaining the quality of water resources (provinces & regional water authorities) and the management of sewage water (municipalities) overlap. Also the connection between sewage water collection (municipalities) and treatment (regional water authorities) creates interdependencies. Second, local authorities are dependent on state and European level (Termeer et al, 2011) for subsidies, legislative frameworks and policy guidance. For instance, in recent years several European states have begun to develop national adaptation strategies, policies and legislation to stimulate the adaptation (Biesbroek et al, 2010).

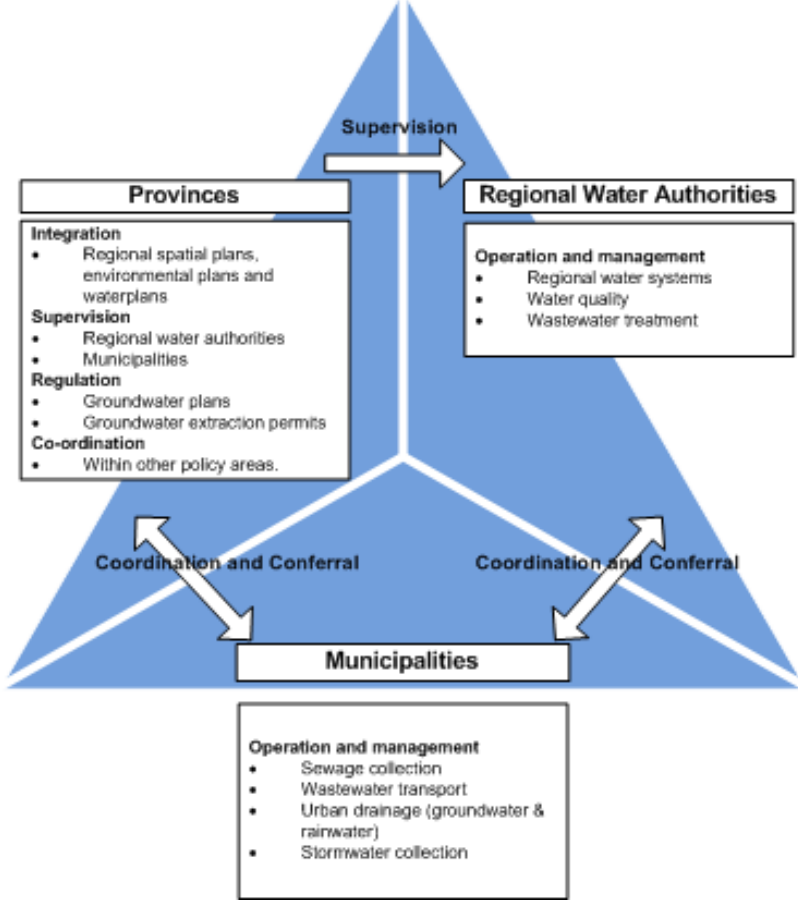


FIGURE 6: MUTUAL DEPENDENCY ACROSS THE THREE PUBLIC COMPONENTS OF THE SUB-NATIONAL “TRIANGIE”, BASED ON: OECD (2014).

Horizontal interdependency (in this research network governance) refers to collaboration in horizontal networks. The interdependency between state, market and civil society actors has already been discussed as a form of network governance. Practice shows that climate adaptation also occurs in horizontal governmental networks between different cities (Bulkeley, 2010) and amongst sectors within a municipality (Uittenbroek, 2013). The Climate Proof Cities program is an example of a program bringing multiple Dutch cities together in addressing climate adaptation. The horizontal integration of climate adaptation into existing policy sectors is earlier referred to as mainstreaming.

Key market actors in the flash flood governance network

- Housing associations

CBS (2014) shows that housing associations own a little over 2.2 million dwellings in the Netherlands. This corresponds to 30% of the total Dutch housing stock of 7.2 million. In general a single association possesses a large number of dwellings. In 2011, 389 housing associations each owned on average 6200 houses (CFV, 2012). Roders et al (2013) describe housing associations as an “*important starting point in the implementation of climate change adaptation measures*” (p. 279). There is a lot of potential to improve implementation of adaptation through housing associations since climate adaptation is generally not included in their policy (CPC, 2014).

Roders & Straub (2015) assess the likelihood of the implementation of climate adaptation strategies based on diverging conceptual approaches among 102 Dutch housing associations. The results show that for many associations, climate adaptation has no priority at all due to lack of financial resources. Working with external partners (municipalities, water boards, insurance companies) to finance adaptation was mentioned by some as a condition under which climate adaptation was likely or very likely to occur. In addition Roder & Straub (2015) found that: “*housing associations felt that it was important to involve tenants, who in their view should take the initiative for any action*” (p.173). In collaboration with tenants there are two main barriers that hamper implementation. The first is a lack of awareness and problem acknowledgement among tenants. The second is that tenants are generally not willing to pay for climate adaptation. Furthermore Roder & Straub (2015) show there is no consensus among the associations on the likelihood of implementation of climate adaptation. This shows that the way in which associations are willing to participate in climate adaptation varies greatly between individual associations. However, a large number of associations see opportunities and might take adaptive action if they were provided with wide diversity of measures from which they could make a suitable selection (Roders & Straub, 2015).

Legal responsibilities

Housing associations have two legal responsibilities relevant for implementing flash flood adaptation measures. The first is defined by the Water Act article 3.5 stating that landowner are primarily responsible for processing rainwater that falls on their land. The Water Act states rainwater should be processed through either infiltration into the ground or discharge on open water. Only when it is not reasonable to expect from property owners to process the water themselves the collection and discharge of surface runoff becomes a municipal task (Mols & Schut, 2012). What reasonability can be expected of landowners differs locally. Measures that landowners can reasonably be expected to take are defined in the municipal sewage plan³. It is importance to note that this act is in force since 2008, is not valid in retrospect and therefore only applies for developments build since 2008 (VNG, 2007). The second relevant responsibility of housing associations for this research is defined in the “Social Rented Sector Management Order” (Besluit beheer sociale-huursector) which requires housing associations to provide their tenants with a good quality of life and housing, now and in the future (Roders et al, 2013).

³ Parliamentary Papers II 2005-06, 30 578, nr. 3, p.12

Roles in climate adaptation

Housing associations play two roles in climate adaptation: an executive role and a facilitating role. The executive role refers to concrete implementation of adaptation measures which either aims at reducing the impacts of flash floods by preventing the damage of water ingress (dry-proofing), using building materials that are not effected by flash floods (wet-proofing), creating more storage capacity or increasing infiltration capacity (Roder & Straub, 2015). The facilitating role refers to the conception that tenants should take initiatives for climate adaptation. Housing associations can stimulate initiatives of tenants by facilitating them.

Interdependencies

Mainly due to financial barriers it is unlikely for housing association to invest in climate adaptation without external partnerships. Roders & Straub (2015) and CPC (2014) mention municipalities, insurance companies and construction companies as important collaboration partners that could increase attractiveness to invest in climate adaptation. In addition Roders et al (2013) express the dependency on construction sectors for the development of technological solutions. Finally due to the limited possibilities to compensate costs of climate adaptation by raising rents, implementation is dependent on collaboration with tenants (Roders et al, 2013).

- Insurance companies

Research by Mills (2007a) shows that industry analysts, representatives and boards of insurance companies throughout the world rank climate change as a leading risk for the insurance sector. Insurers bear a big financial share of an increasing total (Munich Re, 2006) of weather-related damage (Mills, 2007a). Due to their financial capacity (in 2005 insurance companies worldwide collected \$3.2 trillion in premiums) (Mills, 2007b) and ability to encourage risk-reducing behavior amongst policy holders, insurers can play a big role in climate adaptation (World bank, 2002). The expected increase in extreme precipitation in the Netherlands as a result of climate change can be considered a concern for insurance companies (Botzen et al, 2010) since increase in the volume of precipitation results in a higher burden of claims (CVS, 2010; Spekkers et al, 2013; Verbond van Verzekeraars, 2015).

In the Netherlands damage by rainwater is usually covered by standard building structure insurance (opstalverzekering) and content insurance (inboedelverzekering). In the “precipitation clause” (neerslagclausule) it is determined that damages as a result of downpours more intense than 40 millimeter in 24 hours, 53 millimeter in 48 hours or 67 millimeter in 27 hours, on and/or nearby of the location where the damage occurs will be covered (Kok et al, 2000). Home insurance and content insurance contracts are short-term contracts. Premiums are regularly updated based on claim patterns of past years. The Dutch insurance sector considers itself capable of adapting to climate change due to this flexible nature of insurance policy (Botzen et al, 2010). But Botzen et al (2010) is critical about this: *“adjusting premiums based on experiences of past claims may insufficiently reflect changes in the probability of extreme weather events due to their low probability nature”* (p. 578). An example of this is the city of Copenhagen where in 2011 an exceptional extreme cloudburst resulted in 600 to 800 million euros worth of damage (City of Copenhagen, 2012).

CVS (2010) and Verbond van Verzekeraars (2015a) did research on damage as a result of extreme downpours on building structure insurance and content insurance in the Netherlands. They found that the total amount of claims add up to roughly €90 million a year (€ 10 million on content insurances and € 80 million on building structure insurance) (CVS, 2010; Verbond van Verzekeraars, 2015a). In addition

they found that more precipitation results in more claims rather than higher claims. The downpour intensity is a good indication for the height of damage but the total amount of rain that fell in 24 hours proves to be a better forecasting factor. From the data it shows there is a threshold value of 38 millimeters of rain per 24 hours where damage stays minimal. Above this threshold damage is increasing rapidly in a linear fashion (Verbond van Verzekeraars, 2015). Linking their findings to the KNMI'14 climate projections, Verbond van Verzekeraars (2015a) concludes that flash flood related claims could increase between 5% and 139% in 2085 (table 4). Damage of single downpour events can lead up to €22 million worth of damage (Verbond van Verzekeraars, 2015b).

KNMI'14 climate scenario		GL	GH	WL	WH
Total damage increase	Min	5%	5%	13%	23%
	Max	43%	46%	109%	139%

TABLE 4: EXPECTED INCREASE IN DAMAGE CLAIMS AS RESULT OF EXTREME DOWNPOURS ON PRIVATE BUILDING STRUCTURE- AND CONTENT INSURANCE UNDER THE KNMI'14 CLIMATE SCENARIOS EXPRESSED IN PERCENTAGES, SOURCE: VERBOND VAN VERZEKERAARS (2015).

Role in climate adaptation

The insurance industry is increasingly seeing itself as a key actor in finding solutions for climate change (Mills, 2007a). But currently actions by the insurance sector primarily focus on mitigation rather than adaptation and risk reduction (Botzen et al, 2010) despite that insurance sector could play an important role in facilitating the adaptation to flash flood risk (Botzen et al, 2010; CPC, 2014; Roders & Straub, 2015). Literature describes different ways in which insurance companies could facilitate adaptation to flash flood risk.

- *"Insurers are, by definition, interested in preventing losses rather than paying to repair post event damages"* (Mills, 2007b, p. 829). Rewarding policyholders when they invest in flash flood risk reducing measures by lowering premiums, increasing coverage or lowering deductibles can be a way to prevent damages (CPC, 2014). Wet-proofing and dry-proofing of buildings directly minimizes the impact of flash floods on house and content (Roders & Straub, 2015). A survey by Botzen et al (2009) amongst 500 residents has shown that many homeowners are willing to make investments in flood risk adaptation in exchange for premium reduction. Approximately two-thirds are willing to invest in water barriers in exchange for a premium reduction.

- Partnerships with external public or private partners could be a way of deploying and developing innovations which can stimulate adaptations (Mills, 2007b). Collaboration encourages the flow of financial and knowledge resources amongst different actors (Hoff et al. 2003). Such partnership could be aimed at a diversity of goals such as developing innovative insurance products, cost effective adaptation technologies, communicating information on adaptation to policy holders, defining building codes or creating early warning systems (Mills, 2007b).

- Companies could encourage policyholders to implement cost-effective risk reducing adaptation measures (Botzen et al, 2010). Research by Sušnik et al (2014) show how adaptation (detaching waste and storm water sewage networks) to flash flood risk was cost effective in Eindhoven. Sušnik et al (2014) conclude that during a shower with a 2 year return period benefits are expected to be €136.000 and 10 year return period €780.000; *"These potential savings are made for every flood event, and not just once, any cost of implementing the risk-reduction measures will be paid back over time"* (Sušnik et al, 2014, p.1627). And due to the statistical relation between volume of precipitation and total

burden of claims (CVS, 2010; Spekkers et al, 2013) future benefits of flash flood adaptation can only be expected to grow as the frequency, volume and intensity of downpours is increasing.

- Applying a risk based approach to insurance claims is also mentioned in the literature as a potential solution (e.g. Ward et al. 2008). A risk based approach implies that premiums are quantified by three factors: the probability of a flood to occur, exposure and vulnerability and the potential cost of being affected (Ward et al. 2008). Lower risk can then be rewarded by lower premiums. This way of pricing insurance can be a way of encouraging adaptation practices (Mills, 2007b). The UK is currently in a transition towards risk reflective flood insurance premiums.

Although there is plenty of opportunity for insurers to get involved in flash flood adaptation it is unclear whether the sectors has clear interest in doing so. Despite evidence that damage due to intense and long-lasting downpours will increase, it is unclear whether increase in risk is a significant threat for the insurability of flash flood damage. Damage by extreme precipitation constitutes only small portion of total private home- and content insurance claims (figure 7). The case study should give more insight on the willingness of insurers to get involved in flash flood adaptation.

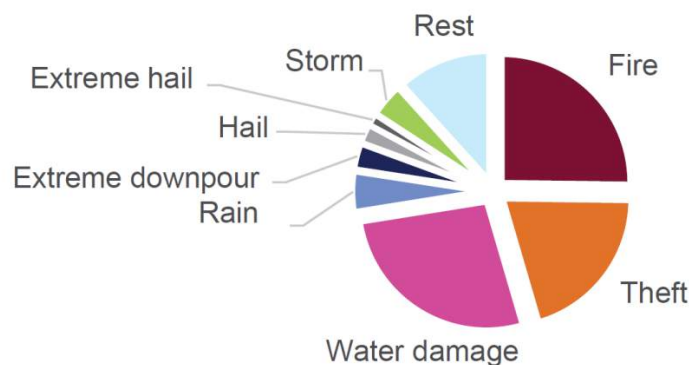


FIGURE 7: SHARE OF DIFFERENT TYPES OF CLAIMS ON THE TOTAL DAMAGE OF CLAIMS ON PRIVATE BUILDING STRUCTURE- AND CONTENT INSURANCE BETWEEN 2000-2013, SOURCE: VERBOND VAN VERZEKERAARS (2015).

Interdependencies

Insurers have interests in reducing the financial losses of weather related damages (Mills, 2007b). Mills (2007a) shows how this interest motivates the insurance sector to get involved in diverse public-private partnerships on international scale involving large variety of actors. It is unclear whether insurers also have this clear interest in the context of flash flood damages in the Netherlands. The fact that insurers are not actively involved in climate adaptation in the Netherlands hints a lack of interest. Sharing a common interest is a key element of the concept interdependency (Kooiman, 2003). The case study research will have to provide more insight on the interests of the insurance sector in flash flood adaptation.

Key civil society actors in the flash flood governance network

- Residents

Residents play a significant role in the actual adaptation to climate change (Adger, 2003). Due to a trend of withdrawing government and limited governmental budgets, climate adaptation is more dependent on private actors (CPC, 2014). Woods-Ballard et al (2007) and AMPF (2007) show there is a lot of opportunity at local level for flash flood risk reduction by collaboration with civil society actors. Pilot project “Amsterdam Rainproof” confirms this by emphasizing that civil society and market are key players in making the city of Amsterdam rainproof (Waternet, 2014). The Civil Society arena includes a big variety of actors. It is therefore important to note that this research focusses particularly on residents. Residents can be split up into two groups, tenants and homeowners. Each have a slightly different role in the flash flood risk governance network due to variances in legal responsibilities and interdependencies.

In general, Dutch residents are unaware of their personal responsibilities in flood management (Terpstra & Gutteling, 2008; Watermonitor, 2009). According to research among Dutch citizens by Watermonitor (2009) (1227 respondents), citizens consider flash flood management the responsibility of the government (90%), and see themselves as the least responsible actor (28%). Furthermore only a small percentage considers climate adaptation as an urgent matter (8%). Also there is a low willingness amongst citizens to participate in flash flood management. Only 8% of the respondents have taken concrete measures to reduce flash flood damages on their homes (all of them experienced a flash flood before). Boltzen et al (2009) describes individual’s risk perception and previous personal experience of a flood event as a key determinants for individuals to engage in flood risk management and take precautionary measures. This is in line with the findings by Watermonitor (2009). Raising awareness is needed to stimulate the engagement of residents in flash flood management (Boltzen et al, 2009). In addition Bubeck et al (2012) show that the perceived effectiveness, of measures, the financial costs, and sense of responsibility are key factors determining individuals involvement in flood risk adaptation.

Legal responsibilities.

Legal responsibilities for processing surface water runoff are for homeowner the same as for housing association. Water Act article 3.5 ascribes landowners primarily responsibility for processing surface runoff from their parcel. This should occur by means of either infiltration into the ground or discharge on open water⁴. Only when it is not reasonable to expect from homeowners to process the water themselves collection and discharge of that water becomes a municipal task (Mols & Schut, 2012). It could be the case that there is no open water nearby or that high groundwater level does not allow rainwater to infiltrate. What reasonability can be expected from landowners differs locally, and is divined by the municipality in the municipal sewage plan⁵. But as mentioned before, the Water Act does not work in retrospect and therefore only applies for developments built after 2008. In addition it is important to mention that, article 5:38 of the Civil Code of the Netherlands (Burgerlijk Wetboek) states that lower-lying parcels are obligated to receive natural runoff from higher areas. This implies that property owners from higher properties cannot be held responsible for water damages that occur due to natural water runoff from their property.

⁴ Parliamentary Papers II 2005-06, 30 578, nr. 3, p.12

⁵ Parliamentary Papers II 2005-06, 30 578, nr. 3, p.12

Earlier the municipal duty of care for collecting and discharging surface runoff has been defined as the obligation to make an effort rather than to achieve a certain standard. Practice shows that due to this specific legal formulation municipalities generally cannot be held accountable for flash flood damage on private properties (Mols & Schut, 2012; Gemeente Arnhem, 2014). This indirectly puts responsibility for preventing damage on properties in the hands of landowners. In addition building regulations explicitly state that landowners are responsible for making sure their building and parcel meets their own wishes they have considering the object (VNG, 2007).

Role in climate adaptation.

Residents can be approached as individuals or as a collective. From both perspectives residents play a key role in the actual adaptation (CPC, 2014). As individuals they have an executive role by implementing concrete adaptation measures on local building/parcel scale (table 2). As a collective residents can encourage each other to get involved in climate adaptation. Dynamics that occur when civil society actors start interacting stimulate self-organizational processes which can encourage climate adaptation (CPC, 2014). Elaborating on the potential for self-organization in flash flood risk adaptation goes beyond the scope of this research. This research considers residents to be individuals having an executive role in implementing adaptation measures on local, building/parcel scale.

Interdependencies

For performing their role residents are interdependent on multiple other actors. These interdependencies differ slightly between tenants and homeowners. Tenants, unlike homeowners, need the approval of their landlord to take certain adaptation measures. Earlier in this chapter the capacity of individuals to adapt is determined to be dependent on the financial, informational, technological and human resourcefulness of individuals (Smit & Wandel, 2006). Since adaptation is location specific and the resourcefulness of individuals vary (difference in background, income etc.), the need for resources differs strongly between individuals. This research states that individual residents are dependent on housing associations, insurers and municipality in providing them with the right resources to build their adaptive capacity.

Other Actors

Besides the four key actors found in the literature, multiple other actors are involved in flash flood risk governance network. Although this research does not focus on them they are important to mentioned here.

- In the state arena regional water authorities, provinces, national government and the EU play a role in adaptation to flash flood risk (Termeer et al, 2011; OECD, 2014; Roders & Straub, 2015).
- Market, other private landowners such as retailers, industries (Waternet, 2014), reinsurers & brokers (Mills, 2007a), corporate investors & construction sector (Roders et al, 2013; CPC, 2014), private rental sector, real estate, consultants, engineers (CPC, 2014; Waternet, 2014)
- Civil society: NGO's, knowledge institutes, media, homeowners associations (Waternet, 2014).

The flash flood governance network

Based on literature research the following governance network is constructed (figure 8). The black arrows show the interdependencies and interactions between the different arenas. But it is important to realize that these interdependencies and interactions also exist between actors within an arena. Due to the complexity of the total network a clear delineation is needed. This research focuses on four key actors in the governance of flash flood adaptation on local level: municipalities, housing associations, insurers and residents.

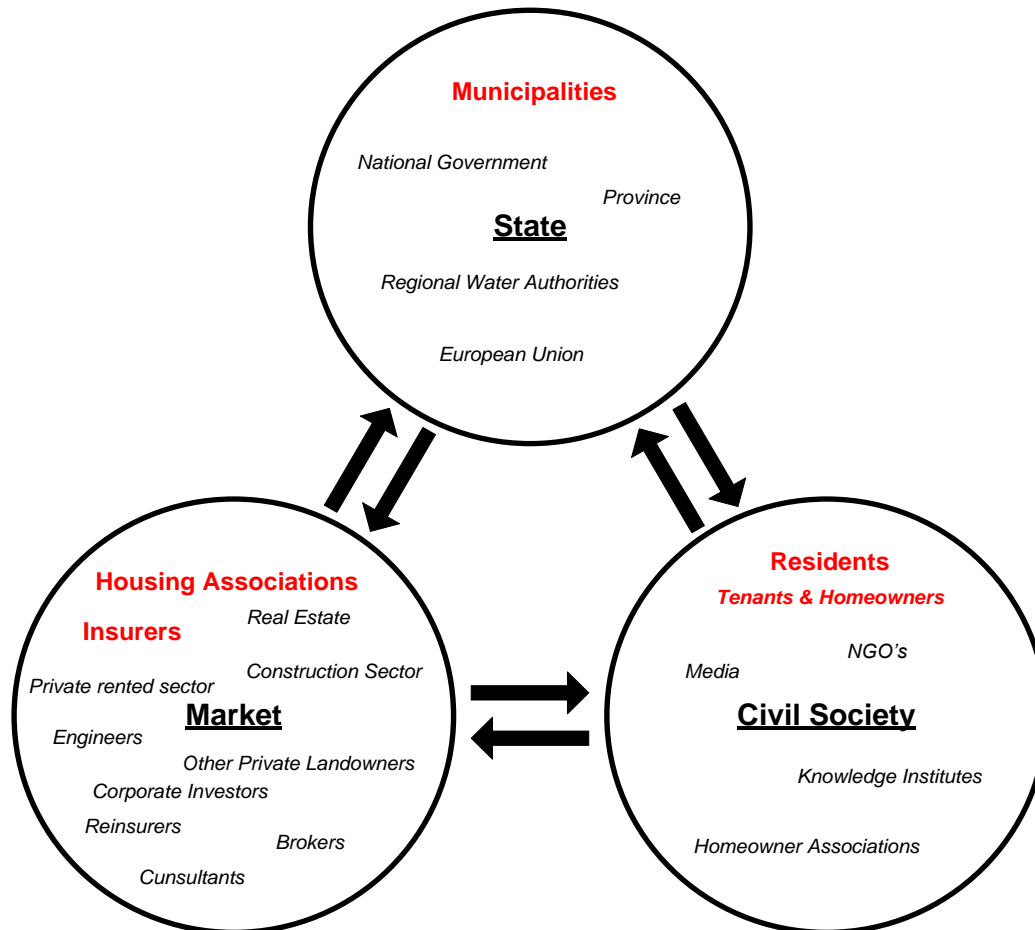


FIGURE 8: THE DUTCH FLASH FLOOD GOVERNANCE NETWORK BASED ON LITERATURE RESEARCH. DISTINGUISHING KEY ACTORS (RED) AND OTHER ACTORS (ITALIC BLACK).

2.7 Syntheses and Conceptual model

Climate change and ongoing social economic development are the two main drivers behind growing urban flash floods risk in the Netherlands. Traditionally climate adaptation is seen as a governmental task. But due to divided legal responsibilities, a trend of withdrawing government and an economic crisis adaptation to growing flash flood risk requires effort from both public and private actors. Multiple scholars acknowledge the appropriateness of using a governance approach in such a context of interdependency. In addition multiple scholars acknowledge the appropriateness of a governance approach to steer climate adaptation in general. This research applies the governance approach to steer adaptation to flash flood risk

in Arnhem. The goal is to formulate a set of governance arrangements to effectively steer climate adaptation. By doing so this research for one adds to the still fairly limited understanding of climate adaptation governance on local scale, governance as a descriptive tool. Also it offers Arnhem a governance approach to respond to the extreme downpour on the 28th of July 2014 where significant parts of the city flooded leading to significant material damage and societal disruption, governance as a normative tool.

The literature review presented earlier in this chapter embeds this research into a theoretical framework (figure 9). This framework visualizes the answer to secondary research question 1: how can governance of flash flood adaptation be conceptualized from a theoretical perspective? Although governance can be seen as an extensive concept which is theoretically discerned in diverging ways it does not provide an absolute conceptualization in the context of flash flood adaptation. Flash flood governance is more than the totality of interactions between interdependent state, market and civil society actors united in a, horizontally oriented as well as multi-leveled network, around flash flood adaptation. Including the reciprocal influence between governance and institutionalism (Root et al, 2014), and governance and adaptive capacity (Adger, 2003) add to a more comprehensive insight and understanding of processes driving the complex and dynamic governance interactions in flash flood adaptation. Capturing the governance of flash flood adaptation therefore requires a theoretical scope including institutionalism and adaptive capacity. To best visualize the relation between the four key concepts the framework has been divided in three layers (figure 9). It is important to note here that there is considerable overlap and interlinkage between the integrated concepts.

Flash flood adaptation

The bottom layer can be seen as the base of the model and refers to the actual adaptation to growing flash flood risk. Adaptation to flash floods is seen as taking concrete measures to reduce flash flood risk. Table 2 formulates concrete measures that can be taken on varying scales. Measures can broadly be divided in two categories: measures aimed at preventing damage on properties (Dry proofing, wet proofing) and measures aimed at reducing surface runoff (increase infiltration & storage capacity).

Adaptive capacity

Adaptive capacity can be seen as an indication as to whether a system is capable of adapting to adverse effects of climate change (IPCC, 2007). The presence of adaptive capacity has been shown to be a prerequisite for the implementation of adaptation strategies (Brooks & Adger, 2005). The capability of a system to adapt depends on the capacity of individuals to adapt and the ability to act collectively in the face a certain threat (Adger et al, 2004). The capacity of individuals to adapt is determined by their financial, informational, technological and human resourcefulness. The capacity to act together is determined by networks and flow of information between both public and private parties (Adger, 2003). This aspect of adaptive capacity refers to governance structures and their institutional contexts to enable and stimulate adaptation (Root et al, 2014).

Institutionalism and governance

Governance is the focal point of this research. Governance is described as the totality of interactions between state, market and civil society actors in realizing the collective goal of adapting to growing flash flood risk. Governance is used as a descriptive tool to provide insight in the roles, responsibilities and positions of relevant actors. Municipalities, insurers, housing cooperatives and residents are appointed as

key actors within the local flash flood governance network. Subsequently governance is used as a normative tool to steer climate adaptation through governance arrangements.

A literature research on the flash flood governance network on local level in the Netherlands has given more specific content the theoretical framework. It has given insight on the adaptive capacity of individuals. Lack of financial resources are barriers for housing association and municipalities to invest in climate adaptation. Lack of awareness among Dutch citizens on climate risks is hampering adaptation (Boltzen et al, 2009). In addition Bubeck et al (2012) show that the perceived effectiveness, of measures, the financial costs, and sense of responsibility are key factors determining individuals involvement in flood risk adaptation. Formal institutional context is determined by Dutch law. Both municipalities and landowners have responsibilities in the collection and discharge of surface runoff. Literature research also give insight in the complexity and extensiveness of the flash flood governance network. Among the wide variety of actors involved, four key actors can be defined. Each of them has their own roles, responsibilities and interdependencies in flash flood adaptation.

Also this more detailed understanding of flash flood governance based on literature research can be considered general since adaptation is context specific (Smit and Pilifosova, 2003; Adger et al, 2004; Smit & Wandel, 2006; Adger, 2003; Brooks & Adger, 2005). Furthermore the institutional context can vary between locations. Therefore the governance of climate adaptation is very dependent on local contextual factors. This research acknowledges the context specificity of flash flood adaptation and focusses on Arnhem to improve understanding of climate adaptation governance on local scale.

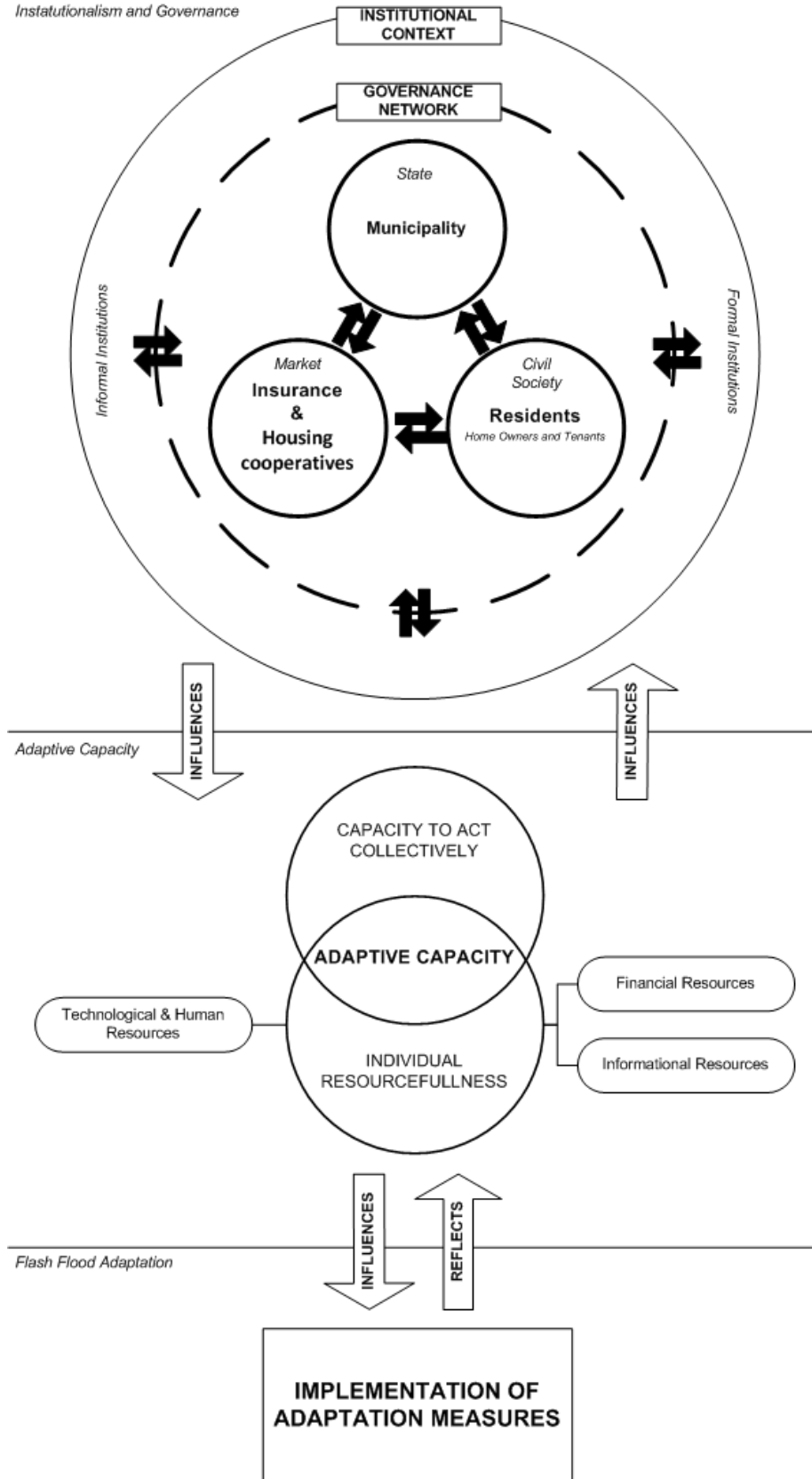


FIGURE 9: THE CONEPTUAL MODEL/THEORETICAL FRAMEWORK. IT VISUALIZES THE CONCEPTUAL LINKS BETWEEN THE KEY CONCEPTS IN THIS RESEARCH: CLIMATE ADAPTATION, INDIVIDUAL CAPACITY, GOVERNANCE AND INSTTTUTIONALISM.

3. Methodology

This thesis uses a case study research to understand the social complex dynamics that occur in climate adaptation governance on local scale. The ultimate goal is to use these insights to formulate governance arrangement to steer effective climate adaptation. Effectivity in this context is about efficiently (with minimal governmental resources and burden on society (Hood & Margetts, 2007, p.145) achieving the goal of making a city better rainproof by successfully adapting to growing flash flood risk. To achieve this goal it is important to come to powerful results to support the obtained insights. A well-structured research design contributes to the transparency, legitimacy and credibility of the research and results and therefore contributes to more powerful evidence (Yin, 2003).

Designing a case study is in one sense very flexible since it can be based on any mix of qualitative and quantitative evidence (Yin, 2003), also known as triangulation. But to responsibly deal with this flexibility a researcher is required to make deliberate choices in defining the type of case study, the logic of research design, data collection techniques, approaches to data analysis, interpretation and reporting (Yin, 2003). This chapter describes Yin's (2003) perspective on how to do a case study research and explains how his views are translated into the research design structuring this study.

3.1 Case study as a research methodology

A qualitative case study is a specific way of empirical inquiry that investigates a contemporary phenomenon within its context extracting the required data from different sources (Baxter & Jack, 2008). Using the case study as a research methodology is appropriate in contexts in which the purpose is to understand complex social phenomena (Kim, 2003) like governance contexts because it provides opportunity to study a complete complex system in detail (Buijs e.a., in: Teisman et al, 2009, p. 45). Stake (1995) and Yin (2003) are considered the developers of the two main approaches for conducting a case study research (Baxter & Jack, 2008). This research design was constructed along Yin's (2003) work.

“A case study is an appropriate research strategy when a “how” or “why” question is being asked about a contemporary set of events, over which the investigator has little or no control”(Yin, 2003, p.9). Although the primary research question formulated as a “which” question, the focus of this study is about understanding *how* local climate adaptation governance processes work and *how* they can be effectively guided. The case study methodology as described by Yin (2003) relates to a constructive paradigm. The constructive paradigm implies that the truth is relative and dependent on one's point of view and interpretation. Research is not value free because reality is a social construct (Neuman, 2007). A case study is therefore also not about finding the truth but about the interpretation of the truth.

This constructive paradigm stands at the nature of the social sciences in general (Verhees, 2013). The case study methodology is therefore used often in the realm of social science research. The socially complex nature of this research, due to the focus on interactions and interdependencies between multiple actors, makes the case study methodology an obvious choice. Yin (2003) describes three main forms of case studies which in turn can be specified along four typologies. The three main forms of case study are: descriptive, exploratory and explanatory. The four typologies for a case study are holistic single case study, embedded single case study, holistic multiple-case study and embedded multiple-case study.

Based on Yin’s (2003) categorization this case study research is defined as an exploratory, single case study with embedded units. The municipality of Arnhem will be the single case that is studied. Citizens, housing association, insurers and the municipality, being the key actors which are analyzed, are the four embedded units of analysis within the case (figure 10). The goal of this case study research is to obtain more understanding on the governance of climate adaptation to flash floods on local scale. Governance is used in the case study as a descriptive tool.

In designing an exploratory case study the researcher is required to pursue the external validity, construct validity and reliability of the research (Yin, 2003). Table 5 elaborates on these three aspects and describes where in these chapter they are considered.

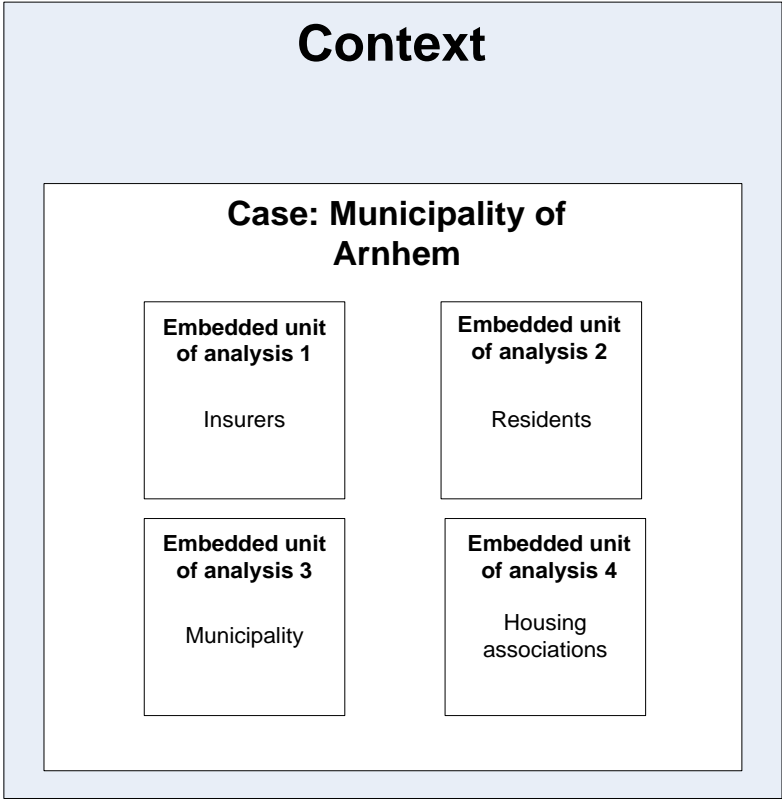


FIGURE 10: A VISUALIZATION OF THE TYPIFICATION OF THIS RESEARCH: THIS RESEARCH CAN BE TYPIFIED AS A SINGLE CASE STUDY WITH FOUR EMBEDDED UNITS OF ANALYSIS EMBEDDED IN A UNIQUE CONTEXT, BASED ON: YIN (2003).

3.2 Research design

A research design defines the steps that are made in a research to connect the empirical findings to the research questions and its conclusion. Yin (2003) describes the research design as the blueprint of the research which is embedded in a theoretical framework. A research design includes: research questions, the proposition underlying the case study, the unit of analysis, logic of linking the data to the research questions and the way the findings are interpreted (Yin, 2003). These four aspects that constitute the research design are discussed in different sections in this report. Chapter one introduces the research questions. The theoretical propositions underlying this research are discussed in chapter two. The unit of analysis, data explanation and interpretation of the findings will be discussed in the remaining of this chapter.

Research quality tests for exploratory case studies.	Purpose of test	Place where the test is embedded in this study
External validity	Establishing the domain to which the conclusions can be generalized. For single case studies this means embedding the research in a theoretical framework.	Research design (page 40-41)
Construct validity	Establishing a correct operational strategy for executing and the research and coming to the conclusion. It is important to use multiple data sources and have key informants review the draft report.	Data collection and presentation (page 42-48)
Reliability	Demonstrating that the operations of the case study can be repeated, with the same results. This can be done by using a case study protocol and develop case study database.	Data collection techniques (page 42-48)

TABLE 5: THE INDICATORS USED FOR TESTING THE QUALITY OF THIS EXPLORATORY CASE STUDY, BASED ON: KIDDER & JUDD (1986) AND YIN (2003).

3.3 Unit of analyses

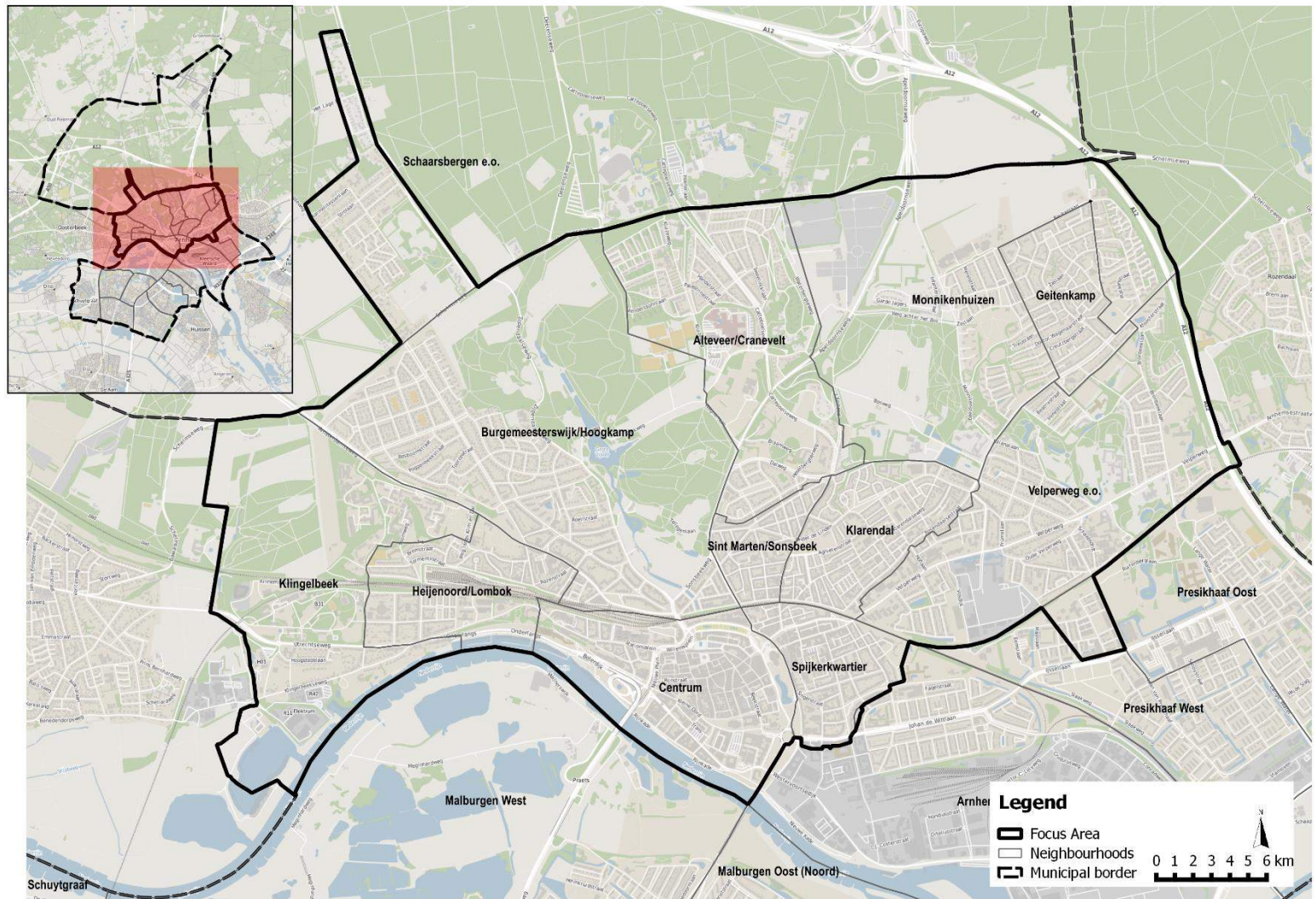
The unit of analyses, or the case, is determined by defining spatial boundary, theoretical scope, and timeframe (Yin,2003).

The spatial boundary of this case study is the border of the municipality of Arnhem. After a first orientation on the flash flood vulnerability of the city done the municipality (Gemeente Arnhem, 2014) the decision was made to put focus on the northern part of the city Arnhem (map 1). Due to the great variety in altitude and the paved character of most of the neighborhoods in that area, rainwater that falls in the higher parts runs off to the lower parts, reacting flash floods. During an extreme downpour on July 28th 2014 where 110 millimeter fell in 24 hours all flash floods occurred in the focus area. The choice for taking Arnhem as the case has three main reason. First, the researcher is familiar with Arnhem . Second, the research could be combined with an internship at the municipality creating more opportunities for good quality data collection. And third, Arnhem is due to the downpour event on 28th July a very interesting and relevant case for this study.

The theoretical scope is defined based on a literature study. Governance, institutionalism, adaptive capacity and climate adaptation are the key concepts theoretically embedding this study. The preliminary focus is on governance. Adaptive capacity and institutionalism are integrated into the scope since literature research has shown they are influencing climate adaptation governance processes. Climate adaptation to growing urban flash flood risk on local level is the focus around which governance processes are researched. The findings are used to divine a set of governance arrangements for guiding future flash flood adaptation governance processes. Due to the extensive network of actors which constitute the local

flash flood governance network this study puts emphasis on four key actors: residents, municipality, housing associations and insurers. The conceptual model (figure 9) visualizes the theoretical scope of this research.

Especially in studying governance processes it is relevant to define a timeframe. The relationships between actors and the attitudes of actors can change over time. The research ran from 09-2014 until 08-2015. Data collection occurred from 04-2015 until 06-2015. The results are based on the perceptions of respondent during that period. The data collection period defines the specific time boundaries of the case.



MAP 1: THE GEOGRAPHICAL UNIT OF ANALYSES FOR THIS CASE STUDY RESEARCH, SOURCE: RESEARCHER.

3.4 Data collection framework and techniques

Data collection requires good preparation (Yin, 2003). This research used a case study protocol to organize and structure the data collection process. In addition to using a case study protocol Yin (2003) mentions three overriding principles significant for any data collection effort.

- Use multiple sources. The rationale behind using multiple sources of data is referred to as triangulation. The big advantage of doing a case study research is that data can be collected from different data sources using different methods. Collecting data from different sources enables the researcher to converge his evidence. Findings which are based on multiple sources of information are more powerful. In addition using multiple data sources gives the research a more complete understanding of the phenomena which is being studied (Baxter & Jacks, 2008). The next paragraph elaborates on the data collection methods used in this study.

- Create a case study database. Having a database in which all the data that has been used to come to the conclusions which are presented in the report adds to reliability of the research. A digital database has been kept which contains all the raw data, results of different analyses and that literature that has been used for this research. Storing all this data enables the researcher to validate the statements and results which are presented in the study.

The database is only accessible in consultation with the researcher due to classified information that is stored in the database.

- Maintain a chain of evidence. This principle implies that the reader of the final report is able to understand which steps are made to arrive to a certain conclusion and understand why this conclusion is relevant for the research. This research aims to maintain the chain of evidence by providing a transparent research design, creating a case study protocol, describing the procedures that were followed in data collection process, using good referencing and transparently using data to answers the research question.

Four methods were used for collecting data in this study: literature research, semi-structured interviews, questionnaire and Geo Information Systems (GIS) analysis. Although case study researches in social science domain are traditionally related to qualitative research methods (Yin, 2003) this study deliberately incorporates two quantitative research methods.

Literature research

Literature research for this study happened from September 2014 until April 2015. The rationale behind doing literature research is that the researcher learns from and builds on work from others (Neuman, 2007). This study focuses on the knowledge gap on local climate adaptation governance and aims to create new insights that accumulate on the existing knowledge on the subject. As mentioned above it is vital that a case study is embedded in a theoretical framework. The theoretical framework presented in figure 9 functions in multiple ways as an anchor for the rest of the study. For one the theoretical framework defines the scope of the study and creates a context around the research questions. Furthermore it structures, as will be shown later, the processes of data collection, - analysis, - interpretation, -presentation. Finally the theoretical framework is used as vehicle to generalize the results of the case study. Due to the key role the theoretical framework literature research was done in an early stage. Papers from scientific journals were the main source of literature. These were mostly used to link the different theoretical concepts referred to in this study. In addition government documents and varying research reports have been drawn on to give the general theoretical concepts more specific contextual content. Referencing has been used to ensure transparency and avoid plagiarism.

Semi-structured interviews

Interviewing is a form of primary data collection (Flowerdew & Martin, 2005). In an interview the interviewer tries to obtain information from the interviewee by verbal interchange (Dunn, 2005). Three different types of interviews can be distinguished: structured, semi-structured and unstructured. This research used semi-structured interviews for collecting data. *“This form of interviewing has some degree of predetermined order but still ensures flexibility in the way issues are addressed by the informant”* (Dunn, 2005, p.80). The reason for conducting semi-structured interviews was to have the advantage of an unambiguous structure

assuring the collection of relevant data while keeping the flexibility to go into more depth on interesting topics the interviewee touched upon in his answers. All interviews were guided by an interview guide (appendix I). Interview guides were tailor-made to the interviewees but were all designed and structured along the theoretical framework. In total 8 interviews were conducted to collect data on three embedded units of analysis and on the context of flash flood governance on local level in Dutch cities. Some of the data that was obtained in the interviews should be considered confidential. So out of respect for the interviewees each respondent was kept anonymous. Also all the data obtained through the interviews were made anonymous. Transcripts of the interviews can be found in appendix II.

Context of flash flood management.

Interview 1, 11-05-2015. Interviewee context D.

Embedded unit 1: insurers.

Interview 2, 28-04-2015. Interviewee insurance A.

Interview 3, 19-05-2015. Interviewee insurance F, Interviewee insurance G, Interviewee insurance H, Interviewee municipality B.

Embedded unit 3: municipality.

Interview 4, 01-05-2015 Interviewee municipality B.

Interview 5, 12-05-2015 Interviewee municipality E.

Interview 6, 05-06-2015 Interviewee municipality J.

Embedded unit 4: housing associations.

Interview 7, 07-05-2015 Interviewee housing association C.

Interview 8, 22-05-2015 Interviewee housing association I.

Questionnaire survey

A questionnaire survey is a method for collecting data on behavior, attitudes, characteristics, expectations, self-classification and knowledge of a certain population by administering a set of standardized questions (Neuman, 2007; McLafferty in: Clifford et al, 2010). By using a standardized questionnaire the subjective characteristics of a population can be generalized and quantitatively analyzed. A survey was used to gather data on embedded unit of analysis 2: residents. To make sure the results of the questionnaire are relevant to answer the research questions the theoretical framework had a key role in designing the questionnaire. The following hypotheses which were formulated for the survey.

Hypotheses:

1. Respondents who are aware of their legal responsibilities are involved in flash flood adaptation by taking risk reducing measures.
2. Respondents who see flash floods as a threat for their personal situation are involved in flash flood adaptation by taking risk reducing measures.
3. Respondents who see flash floods as a threat for the city of Arnhem are involved in flash flood adaptation by taking risk reducing measures.
4. Respondents who fear flash floods are involved in flash flood adaptation by taking risk reducing measures.
5. Respondents who find flash flood management an interesting topic are involved in flash flood adaptation by taking risk reducing measures.
6. Respondents who feel responsibility to take flash flood risk reducing measures are involved in flash flood adaptation by taking risk reducing measures.
7. Individual resourcefulness of respondents influences individuals to what extent respondents get involved in flash flood adaptation by taking risk reducing measures.

The theoretical framework splits residents in tenants and homeowners. In designing the survey the different position of tenants and homeowners in the flash flood governance network was considered by making slightly different questionnaires. The respondent was asked whether they rented or owned their house and depending on their answer the respondent was forwarded to the correct question list. Except for one open-ended question the survey consisted of fixed-response questions. This was a deliberate choice. Fixed response questions are easier and faster for respondents to answer and are more practical to analyze, compare and interpret (Atteslander, 2010). But it is important to realize that there are also disadvantages to using closed questions. Respondents without knowledge or opinion can answer anyway, answers might suggest ideas the respondent would not have had otherwise and the respondent's desired answer might not be included (Neuman, 2007). The researcher tried to deal with these disadvantages by including what Mayer (2004) refers to as an "escape answer" or giving the respondent the option to leave the question open. In formulating the questions the researcher aimed to keep it clear, simple and keep the respondent's perspective in mind. This was done by providing extra information on terminology when questions included vocabulary the respondent might not be familiar with. The complete questionnaire can be found in appendix I.

The target population of the survey are all residents living in the focus area of the case study research presented in map 1. The population of the focus area has been set on 60.000 people. This is done along the data presented in table 6, supplemented with estimations on two parts of the focus area which only partly overlap neighborhood territory (see map 1).

Neighborhoods in study area *	Population
Centrum	4980
Spijkerkwartier	6292
St.Marten/Sonsbeek-Zuid	4558
Klarendal	7394
Velperweg e.o.	8514
Alteveer en Cranevelt	4393
Geitenkamp	4002
Monnikenhuizen	3685
Burgemeesterswijk / Hoogkamp	7584
Heijenoord / Lombok	4088
Klingelbeek	1259
Total	56749

TABLE 6: DATA ON POPULATION OF THE FOCUS AREA.* THE NEIGHBORHOODS PRESIKHAAF-WEST AND SCHAARSBERGEN ARE NOT INCLUDED IN THIS TABLE BECAUSE THE FOCUS AREA ONLY HAS PARTIAL OVERLAP WITH THESE NEIGHBORHOODS, SOURCE: GEMEENTE ARNHEM (2015a)

The survey was conducted online with help of Google Forms. To spread the link amongst the target population the researcher used various methods.

- The researcher randomly spread 1000 letters through all neighborhoods in the focus area (600 on 01-06-2015 and 400 on 10-06-2015).
- The link was shared through social media. The municipality posted the link on their Facebook page and twitter account on 01-06-2015.
- Newspaper De Gelderlander published an article on the questionnaire on 04-06-2015 which included the link.

In total 141 people filled in the questionnaire. Extracting the responses from outside the focus area left an utilizable sample size of 125 respondents. According to undermentioned formula by Yamane (1967), where n is sample size, N is population size and e is level of precision, a sample size of 125 for a population of 60.000 relates to a confidence level of 91%.

$$n = \frac{N}{1 + N(e)^2}$$

This is not enough to make statistical generalizations, for this a minimum confidence level of 95% is required (Smithson, 2003). But since this research aims at analytical generalization, where the data acquired by multiple methods is collectively used for generalization to broader theory, a confidence level of 91% is seen considered appropriate. Figure 11 presents some characteristics of the sample size.

Cross tabulation analysis was done with IBM SPSS 20 software to determine the significance and association between different variables and respond to the hypotheses. The Chi-square test was used to determine the significance. Depending on the on the type of variables a relationship measure was chosen based on table 7. Strength of the association is determined along the values presented in table 8.

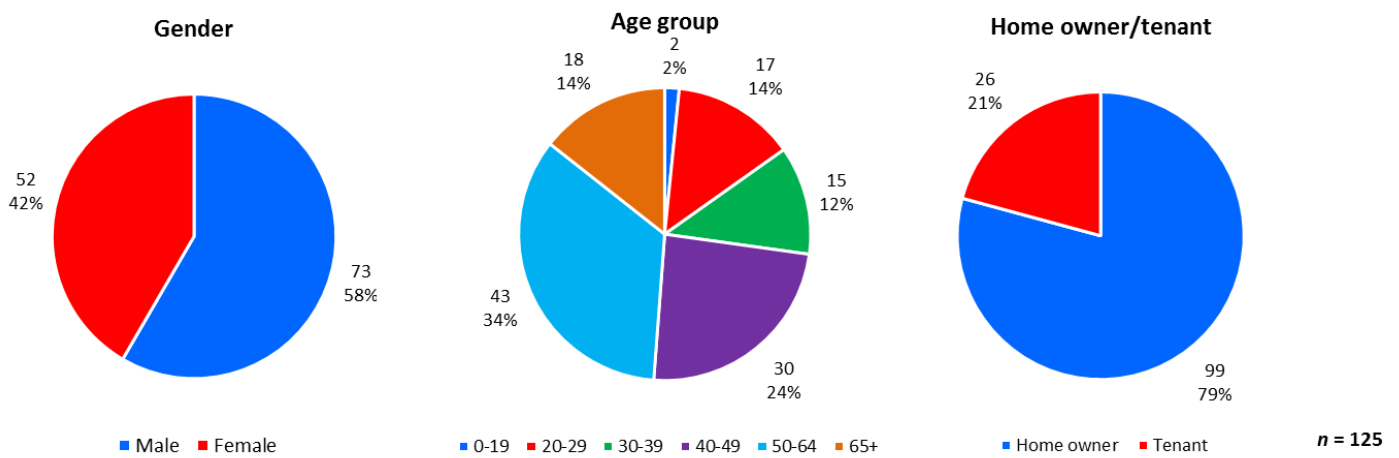


FIGURE 11: CHARACTERISTICS OF THE SAMPLE SIZE.

	Nominal	Binary	Ordinal
Nominal	Cramer's V	Cramer's V	Cramer's V
Binary	Cramer's V	Phi Coefficient	Kruskal's Gamma
Ordinal	Cramer's V	Kruskal's Gamma	Kruskal's Gamma

TABLE 7: GUIDE FOR DETERMINING WHEN TO USE WHICH MEASURE OF ASSOCIATION, BASED ON: HEALEY (2013).

Cramer's V	Phi Coefficient	Gamma
1 = Perfect relationship	1 = Perfect relationship	1 = Perfect relationship
0,30 – 0,99 = Strong	0,30 – 0,99 = Strong	0,61-0,99 = Strong
0,11-0,30 = Moderate	0,11-0,30 = Moderate	0,31-0,60 = Moderate
0-0,10 = Weak	0-0,10 = Weak	0-0,30 = Weak
0 = No relationship	0 = No relationship	0 = No relationship
		-/+ indicates whether it is a positive or negative relationship.

TABLE 8: GENERAL GUIDELINES FOR DETERMINING THE STRENGTH OF AN ASSOCIATION BASED ON THE OUTCOME OF A MEASURE OF ASSOCIATION TEST, BASED ON: HEALEY (2013).

Geographical information systems (GIS) analysis

GIS covers a wide spectrum of researching methods and includes different data processing tools which can be used to extract, combine, manipulate, analyze, understand and present a wide variety of spatial data (Batty in: Clifford et al, 2010). Due to its versatility, GIS can support many different research projects (Flowerdew & Martin, 2005). In this research GIS was used for executing two analyses.

- 1. Analyzing the landownership in Arnhem amongst three key flash flood risk governance actors.
- 2. Combining a contour plot with data on build up land to explain the vulnerability of Arnhem to flash floods.

Flowerdew and Martin's (2005) toolkit approach is used to effectively describe the application of GIS in this research in more detail (figure 12).

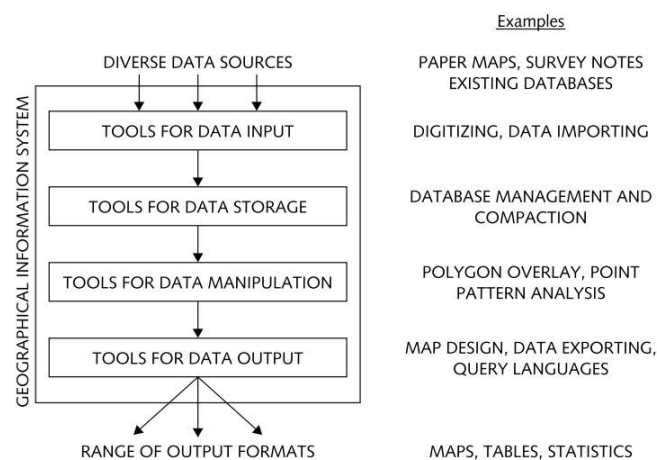


FIGURE 12: COMPONENTS OF THE GIS 'TOOLKIT', SOURCE: FLOWERDEW & MARTIN (2005, P.273).

For both maps the researcher made use of the municipal GIS-database of Arnhem to obtain the required spatial data. ESRI ArcGIS and Q-GIS software have been used to digitize and import the data and execute the spatial analyses. All used data has been kept together in one database. Because most of the used data is not publicly accessible the researcher made sure the data was exclusively used for the research. The standard Geo processing tools of the software programs were used to perform the analyses. Final results of all spatial analyses have been presented in maps and pie charts.

3.5 Data analysis and interpretation

Data analysis and interpretation is required to turn the collected qualitative and quantitative data into credible evidence that can be used for answer the research questions (Yin,2003). For maintaining a transparent chain of evidence the data analysis (chapter 4) and interpretation (chapter 5) occur in separate chapters.

For analyzing data a variety of analytic manipulations are used. Quantitative data obtain through GIS analyses and the survey questionnaire are analyzed through maps, charts and tabulations. The qualitative data obtained by the semi-structured interviews have been transcribed and coded using NVIVO software. The decision for what codes to use has been based on the content of the theoretical framework. To ensure the data analysis had the right focus the process was structured along the theoretical framework.

Interpreting data is done by what Yin (2003, p.120) refers to as *explanation building* (Yin, 2003, p.120). In *explanation building* the researcher explains the studied phenomenon by stipulating causal links between which are supported by the acquired empirical data. This form of data interpretation requires considerable analytical insight from the researcher. Feedback from the supervisor from the university and the supervisor from the municipality were integrated in the process to reflect on the interpretation of the researcher from both a theoretical and empirical perspective.

3.6 Combining research and internship

As part of the research process the researcher did a two month internship at the municipality of Arnhem (03-2015-04-2015). This internal position within the municipal organization gave the researcher access to valuable expertise, data, and interviewees. Furthermore this internship was used as a tool to overcome the gap between theory and practice by taking guidance from practitioners. Feedback by the municipal supervisor is included in the research process to test the researcher's findings, interpretations and arrangements. During the internship the researcher participated in several meetings, neighborhood visits and a workshop on flash flood adaptation. Although these events are not included as a formal method, they did contribute to the researchers understanding of the local flash flood governance context. Combining a research with and internship requires a researcher to consider his role. The researcher tried to stay objective by taking the role of observer rather than a participant.

4. Case study on the municipality of Arnhem

This chapter describes the empirical findings of the case study research. After an introduction on the case itself the results of this research are presented along the components of the conceptual model. To get an thorough understanding of flash flood adaptation governance it is required to understand its links and dynamics with institutional context and adaptive capacity. Therefore it is chosen to structure this chapter in a specific order. First the institutional context, then adaptive capacity and finally governance is discussed.

In chapter 2 governance has been defined as both a normative and as a descriptive tool. This chapter focuses preliminary on governance as a descriptive tool, used for formulating and understanding the relations between key flash flood governance actors. The goal of this chapter is to get insight in the flash flood adaptation governance processes on local scale in Arnhem. These insights will be the basis for the conclusions and the governance arrangements which are presented in chapter 5. The governance arrangements in chapter 5 focus on governance as a normative tool, governance is used for organizing and managing society.

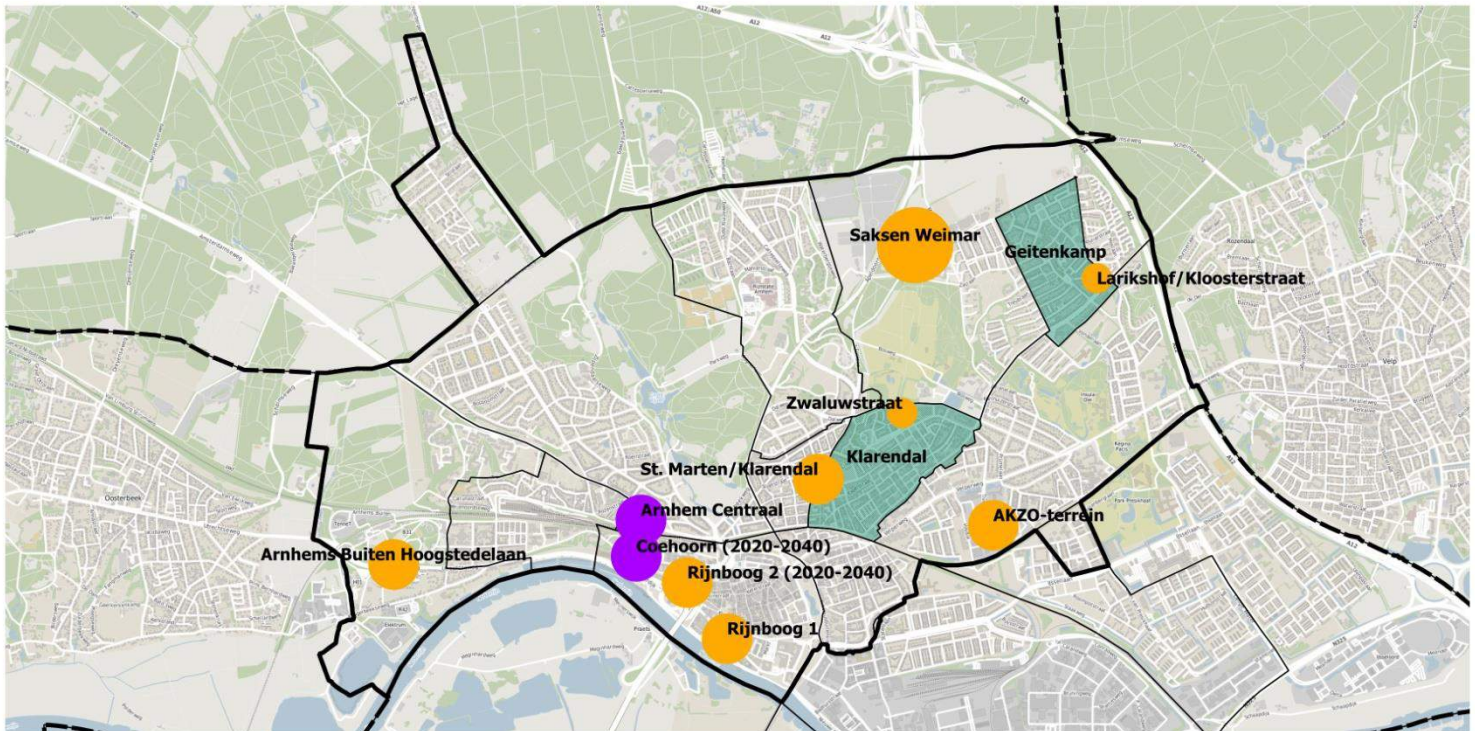
4.1 Municipality of Arnhem, an introduction to the case

The municipality of Arnhem is located in the east of the Netherlands and has a population of 152.288 (Gemeente Arnhem, 2015a). The municipality consist of the city of Arnhem and the villages Schaarsbergen en Elden. Arnhem is the capital of the province Gelderland and is located along the river Nederrijn. Due to its key position in both the rail and road infrastructure network Arnhem has grown out to a city of great economic value for the region. The gradient of the Veluwe lateral moraines, the river zone and polder areas on which the 101,54 km² of the municipality of Arnhem is located give the city a very diversified appearance. Furthermore Arnhem is known for its fifteen public parks giving the city plenty of green spaces.

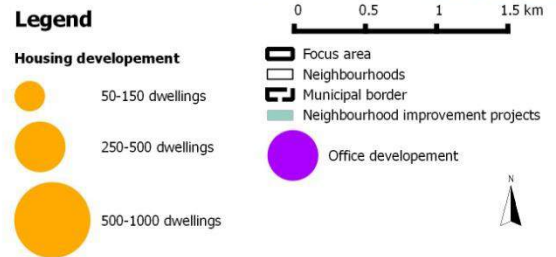
Relevance of Arnhem as a case

During an extreme downpour on the July 28th 2014, when between 80 and 120 millimeter fell in under three hours, flash floods caused a lot of damage in Arnhem. A first orientation of the effects of that downpour done by the municipality shows that all of the damage occurred in the north of the city Arnhem (Gemeente Arnhem, 2014). This area has therefore been chosen as the focus area of this case study. The total financial damage of the flash floods is not known. But interviewee B (2015, 1 May) states it most likely runs into the millions of euros.

Although the downpour event of 28 July 2014 can be considered very extreme it has shown that the northern part of the city of Arnhem is vulnerable to flash floods due to difference in elevation and the high fraction of sealed surface of some of the higher located neighborhoods. This is a relevant notice



MAP 2: THE PLANNED DEVELOPMENTS IN THE FOCUS AREA MENTIONED IN THE MUNICIPAL DEVELOPMENT STRATEGY FOR 2020 AND 2040. DEVELOPMENTS AIM AT ACCOMODATING POPULATION GROWTH AND DEMAND FOR NEAR CENTRE OFFICE SPACE (130.000 M2 UNTIL 2020), AND IMPROVE LIVING QUALITY OF POORER NEIGHBOORHOODS, SOURCE: RESEARCHER, BASED ON GEMEENTE ARNHEM (2012).



because flash flood risk is expected to increase due to climate change (CPC, 2014) and growing potential damage due to ongoing development. The municipal spatial strategy describes multiple planned developments for the focus area (map 2). Besides those concrete developments the municipality formulates general policy that aims at intensifying land use and property value. This is necessary to enable development and keeping existing green and open spaces in tact (Gemeente Arnhem, 2012). Due to these development ambitions the potential damage for flash floods in the focus area will rise in the future.

Besides the extreme downpour event and the expected increase in flash flood risk, Arnhem is relevant because it can be seen as a typical Dutch city where climate adaptation is hampered due to varying barriers. Results from Arnhem can therefore be valuable for other Dutch cities struggling with the realization of climate adaptation.

4.2 Institutionalism, Institutional context

The results presented in this paragraph will be reflected upon in chapter 5 to answer secondary research question 2: how does institutional context influence the governance of flash flood adaptation in Arnhem?

Formal institutions

The principle of legal certainty is key to Dutch spatial planning which hinges strongly on formal institutions (Spit & Zoete, 2009). Therefore it is not surprising that the case study research shows that formal institutions influence flash flood governance processes on local scale. Besides the rules and regulations described in paragraph 2.6 the formal institutional context is made up by rules defined on local scale in the Municipal Sewage Plan (GRP). After elaborating on the GRP to complete the understanding of the local formal institutional context this paragraph presents results on how the formal institutional context influences the behavior of the key actors in flash flood adaptation.

GRP on extreme downpours and growing flash flood risk

The key principle of the GRP, in accordance with the 2009 Water Act, is that landowners are primarily responsible for processing rainwater which falls on their land. But because this act is not valid in retrospect it does not apply for a big share of the buildings in the focus area. In these cases the existing regulations remain valid. Those regulations are formulated in the Municipal Sewage Plan and strongly relate to the type of sewer system. Due to variation between systems (see map 3) rules are ambiguous and location specific (Gemeente Arnhem, 2009a).

Most neighborhoods in the focus area have combined sewer systems. The rainwater discharge capacity of these traditional systems is minimal. For this reason the municipality has put effort in renewing parts of the system and detaching rainwater from the combined system (Gemeente Arnhem, 2009b). These efforts have improved the discharge capacity and reduced flash flood risk. Due to high financial costs this is a slow process. To enlarge the detached region in the focus area municipality could force detachment through a legal ordinance. But the municipality does not see this as a good option. *“Yes it is possible to force detachment. Then the area and terrain needs to be described in a Counsel Decision (raadsbesluit). But I don’t think that is a good option. And I don’t think the council thinks that is a good option. Because then you are forcing people to detach in an existing situation. I think that will turn out quite hopeless. Plus, you need to audit if it is actually happening.”* (Interviewee municipality B 2015, 1 May).

On increasing frequency of extreme downpours due to climate change, current GRP states the following *“sewer systems are not calculated on these extreme downpours. Adjusting the systems to these extreme downpours will lead to very high costs...therefore, besides traditional underground systems, it is necessary to acknowledge the systems above ground as well... This demands adjustment with disciplines that are associated with the designing of public space such as spatial planning, urban development, infrastructure and greening”* (Arnhem, 2009, p.23).

Municipality and formal institutional context

In principle all landowners are responsible for processing water that falls on their own land. This makes the municipality responsible for processing rainwater which falls on the public domain. In addition the municipality has a duty of care for processing the water runoff that cannot be processed on private land. To what extent these responsibility apply is unclear since they are not underwritten with legal norms. Standards which are used to formulate policy and design rainwater discharge systems are based on informal directives formulated by the VNG (Association of Netherlands Municipalities). Adaptation to flash floods can therefore not be considered a formal responsibility for the municipality (Interviewee municipality B, 2015; Interviewee municipality J, 2015). And as long as the municipality has its policy and plans and maintains sewage system in good order and they adequately respond to complaints and damage reports the municipality will generally not be held accountable for flash flood damage on private property

(Gemeente Arnhem, 2014). Damage claims made to the municipality as a result of the downpour of 28 July are all rejected (Interviewee insurance H 2015, 19 May). The municipality is legally accountable for paying damage on their buildings and the public infrastructure. The total cost the municipality had in restoring all damage done resulting from the downpour is not calculated but Interviewee municipality B (2015, 1 May) estimates it to be several hundred thousand euro. This financial damage was not mentioned by the interviewees as a key motivation for flash flood adaptation.

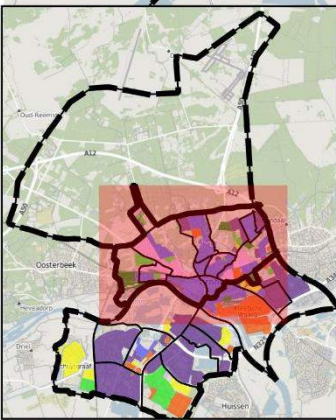
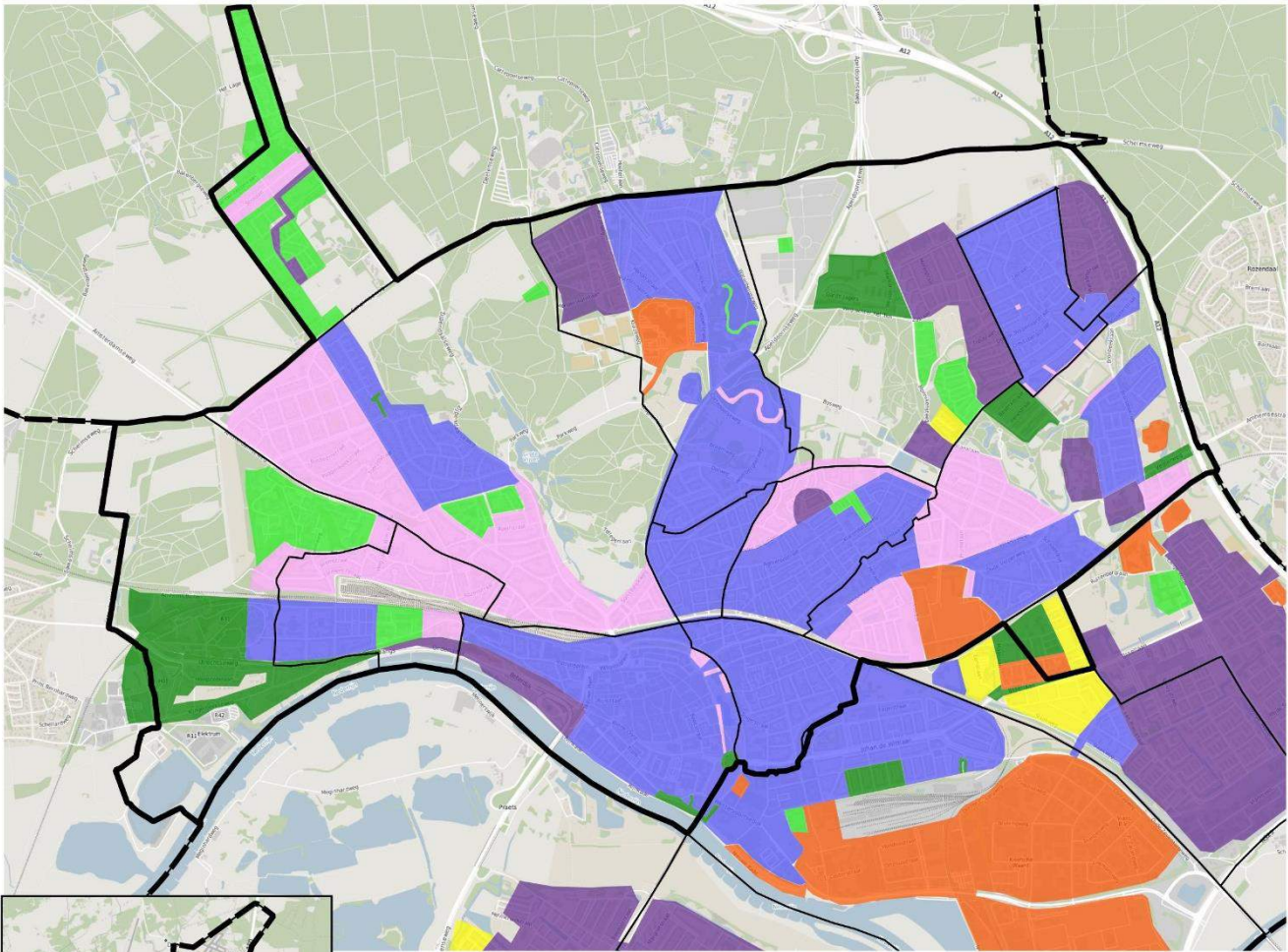
Housing associations and formal institutional context

How housing associations process rainwater is determined by formal institutional context. *“We follow national and municipal regulation. For us the municipality determines what needs to be done in the first place.....We follow the legal legislation, the requirements the municipality formulates. In some cases we need to infiltrate more, and therefore detach. Then we do that.”* (Interviewee housing association C, interviewed 07-05-2015). The rules housing association have to follow concerning processing and discharging rainwater depend on the location where, and date on which the owned dwellings were constructed (Gemeente Arnhem, 2009a). These regulations do not oblige housing association to take additional flash flood adaptation measures as risk increases.










Housing associations are accountable for damage on their dwellings as a result of flash floods. In total housing associations received around 1200 messages after the downpour on July 28th 2014 (Interviewee municipality B 2015, 1 May). It is not known what the financial costs for restoring all damages were (Interviewee housing association C, 2015; Interviewee housing association I, 2015). This financial damage was not mentioned as a motivation to take adaptive measures.

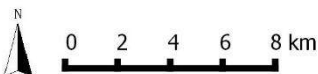
Insurers and formal institutional context

Insurers are not obliged to insure flash flood damage. *“We as insurers generally don’t have, we don’t have a duty of acceptance towards individuals, companies and municipalities. Bluntly said, if flash flood damage costs get out of hand we have the possibility to say we don’t insure you anymore. This is very simplistically said. But it is possible”* (Interviewee insurance G 2015, 19 May). From a formal institutional perspective they also do not have a responsibility to take adaptive measures. *“Strictly speaking, insurers do not have to do anything to prevent damage”* (Interviewee insurance A, 2015, 28 April).



Legend

-  Focus area
-  Neighborhoods
-  Municipal border
-  Combined sewer system
-  Separated (classic) sewer system
-  Separated (50%) sewer system
-  Separated (improved) sewer system
-  Detached sewer system
-  Infiltration sewer system
-  Integrated sewer system



Combined system: sewage water and surface runoff are collected in the same pipe and discharged to the sewage treatment. This type of sewer system is found in older parts of the city.

Separated system (classic): sewage water and surface runoff are collected and discharged in separate pipes. Surface runoff generally discharged on open water. In a few cases surface runoff is being infiltrated into the ground. Sewage water is discharged to the sewage treatment.

Separated system (50%): this system stands in between the combined system and the separated system. Sewage water and surface runoff from buildings are discharged through the same pipe to the sewage treatment. Surface runoff from roads is directed separately towards either open water or infiltration zones.

Separated system (improved): Is similar to the classical separated sewer system. The difference is that during precipitation the first 'dirty' runoff water is discharged through the sewage system to the water treatment plant. This is possible due to a connection between the surface runoff system and the sewage system. The cleaner surface runoff water which enters the system later is discharged on open water or processed through infiltration.

Detached system: surface runoff is detached from a combined sewer system. Surface runoff is directed (if necessary after filtering) to either open water or to areas where it can infiltrate.

Infiltration system: Sewage water and surface runoff are discharged separately. Sewage water is directed to the sewage treatment. Surface runoff is discharged on land where the water infiltrates.

Integrated system: there is one pipe to discharge sewage water underground to the sewage treatment. Surface runoff is discharged (if necessary after filtering) above ground through to open water or infiltration zones.

MAP 3: THE SPREAD OF THE DIFFERENT SEWER SYSTEMS IN THE FOCUS AREA INCLUDING A DISCRIPTION OF EACH SYSTEM. *IN 2004 ARNHEM OPENED A WATER SERVICE POINT WHERE PEOPLE COULD GET S SUBSIDY FOR DETACHING THEIR HOUSE INDIVIDUAL CASES THAT MADE USE OF THIS SUBSIDY ARE NOT SHOWN ON THIS MAP, SOURCE: RESEARCHER, BASED ON DATA FROM MUNICIPAL GIS DATABASE.

Residents and formal institutional context

The survey results shows that residents are generally not aware of the formal institutional context (figure 13). This is in line with Terpstra & Gutteling (2008) and Watermonitor (2009) who state that Dutch residents are unaware of their personal responsibilities in flood management. The statistical correlation between knowledge on formal institutions and whether or not residents have taken flash flood adaptation measures determines to what extent formal institutional context is a motivator for residents to engage in flash flood adaptation.

Statistical analyses shows a moderate significant association ($P = 0,013$, $\Phi = 0.226$) between awareness of legal responsibilities and taking measures to reduce rainwater runoff. Between awareness of legal responsibilities to protect owned property against flash flood damage and taking measures to protect owned property against flash flood damage exist a strong significant association ($P = 0,001$, $\Phi = 0.364$).

Based on these result survey hypothesis 1: “respondents who are aware of their legal responsibilities are involved in flash flood adaptation by taking risk reducing measures” is accepted.

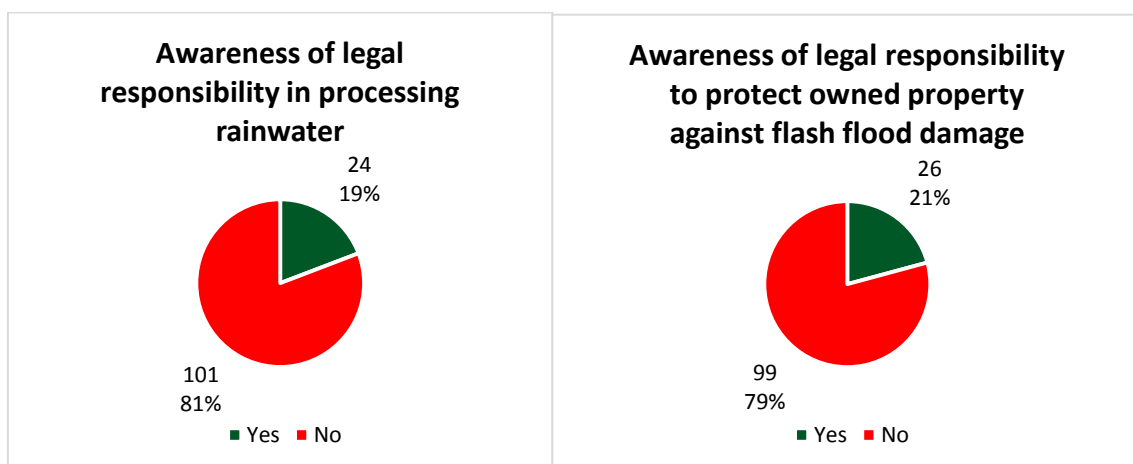


FIGURE 13: SURVEY RESULTS 1, VISUALIZING TO WHAT EXTENT RESIDENTS ARE AWARE OF THEIR LEGAL RESPONSIBILITIES IN PROCESSING RAINWATER AND PROTECT OWNED PROPERTY AGAINST FLASH FLOOD DAMAGE.

Informal institutions

Compared to formal institutions, informal institutions are much more ambiguous and dynamic. Perspectives on flash flood governance differ between actors and change over time. Based on interviews and survey results the next paragraph describes informal institutional context according to each key flash flood actor. But what defines the local flash flood governance informal institutional context? Due to the multifaceted nature of institutionalism there is not one correct answer to this question. In context of this research informal institutional context is determined along two features: the attitude towards flash flood adaptation and perception on the distribution of roles and responsibilities in flash flood adaptation. The case study shows a strong influence of institutions on governance processes. This is in line with findings by Root et al (2014).

Municipality and informal institutional context

The attitude of the municipality towards flash flood adaptation

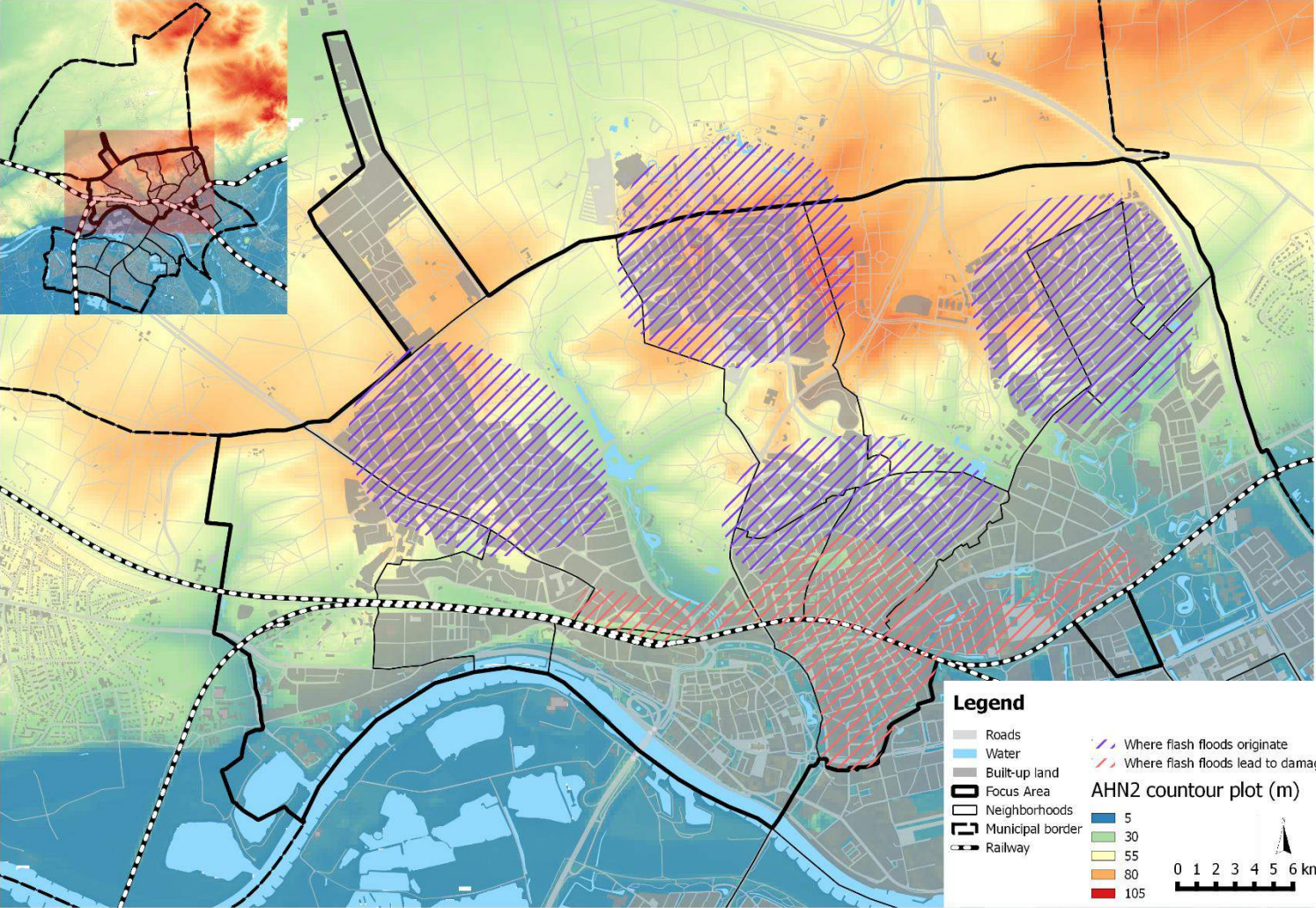
The downpour event of July 28th 2014 has put flash floods prominently on the political agenda. The municipal Action Plan, which aims to assess what measures can be taken to reduce the impact of heavy downpours (Arnhem, 2014), can be seen as a direct result of that downpour event. Results from the interviews show that the approach the municipality formulates in the Action Plan, which can be captured in three key principles, is a good reflection of the informal institutional context.

- Preventing damage after an extreme downpour such as the 28th of July 2014 is impossible due to the topography of Arnhem (map 4). Difference in elevation and the location of the built-up land causes rainwater runoff to accumulate quickly. The Action Plan does not aim at solving the problem but aims at dealing with the most extreme bottlenecks (Gemeente Arnhem, 2014). This is in line with what Interviewee municipality B (2015, 1 May) says: *“The neighbourhoods which are almost completely covered by hard surfaces, that are located around the city centre. The old neighborhoods. Spijkerkwartier, Klarendal, Sint-Marten those are for 95% covered by hard surfaces. The city center to, but that lays on flat surface. But there (see map 4) is where a lot of rainwater runs off because of the hard surfaces, leading to problems there (see map 4) because of the slope. Geitenkamp, Alteveer Kranenveld those neighbourhoods are positioned on a slope. The water runs down there very quickly. Locally you will also have problems in those higher areas but the real trouble occurs more downhill”*.
- The municipality cannot do this on its own. Effective adaptation requires effort from private actors such as housing associations and residents. Municipalities and residents are therefore involved in the creation of the Action Plan (Gemeente Arnhem, 2014). This is in line with what Interviewee municipality E (2015, 12 May) says: *“Well I think, definitely in the first place, the shared responsibility. That every individual in the city takes his or her responsibility for his own place, own home, own building, own real estate”* and Interviewee municipality J (2015, 5 June) says: *“Well I think making residents aware so that they consider the way they design their gardens....communication is definitely very important. And that the municipality works together with the residents”*.
- Flash flood adaptation should not be a separate goal. Measures to reduce flash flood risk should be taken during the general design of the public space and integrated in existing projects and processes such as large scale maintenance work, new development and redevelopment projects (Gemeente Arnhem, 2014). This is in line with what Interviewee municipality B (2015, 1 May) says *“Climate adaptation should not be considered from a drainage systems perspective. You have to have an integral perspective. Climate adaptation starts with designing public and private space”*.

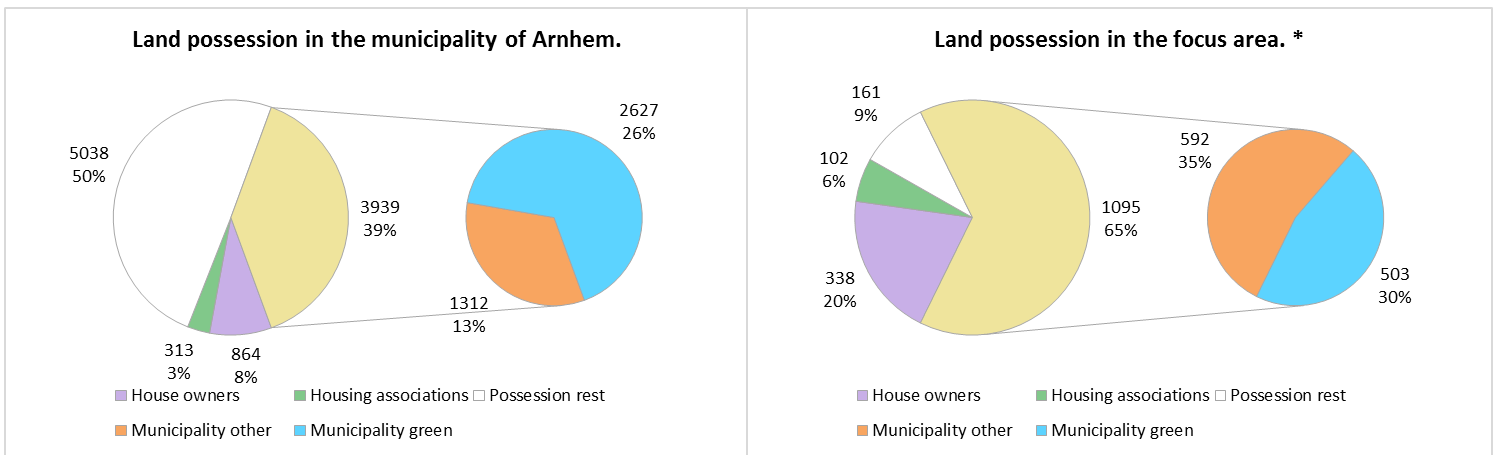
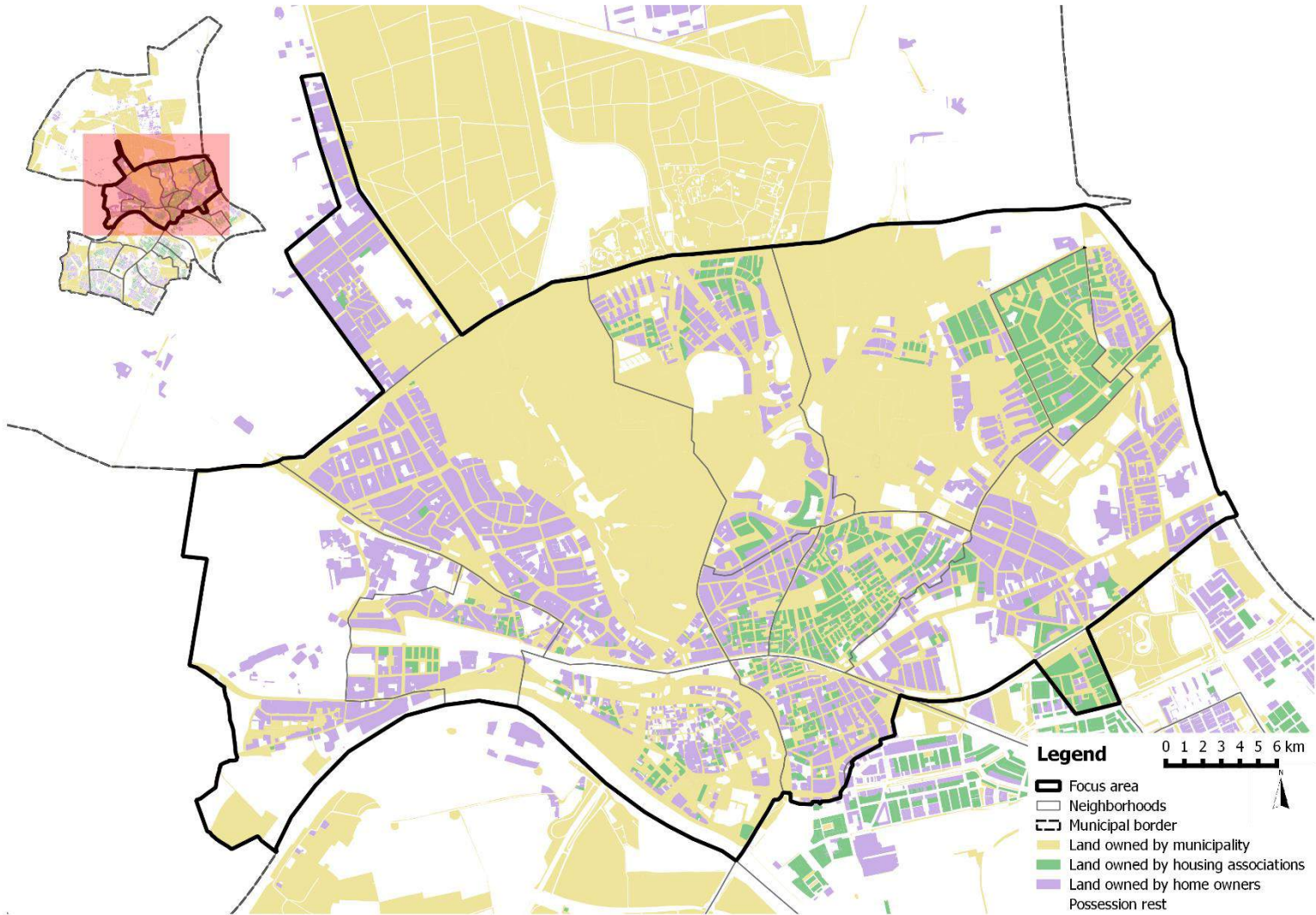
Perception of the municipality on the distribution of roles and responsibilities in flash flood adaptation

The Action Plan, GRP and interviewees are unambiguous on the perception that flash flood adaptation is a shared responsibility. This view is based on the idea that the technical oriented approach of increasing sewer capacities is financially unrealistic (Interviewee municipality B 2015, 1 May) and flash flood adaptation measures should therefore mainly be taken above ground. Due to the distribution of land between public and private actors (map 5) all landowners have a responsibility in flash flood adaptation. *“That applies for water, but also in general sense. As a private owner of a piece of land, whether it is a business or private house owner, you are responsible for what you can do on your own land”* (Interviewee municipality E 2015, 12 May). The Action Plan is therefore created in collaboration with residents and housing associations.

In addition, Interviewee municipality B (2015, 1 May) says the following on the role of housing associations in flash flood adaptation: “they cannot force their tenants to adapt. What they could do is give them information and cooperate in detachment efforts”. On the role of residents Interviewee municipality B (2015, 1 May) states: “Flash flood adaptation demands a good spatial planning, spatial design and good urban development. Here lays an important role for residents. Residents determine what happens in a neighborhood”. Interviewee insurance F (2015, 19 May) describes how residents are important in influencing the council’s decision, which will be made later this year, on what to do with the findings of the Action Plan. “They need to keep hammering home towards the politics demanding what will be done to make the city better rainproof” (Interviewee insurance F 2015, 19 May). Furthermore Interviewee municipality B (2015, 1 May) and Interviewee municipality E (2015, 12 May) stress the importance of the municipality playing a facilitating role. Interviewee municipality B (2015, 1 May) sees this facilitating role as setting the right example in designing public spaces and giving private actors more input in the design process to bring in their ideas. Interviewee municipality E (2015, 12 May) sees this facilitating role as providing information and formulating clear policy frameworks within which residents have the freedom to take initiatives.



MAP 4: COMBINING DATA ON SURFACE ELEVATION, BUILT-UP LAND AND HOW THIS CAUSES FLASH FLOODS TO FORM AND LEAD TO DAMAGE, SOURCE: RESEARCHER, BASED ON DRAWING FROM INTERVIEWEE B (2015, 1 MAY) AVAILABLE IN APPENDIX I.



MAP 5: SHOWING THE DISTRIBUTION OF LAND POSSESSION IN THE FOCUS AREA AMONG MUNICIPALITY, HOUSING ASSOCIATIONS AND PRIVATE HOME OWNERS. THE PIE CHARTS SHOW THE DISTRIBUTION IN HECTARES AND PERCENTAGES, * NOTE BY MUNICIPAL SUPERVISOR: THE POSSESSION OF THE MUNICIPALITY IS DIVIDED IN PRIVATE AND PUBLIC AFFAIRS, THE AVERAGE POSSESSION OF THE MUNICIPALITY OF ARNHEM FOR PUBLIC AFFAIRS IS APPROXIMATELY 7% (WITHOUT THE PARKS), SOURCE: RESEARCHER.

Housing associations and informal institutional context

The attitude of the housing associations towards flash flood adaptation

Climate adaptation is not something housing associations in Arnhem are concerned with. And therefore is not part of their policy (Interviewee housing association C 2015, 7 May; Interviewee housing association I 2015, 22 May). This is in line with what CPC (2014) states on the attitude of Dutch housing associations towards climate adaptation on national scale. Although downpour event of July 28th 2014 had impact on the housing associations it was no reason to change their policy. If housing associations do anything in the domain of flash flood risk management it is always ordered, or initiated by the municipality (Interviewee housing association C 2015, 7 May; Interviewee housing association I 2015, 22 May).

Perception of the housing association on the distribution of roles and responsibilities in flash flood adaptation

Like the research from Roder & Straub (2015) the case study shows that the willingness of housing associations to participate in flash flood governance varies (Interviewee municipality J 2015, 5 June). Some housing association have been actively involved in meetings with the municipality and residents after the downpour event of July 28th 2014. One of the housing associations has taken concrete measures (Interviewee municipality E 2015, 12 May), and another is helping with providing information to their tenants on what they can do to reduce flash flood risk (Interviewee housing association I 2015, 22 May). But since climate adaptation is not part of their policy their involvement will be of temporal nature. Interviewee housing association I (2015, 22 May) states that they do not have a clear trigger for climate adaptation.

From both interviews with representatives of a housing association it becomes clear they find that the municipality plays a leading role in flash flood adaptation. Interviewee municipality E (2015, 12 May) is quite explicit about it: *“We now know that because the discharge capacity of the municipal sewer system is too low these will result in problems. Therefore we lay responsibility with the municipality and not with us”*. Based on the interviews it can be stated that housing association do not see themselves as a key actors in flash flood management. They are not motivated to take initiative in flash flood adaptation.

Insurers and informal institutional context

The attitude of insurers towards flash flood adaptation

Results from the interviews show that different insurers value flash flood adaptation differently. The quotes presented below show there is general consensus on the fact that climate change will increase flash flood damage, and therefore the burden of claim. But there is animosity on to what extent it is an urgent issue. This has to do with the fact that flash flood damage claims comprise a small part of the total building structure- and content insurance claims. Furthermore it is seen as an issue of the future, there is a low sense of urgency.

- *“With flash floods that [collaborating with other insurers and public institutions to keep flash floods damage insurable] is not necessary because it is a manageable risk. We don’t have to do something about it. Climate change is continuing but we do not experience the consequences directly yet. ... We do see that in 10, 20, 30, 40 years there will be situations where the risk becomes unmanageable. It becomes uninsurable. But we still have some time”* (Interviewee insurance A, 2015, 28 April).

- *“I calculated what the effect of the future KNMI scenarios would have on us. On our burden of claims. The results made a lot of people very nervous. Therefore we put it on our strategic agenda.”* (Interviewee insurance F 2015, 19 May)
- *“What I do, I try to entuse as many insurers as possible but I notice that a lot of them lack a sense of urgency. It is very difficult because the feeling is not there yet.”* (Interviewee insurance F 2015, 19 May)

Perception of insurers on the distribution of roles and responsibilities in flash flood adaptation

The perception of the role that insurers play in flash flood adaptation also varies. Interviewee insurance A (2015, 28 April) acknowledges that insurers have a social responsibility in providing their customers with knowledge and information on the threats of climate change and what people can do to reduce flash flood risk. Generally insurers are not getting involved in flash flood adaptation. They are likely to respond to growing risks by changing policy conditions, raising premiums or raising deductibles (Interviewee insurance A, 2015, 28 April). But Interviewee insurance F sees a different role for insurers: *“that was also said by the director of the trade organization of Dutch insurers.....We will have to raise premiums and deductibles. We want water boards and municipalities to take action. Well I see things differently. I see it as our job to work together with stakeholders. And use our knowledge. Because we know what the economic damage is of an extreme downpour.....We could see what is heading towards us as a threat but also as an opportunity. Threat in the sense that it will result in a higher burden of claim and that we have to give costumers different policy conditions. But you could also grasp it as an opportunity by working together with the relevant stakeholders, then I am talking about knowledge institutes, water boards, municipalities and especially residents. Work together to organize large scale prevention projects on neighbourhood level ...I will never be able to prevent rising burden of claims. I will only be able to dampen the rise with large scale collaboration on innovative prevention”* (Interviewee insurance F 2015, 19 May).

Interviewee insurance F (2015, 19 May) stresses the central role of the residents. But also mentions the roles of knowledge institutions, municipalities, companies and water boards. Interviewee insurance A (2015, 28 April) refers to municipalities, residents, water boards and companies as actors playing a role in flash flood adaptation.

Residents and informal institutional context

The attitude of residents towards flash flood adaptation

The survey questionnaire included four questions to determine the attitude of residents towards flash floods and flash flood management. The response to these questions can be found in figure 14. Results show that residents generally do not see changing precipitation patterns as a threat for their personal situation. Statistical analyses shows that the extent to which people seeing changing precipitation patterns as a threat for their personal situation:

- Has a moderate significant association to whether people experienced flash flood damage ($P = 0.001$, Gamma value = - 0,436).
- Has a moderate significant association to whether people expect downpours to become more extreme and occur more often in 25 years ($P = 0,001$, Gamma value = 0.422)
- Has a strong significant association to whether people fear extreme downpours ($P = 0.000$, Gamma value = -0,622).

Residents generally do see changing precipitation patterns as a threat for Arnhem. Statistical analyses shows that the extent in which people are concerned for their city:

- Has no association to whether people experienced flash flood damage (P=0.689).
- Has a moderate significant association to whether people expect downpours to become more extreme and occur more often in 25 years (P = 0.000, Gamma value = 0,527).
- Has a moderate significant association to whether people fear extreme downpours (P = 0,000, Gamma value = -0,540).

The response to the question to what extent the respondent fear extreme downpours after the event of July 28th 2014 is fairly equally divided. Furthermore residents are generally interested in flash flood management as a topic. There is a moderate significant association between fear of extreme downpours and interest in flash flood management as a topic (P = 0.000, Gamma value = 0.396). A respondent’s concern for Arnhem (P = 0,000, Gamma value = -0,372) and personal situation (P = 0,023, Gamma value = -0,243) are also significantly associated with the extent to which a respondent find flash flood management an interesting topic.

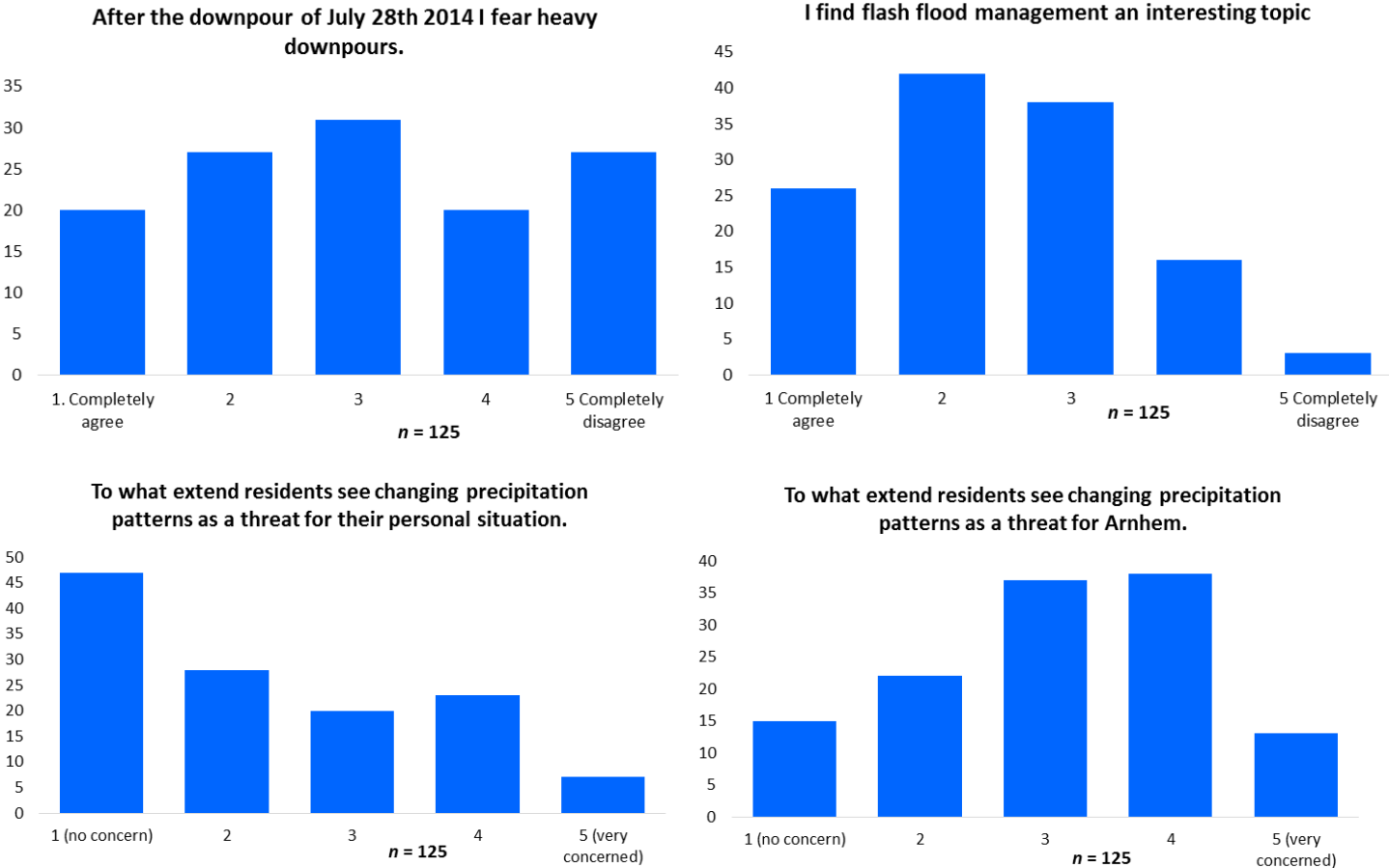


FIGURE 14: SURVEY RESULTS 2, INDICATORS DETERMINING THE ATTITUDE OF RESIDENTS TOWARDS FLASH FLOODS AND FLASH FLOOD MANAGEMENT.

To determine to what extent the informal institutional characteristics presented in figure 14 have influenced a respondents to take flash flood adaption measures different associations have been statistically tested. Results are presented in table 9 below. Boltzen et al (2009) describes individual's risk perception as key motivator for residents to get involved in flood risk management. This in line with the results presented below. People who perceive flash floods to be a threat for their personal situation have taken risk reducing measures.

Variable 1	Variable 2	Significance (P)	Association's strength (Gamma)
Perception on flash floods as threat for personal situation.	Taken measures to protect home against flash flood damage.	0,003	-0,381
Perception on flash floods as threat for personal situation.	Taken measures to reduce rainwater runoff from parcel.	0,003	-0,369
Perception on flash floods as threat for Arnhem.	Taken measures to protect home against flash flood damage.	0,085	-0,231
Perception on flash floods as threat for Arnhem.	Taken measures to reduce rainwater runoff from parcel.	0,281	- 0,144
Extent to which respondent fear extreme downpours after July 28 th 2014.	Taken measures to protect home against flash flood damage.	0,001	0,422
Extent to which respondent fear extreme downpours after July 28 th 2014.	Taken measures to reduce rainwater runoff from parcel.	0,142	0,191
Extent to which respondent finds flash flood management an interesting topic.	Taken measures to protect home against flash flood damage.	0,383	0,122
Extent to which respondent finds flash flood management an interesting topic.	Taken measures to reduce rainwater runoff from parcel.	0,109	0,219

TABLE 9: SURVEY RESULTS 3, RESULTS OF THE STATISICAL ANALYSES DETERMINING TO WHAT EXTENT INFORMAL INSTITUTIONAL CONTEXT INFLUENCES RESIDENTS TO TAKE FLASH FLOOD ADAPTATION MEASURES I. A GREEN NUMBER INDICATES A SIGNIFICANT STATISTICAL ASSOCIATION. A RED NUMBER INDICATES NO SIGNIFICANT STATISTICAL ASSOCIATION.

Based on the results in table 9:

- Survey hypothesis 2: “Respondents who see flash floods as a threat for their personal situation are involved in flash flood adaptation by taking risk reducing measures” is accepted.
- Survey hypothesis 3: “Respondents who see flash floods as a threat for the city of Arnhem are involved in flash flood adaptation by taking risk reducing measures” is accepted.
- Survey hypothesis 4: “Respondents who fear flash floods are involved in flash flood adaptation by taking risk reducing measures” is rejected.
- Survey hypothesis 5: “Respondents who find flash flood management an interesting topic are involved in flash flood adaptation by taking risk reducing measures” is rejected.

The questions on what is seen as the best flash flood management approach reveals a clear preference of residents for taking measures above ground (figure 15). This is in line with the contemporary paradigm on flash flood management where solutions are generally sought above ground rather than underground (CPC, 2014).

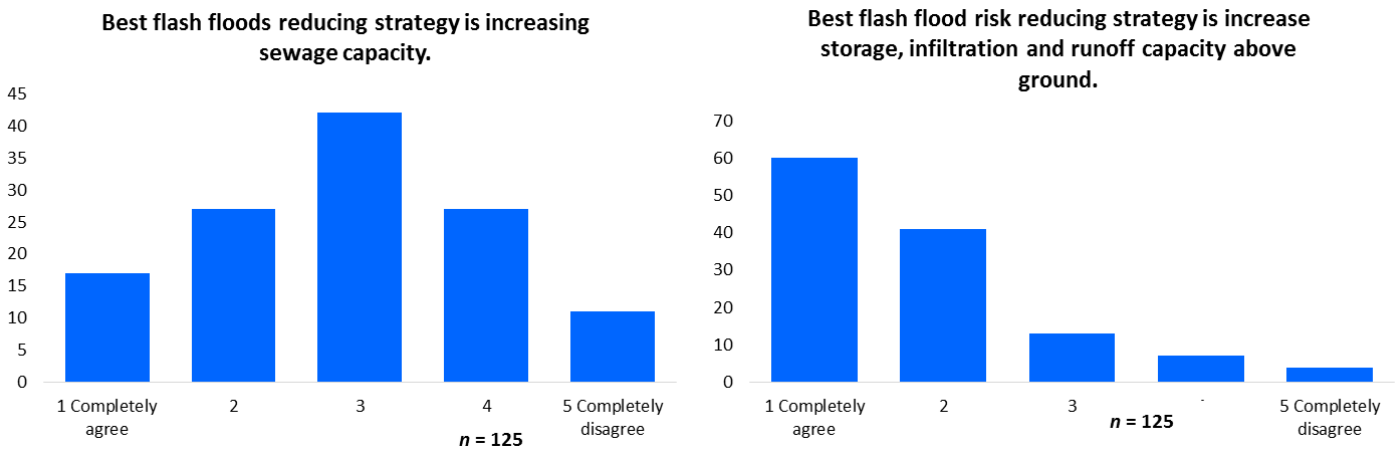


FIGURE 15: SURVEY RESULTS 4, WHAT RESPONDENTS SEE AS THE BEST APPROACH TO FLASH FLOOD RISK MANAGEMENT.

Perception of residents on the distribution of roles and responsibilities in flash flood adaptation.

Figure 16 shows to what extent residents of Arnhem find different actors responsible for reducing flash flood risk. The municipality is seen as the actor bearing greatest responsibility. 80% Of the respondents state that the municipality is either very strongly responsible or strongly responsible for reducing flash flood risk. For the other key actors these percentages are: 34,4% (other residents), 44,8% (housing associations) and 21,6% (insurers). All key actors are considered at least somewhat responsible for reducing flash flood risk: municipality 96,8%, residents 90,4%, housing associations 86,4% and insurers 60%.

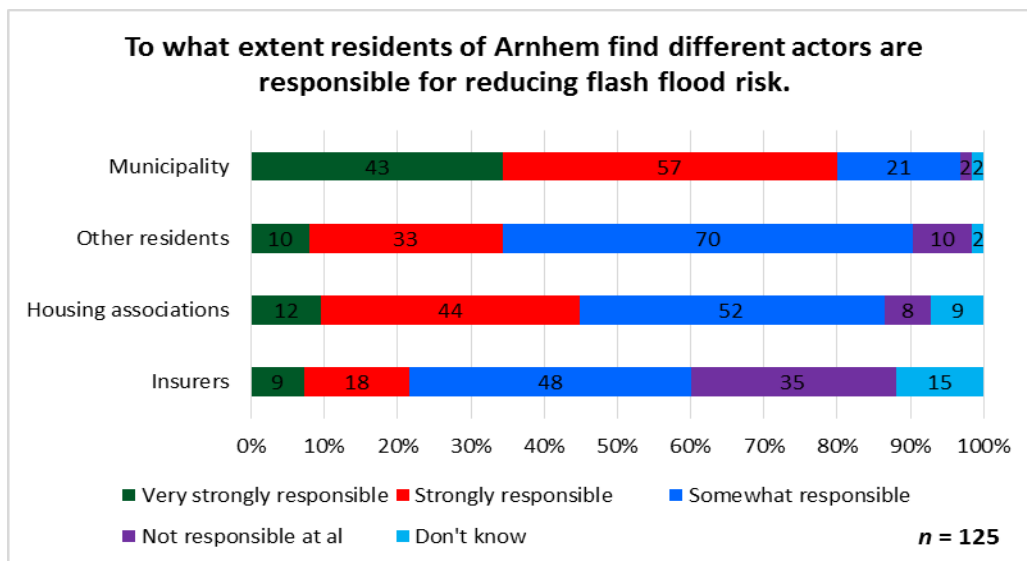


FIGURE 16: SURVEY RESULTS 5, TO WHAT EXTENT RESIDENTS CONSIDER DIFFERENT FLASH FLOOD ACTORS RESPONSIBLE FOR REDUCING FLASH FLOOD RISK.

Figure 17 shows to what extent residents feel responsible for taking measures to reduce flash flood risk themselves. There is a strong significant association between the extent to which residents consider themselves responsible for taking measures to reduce damage on their own property and to what extent they consider other residents as being responsible to reduce flash flood risk in general ($P=0,000$, Gamma value = 0,934). There is also a strong significant association between the extent to which residents consider themselves responsible for taking measures to reduce runoff from their own property and the extent to which they consider other residents responsible for reducing flash flood risk in general ($P=0,000$, Gamma value =0,830).

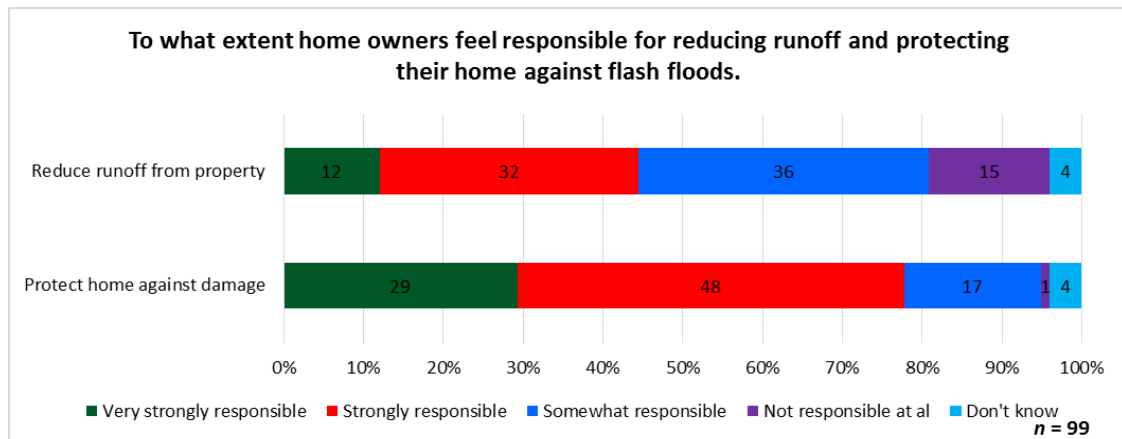


FIGURE 17: SURVEY RESULTS 6, TO WHAT EXTENT RESIDENTS FEEL RESPONSIBLE FOR TAKING FLASH FLOOD REDUCING MEASURES THEMSELVES.

To determine to what extent individual's perception of responsibilities influences respondents to take flash flood adaption measures is statistically tested. Results are presented in table 10. Based on these results survey hypothesis 6: "respondents who feel responsibility to take flash flood risk reducing measures are involved in flash flood adaptation by taking risk reducing measures" is accepted.

Variable 1	Variable 2	Significance (P)	Association's strength (Gamma)
Feeling of responsibility for taking measures to reduce runoff from parcel.	Taken measures to reduce rainwater runoff from parcel.	0,024	-0,344
Feeling of responsibility for taking measures protect home against flash flood damage	Taken measures to protect home against flash flood damage.	0,623	-0,087

TABLE 10: SURVEY RESULTS 7, RESULTS OF THE STATISTICAL ANALYSES DETERMINING TO WHAT EXTENT INFORMAL INSTITUTIONAL CONTEXT INFLUENCES RESIDENTS TO TAKE FLASH FLOOD ADAPTATION MEASURES II. A GREEN NUMBER INDICATES A SIGNIFICANT STATISTICAL ASSOCIATION. A RED NUMBER INDICATES NO SIGNIFICANT STATISTICAL ASSOCIATION.

4.3 Adaptive capacity, taking flash flood adaptation measures

The adaptive capacity of a system determines the capability of a system to adapt to the adverse effects of climate change (IPCC, 2007). Adaptive capacity has been shown to be a prerequisite for the implementation of adaptation measures (Brooks & Adger, 2005). Adaptive capacity of a system is determined by the resourcefulness of individual actors and the ability to act collectively (Adger et al, 2004). The resourcefulness of the flash flood governance actors is discussed in the first part of this paragraph by analyzing the availability of individual financial, informational and technological/human resources. The second part elaborates on the ability of the key actors to act collectively. The results presented in this paragraph will be reflected upon in chapter 5 to answer secondary research question 3: how does adaptive capacity of key actors influence the governance of flash flood adaptation in Arnhem?

Individual resourcefulness of key flash flood governance actors

The adaptive capacity of municipality of Arnhem

Financial resourcefulness

Lack of financial resources is a strong barrier for the municipality of Arnhem to implement flash flood adaptation measures: *“the biggest barrier is money”* (Interviewee municipality E 2015, 12 May). *“Currently we are almost doing nothing. The current GRP has barely to non financial resources available for flash flood adaptation”* (Interviewee municipality E 2015, 12 May). The Action Plan, which is the only thing which is currently done in the domain of flash flood management, is strongly limited by its budget. The counsel already determined there will be no extra financial resources available to implement measures. This strongly determines the scope of the flash flood adaptation practices of the municipality, which is focused on emphasizing responsibilities of private actors and integrating flash flood adaptation measures into planned maintenance work and existing spatial developments. Climate adaptation projects that are being realized in Arnhem are strongly dependent on private initiatives and funding of external partners (Interviewee municipality E 2015, pers.comm.,12 May).

The collected data show that the financial resourcefulness to take adaptive measures is strongly determined by the sense of urgency. *“When the city has to endure such a downpour again this summer. Well then the urgency will be high again.....That is how it works in politics. Politics have different priorities at the moment, with the limited amount of budget they have to spend. So as long as flash floods or heat is not high on the political agenda, other topic are more important. And that is very logical. That is how a politically guided organization like a municipality works. You cannot give priority to everything therefore you give priority to things that are very important.”* (Interviewee municipality E 2015, 12 May).

Lack of financial resources and competition of other planning problems found in this case study to be barriers hampering climate adaptation are in line with the finding of Runhaar et al (2012) presented in table 3.

Informational resourcefulness

Based on multiple policy and strategy documents it can be said municipality has sufficient knowledge about processes which are driving the growth of flash flood risk and what measures can be taken to reduce it (Gemeente Arnhem, 2009a; 2009b; 2012; 2014). But a municipality cannot be considered as a uniform entity. Within such a big organization there are disparities between how officials value and are aware of the need for flash flood adaptation. For successful flash flood adaptation *“everybody who is involved with designing the public domain should know the principles of how to make a city rainproof”* (Interviewee context D 2015, 11 May). In Arnhem there is room to improve this process of mainstreaming. *“As municipality we can improve our designing. That is something I am certain of. And I think it is possible with less money. But I know not everybody thinks about that the same way”* (Interviewee insurance A, 2015, 28 April).

Technological/ human resourcefulness

During the interviews it became apparent that lack of specific expertise hampers a more detailed understanding of flash flood vulnerability and damage. Although the downpour of 28th of July 2014 did significantly contribute to the understanding of Arnhem’s vulnerability to flash floods Interviewee

municipality B (2015, 19 May) states that there are still areas of which they do not know exactly how they were affected. Different kinds of technologies to model rainwater runoff have proven very valuable in mapping a cities flash flood vulnerability (CPC, 2014). Arnhem was not yet using these technologies during the research. The possibility to import technological and human resources is constrained by uncertainty on what the benefits will be. On investing money for water runoff analysis software Interviewee municipality B (2015, 19 May) says: *“is it worth it? Let me put it this way. Will we have the advantages we want in relation to the cost to buy it?”*. Furthermore there is limited knowledge on the financial damage resulting from extreme downpours and the economic benefits of taking flash flood adaptation measures: *“is it something we should invest in? It is such an extreme exception. Well with a little less rain we will also encounter problems. But what does something like that cost? There is no feeling about that”* (Interviewee municipality B 2015, 19 May). Having more insight in the financial damage and the financial cost-benefit relationship can be a powerful way to underpin the need to take adaptation measures.

The adaptive capacity of housing associations in Arnhem

Financial resourcefulness

On the financial resourcefulness of housing associations Interviewee municipality E (2015, 12 May) says: *“I think they [housing association] want to [get involved in flash flood adaptation] but are not able to. They are in a difficult financial situation. But also some years ago when this was not the case their primary task is realizing a sustainable housing stock. So energy, saving energy and generating sustainable energy. So climate adaptation is not really on the agenda”*. Interviewee housing association I (2015, 22 May) adds that it is also the lack of financial stimuli which is making it unattractive for housing association to invest in climate adaptation:

“So we are very much in favor of sustainability and building energy neutral. That is because of two reasons. The first is what I always call save the planet. And the second, being much more important for us, the affordability. You see, housing costs consist of rent but also the energy bill.... And by applying isolation and that kind of stuff we can lower the energy bill. I use this example because it shows a clear trigger for us to invest in sustainability, save the world... When I translate this to climate adaptation. Well what is the financial trigger for me to invest in, let's say a green roof, which adds to the water storing capacity of a city by making the city greener. Well that trigger is not so strong. A green roof is more expensive than a normal roof, it requires more maintenance. In that case the trigger is for us only save the world and not so much affordability... This does not mean that those triggers are not there. They only are more difficult to find” (Interviewee housing association I 2015, 22 May)

Informational resourcefulness

Informational resourcefulness is defined as to what extent individuals are aware of climate change, the growing risks as a result of climate change and, indirectly, how this influences individuals in taking adaptation measures. Interviews with representatives of two Arnhem housing association did not produce an unambiguous picture on the informational resourcefulness of housing association. Housing association representative Interviewee housing association C (2015, 7 May) did not even mention climate change in the interview. Contrarily housing association representative I (2015) states: *“So extreme downpours. It has to do with climate change. The chance that they occur will increase.”*

But interviews revealed that worries for growing risks due to climate change are not a trigger to take climate adaptive measures. This is shown by the limited response by housing associations after the extreme downpour of July 28th 2014. The Interviewee housing association C (2015, 7 May) explained they installed removable barriers to stop water from entering a home on high risk locations. Interviewee

housing association I (2015, 22 May) stated that, as far as he knows, they did not take any structural measures but will work together with municipality in providing information to their tenants. These are one-time actions resulting from meetings with the municipality. *“Climate adaptation is not something we take a leading role in”* (Interviewee housing association C 2015, 7 May). *“When an extreme downpour occurs then we know where problems will occur. Then we know we have to assign extra workers for it. So we anticipate on that. But in first instance we only react when something happens”* (Interviewee housing association C 2015, 7 May).

Technological/human resourcefulness

Climate adaptation does not receive much attention by housing associations in Arnhem. Although it differs between individual housing associations in general it can be said that developing and implementing technologies, innovation and expertise on climate adaptation is not something they are concerned with. The technological and human resourcefulness therefore can be considered low.

“We follow the development concerning building legislation. That is company policy.... Also with the use of building materials, we only use products that are proven to keep functioning properly for 5-6 years.... we are not really anticipating new technologies?” (Interviewee housing association C 2015, 7 May).

The adaptive capacity of insurers

Financial resourcefulness

The interviews did not result in data on the financial resourcefulness of insurers. Mills (2007b) states that insurers are important actors in climate adaptation due to their financial resourcefulness. Based on this it can be assumed that insurers have sufficient financial resources available. The annual numbers of the Dutch insurance industry (Verbond van Verzekeraars, 2014, p.44-53) confirm the financial capacity of the Dutch insurance sector.

Informational resourcefulness

Insurers are well informed about the effect of climate change on varying risks. It is an essential part of their business to be aware of changing risks. A research report on the climate change effects on the burden of claims (Verbond van Verzekeraars, 2015) published by the branch organization for Dutch insurers is an example of their informational resourcefulness. Interviews with representatives from the insurance sector confirmed their awareness of the effects of climate change on flash flood risk. *“Look at the risks around us. With such a report you show, if nothing changes in this country, if climate change continues this way we will be faced with diverging additional risks. Yes that is something we are aware of”* (Interviewee insurance A, 2015, 28 April).

Technological/human resourcefulness

Representative of insurer Interviewee insurance F (2015, 19 May) explains that they are developing different tools in the domain of urban flash flood risk management: *“We know the economic damage, the economic effect of downpours, we have that data, we are able to visualize that. In this neighborhood we paid for this amount of damage. And with that location specific information we can see what certain adaptation measures would mean for future*

damages based on the KNMI scenarios... We work with 3di. That gives me the possibility to simulate a certain downpour with a certain intensity and duration and see where the water runs off to and correlate it to the damages that have occurred” (Interviewee insurance F 2015, 19 May). This type of expertise can be very valuable in supporting the planning and designing of adaptation measures and policies.

The adaptive capacity of residents in the focus area

To determine the adaptive capacity of the residents in the focus area the survey questionnaire included questions on individual resourcefulness and how their resourcefulness effected one’s involvement in flash flood adaptation. The results will be presented per type of resourcefulness. Statistical analyses determines how each type of individual resourcefulness influences the implementation of flash flood adaptation measures. Figure 18 and figure 19 show general results related to adaptive capacity of residents.

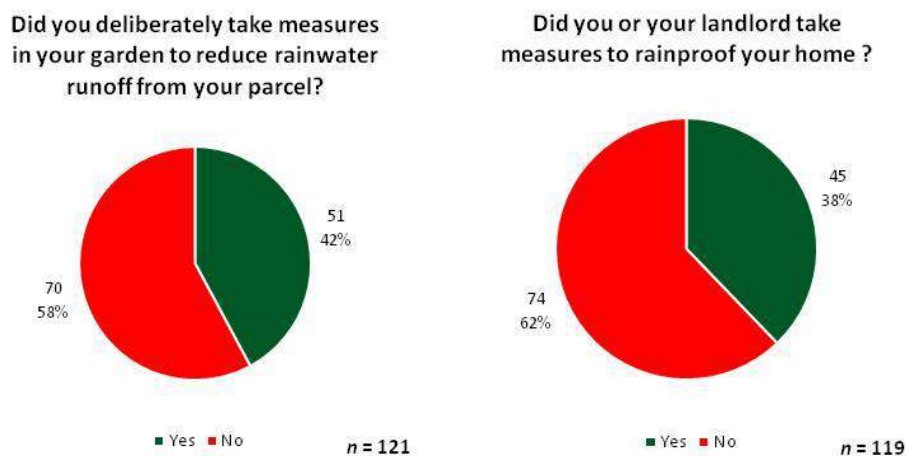


FIGURE 18: SURVEY RESULTS 8, THE AMOUNT OF RESIDENTS THAT ALREADY TOOK FLASH FLOOD ADAPTATION MEASURES.

The amount of residents which are withheld/not withheld to take measures by lack of any individual resources.

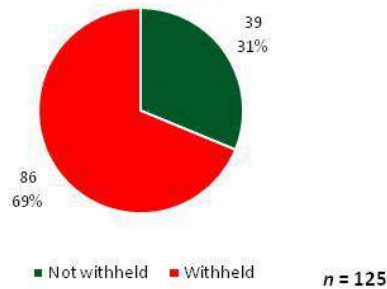
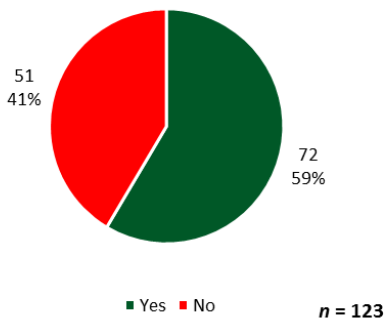


FIGURE 19: SURVEY RESULTS 9, THE AMOUNT OF RESIDENTS WHICH ARE WITHHELD BY LACK OF ONE OR MORE TYPES OF RESOURCEFULNESS IN TAKING FLASH FLOOD ADAPTATION MEASURES.

Financial resourcefulness

Do you have enough financial resources to take flash flood adaptation measures?



Does a lack of financial resources withhold you from taking flash flood adaptation measures?

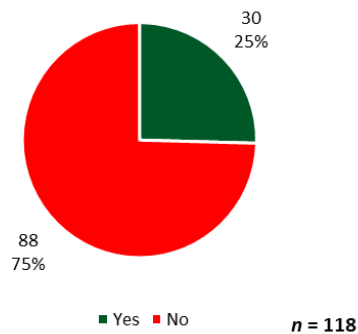


FIGURE 20: SURVEY RESULTS 10, THE FINANCIAL RESOURCEFULNESS OF RESIDENTS AND TO WHAT EXTENT LACK OF FINANCIAL RESOURCES WITHHOLDS THEM FROM TAKING FLASH FLOOD ADAPTATION MEASURES.

Variable 1	Variable 2	Significance (P)	Association's strength (Phi Coefficient)
Whether residents have enough financial resources to take flash flood adaptation measures.	Taken measures to reduce rainwater runoff from parcel.	0,176	0,124
Whether residents have enough financial resources to take flash flood adaptation measures.	Taken measures to protect home against flash flood damage.	0,005	0,259

TABLE 11: SURVEY RESULTS 11, RESULTS OF THE STATISTICAL ANALYSES DETERMINING TO WHAT EXTENT FINANCIAL RESOURCEFULNESS INFLUENCES RESIDENTS TO TAKE FLASH FLOOD ADAPTATION MEASURES. A GREEN NUMBER INDICATES A SIGNIFICANT STATISTICAL ASSOCIATION. A RED NUMBER INDICATES NO SIGNIFICANT STATISTICAL ASSOCIATION.

Informational resourcefulness

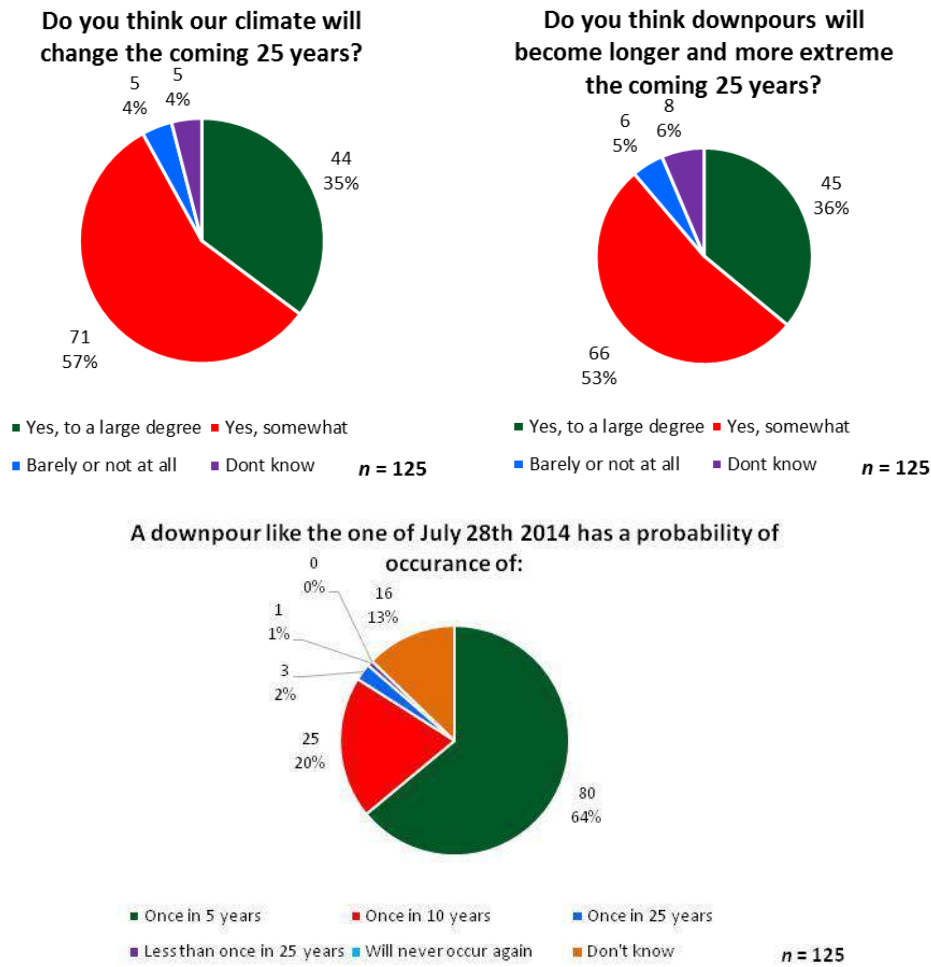
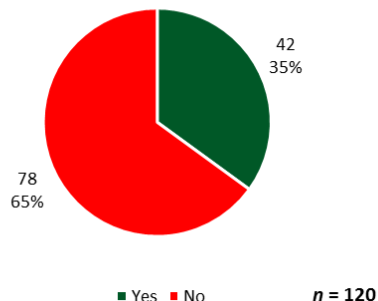


FIGURE 21: SURVEY RESULTS 12, THE INFORMATIONAL RESOURCEFULNESS OF RESIDENTS.

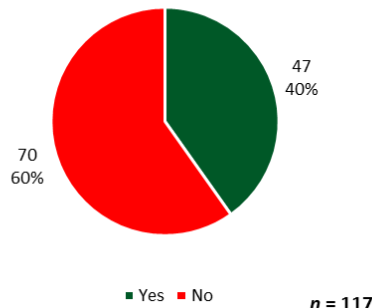
Variable 1	Variable 2	Significance (P)	Association's strength (Phi Coefficient)
To what extent residents think climate will change the coming 25 years.	Taken measures to reduce rainwater runoff from parcel.	0,544	-0,110
To what extent residents think climate will change the coming 25 years.	Taken measures to protect home against flash flood damage.	0,177	-0,246
To what extent residents think downpours will become longer and more extreme the coming 25 years.	Taken measures to reduce rainwater runoff from parcel.	0,699	-0,070
To what extent residents think downpours will become longer and more extreme the coming 25 years.	Taken measures to protect home against flash flood damage.	0,536	-0,113

TABLE 12: SURVEY RESULTS 13, RESULTS OF THE STATISTICAL ANALYSES DETERMINING TO WHAT EXTENT INFORMATIONAL RESOURCEFULNESS INFLUENCES RESIDENTS TO TAKE FLASH FLOOD ADAPTATION MEASURES. A RED NUMBER INDICATES THERE IS NO SIGNIFICANT STATISTICAL ASSOCIATION.

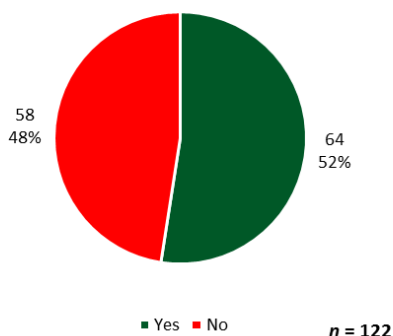
Do you have enough knowledge to take effective and efficient flash flood adaptation measures?



Does a lack of knowledge withhold you from taking flash flood adaptation measures?



Do you have the skills to take flash flood adaptation measures?



Does a lack of skill withhold you from taking flash flood adaptation measures?

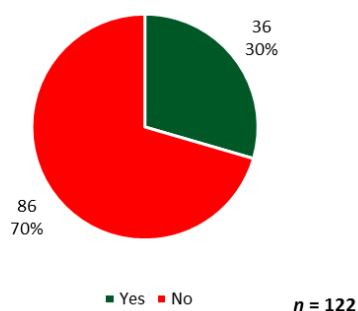


FIGURE 22: SURVEY RESULTS 14: THE TECHNOLOGICAL/HUMAN RESOURCEFULNESS OF RESIDENTS AND TO WHAT EXTENT LACK OF TECHNOLOGICAL/HUMAN RESOURCES WITHOLDS THEM FROM TAKING FLASH FLOOD ADAPTATION MEASURES.

Variable 1	Variable 2	Significance (P)	Association's strength (Phi Coefficient)
Whether residents have enough knowledge to take effective and efficient flash flood adaptation measures.	Taken measures to reduce rainwater runoff from parcel.	0,001	0,300
Whether residents have enough knowledge to take effective and efficient flash flood adaptation measures.	Taken measures to protect home against flash flood damage.	0,049	0,183
Whether residents have the skills to take flash flood adaptation measures.	Taken measures to reduce rainwater runoff from parcel.	0,049	0,181
Whether residents have the skills to take flash flood adaptation measures.	Taken measures to protect home against flash flood damage.	0,639	0,043

TABLE 13: SURVEY RESULTS 15, RESULTS OF THE STATISTICAL ANALYSES DETERMINING TO WHAT EXTENT TECHNOLOGICAL/HUMAN RESOURCEFULNESS INFLUENCES RESIDENTS TO TAKE FLASH FLOOD ADAPTATION MEASURES. A GREEN NUMBER INDICATES A SIGNIFICANT STATISTICAL ASSOCIATION. A RED NUMBER INDICATES NO SIGNIFICANT STATISTICAL ASSOCIATION.

Based on the results presented in tables 10-12 survey hypothesis 7: “individual resourcefulness of respondents influences to what extent respondents get involved in flash flood adaptation by taking risk reducing measures.” is accepted. But it has to be mentioned that the results show great variation in how different types of resourcefulness influence residents to take flash flood adaptation measures. For informational resourcefulness no significant association is found.

Act collectively

From the results of the interviews it shows that amongst all four key actors there is a general consensus that flash flood adaptation should be done in collaboration. Looking at the two main efforts which have been undertaken in flash flood management in the past in Arnhem: large scale detachment in combination with the Water Service Point and the Action Plan, the importance of collaboration, and acting collectively in climate adaptation can be recognized.

- *“We had a service [waterservicepunt] that approached private actors when the public space was redeveloped to offer them the possibility to detach and get a subsidy. So the cost for detaching would, up to a certain level, remain neutral. In some cases we said just discharge your rain pipe on to the street then we will take care of it. That was either on voluntary basis or in collaboration with housing associations”* (Interviewee municipality B 2015, 1 May).
- Interviews have shown that the Action Plan brought parties together to think about improving measures to make Arnhem rainproof. *“As a result of that incident. That is also the good thing of incidents. Interaction and conversations took place between housing associations, municipality and residents about what is going on”* (Interviewee housing association I 2015, 22 May). Those interactions led to several concrete adaptation plans and measures (Interviewee housing association C, 2015; Interviewee housing association I, 2015; Interviewee municipality J, 2015).

Both examples show how the implementation of measures are the result of collective action resulting from interactions between different actors within a network. Temporal, fluid synergetic governance processes, involving public and private actors occur around certain projects in this case detachment projects and the Action Plan. The fact that in both examples specific projects are the trigger for collective action shows the importance of a platform around which governance processes can occur.

Up to now the actors involved in the flash flood management network remain limited to residents and housing association. Interviews and literature research has shown that it is valuable to expand that network. This research motivates that insurers can be a valuable actor due to their expertise and connection with policyholders (Interviewee insurance F 2015, 19 May). But there are many more relevant actors. Interviewee context D (2015, 11 May) states *“everybody who is working on designing public space should know principles of making a city rainproof. That is not something that is done in a few months. It is something which includes giving many presentations about what people could do. Get people excited. So it also requires a lot of persuasiveness.”*

Looking back on his experience with making a city rainproof, Interviewee context D states: *“The most important lesson is there are many parties that are dealing with the city in diverse ways. So that requires a very flexible and diverse message...and it is something that takes long term perspective... So when you talk about a subject like this it is required to stay a serious partner for a long period of time so the subject remains serious and more parties can join the program... changing attitudes takes a long time”* (Interviewee context D 2015, 11 May). Interviewee municipality J (2015) states that for the Action Plan of Arnhem this long term perspective is essential. *It is something that needs to get into our system. That is how I see it. I do not see it as something, a project that you finish and then it is done. It is something, especially with climate change, it is something that needs to be integrated into our way of thinking. And that is how I also see the Action Plan.*

4.4 Governance of flash flood adaptation on local scale

In chapter two interactions and interdependencies are determined as key aspects of governance processes. Therefore interactions and interdependencies are used as indicators to analyze flash flood adaptation governance processes on local scale in Arnhem. Interdependencies and interactions vary between relationships (see figure 23). To get an understanding on flash flood adaptation governance processes and the dynamics within the governance network it is necessary to analyze all six relationships. Governance is after all “*the whole of interactions taken to solve societal problems*” (Kooiman et al. 2005, p.17). The results presented in this paragraph will be reflected upon in chapter 5 to answer secondary research question 4: how do existing interactions, and interdependencies influence the governance of flash flood adaptation in Arnhem?

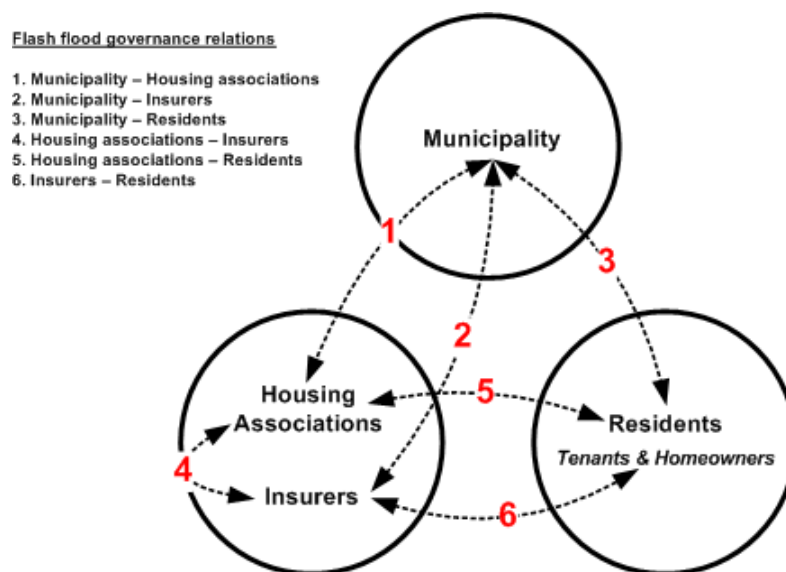


FIGURE 23: THE SIX DIFFERENT RELATIONSHIPS BETWEEN THE FOUR KEY FLASH FLOOD ADAPTATION ACTORS ON LOCAL SCALE.

Interdependencies and interactions in flash flood adaptation governance

1. Municipality - Housing associations

Municipality sees housing associations as a key partner for making Arnhem better rainproof. “*We are definitely dependent on external parties that are developing in Arnhem. External project developers, housing associations*” (Interviewee municipality J 2015, 5 June). *Housing association have many housing areas in their possession. You can do a lot with those areas. That is something we can deliberate on*” (Interviewee municipality B 2015, 1 May). This is in line with what Interviewee municipality E (2015, 12 May) says: “*We as the municipality will never be able to make the city climate proof by ourselves. You cannot do that as government. That is something you need everybody for*”.

Results of the informal institutional context have shown that housing associations are not likely to take a leading role in flash flood adaptation. Interviews show that flash flood adaptation is not

something housing associations see as a priority. Involvement of housing association in flash flood governance is therefore strongly dependent on initiative from the municipality. Furthermore Interviewee housing association C states that the possibilities for them to reduce flash flood risk of their properties strongly depends on the municipal sewage system: *“Where the flash flood risk is the biggest people received a barrier to block the water as much as possible. But that all has to do with a lack of capacity of the discharge system. And that is municipal domain. We can invest in bigger pipes and wells so the water can be processed. But when the municipal sewer system cannot process it then it does not work. And that is where the problem is. At least in our perspective.”* (Interviewee housing association C 2015, 7 May).

Like Kooiman (2003) describes, the case study shows that interdependencies trigger interaction. The strong sense on interdependency from the municipality towards housing association was a trigger to start interaction flash flood management. The extreme downpour on 28 July 2014 was an important event in triggering this interaction. *“It [the downpour event on 28-07-2015] helped placing it on the political agenda again. It lead to consultations between housing associations and municipality. This resulted in concrete agreements. As I mentioned earlier, what we can do short-term is providing tenants with information. So that has definitely lead to something substantial.”* (Interviewee housing association I 2015, 22 May). This interaction resulted in tangible measures: *“So for the Spijkerkwartier and the Geitenkamp we have, measures have been designed, plans have been started which will be elaborated on in the future. This has happened on initiative of the municipality”* (Interviewee housing association C 2015, 7 May).

Besides interdependencies the case study showed two other factors influencing the interaction between municipality and housing associations in a more general sense. The municipality and housing associations work together well on various topics. This good relationship is mentioned as a motivation by Interviewee municipality J (2015) to work together with the municipality on flash flood adaptation. *“well we work together well with the municipality on various issues. So also on this topic... in the past housing associations and municipality have worked together well in general. So when something happens nobody is surprised when the alderman calls to talk about this together. Our connection lines are short and not formal or anything like that”* (Interviewee housing association I 2015, 22 May). Also Interviewee housing association C (2015, 7 May) mentions their good relationship with the municipality as a motivation for them to take an active role in flash flood adaptation: *“Playing an active role immediately shows to what extent the relation with the municipality is good or not... Well we can be active but when the municipality is working against us in other fronts such as granting building permits for example. There has to be a right balance between us needing you and you needing us”*. Complexity of the municipal organization was mentioned as a barrier for interaction:

- *“The thing is the municipality does not exist. This is a different department. We usually work together with in housing and urban development departments”* (Interviewee housing association I 2015, 22 May)
- *“It would be best if there was one person at the municipality to contact. One account so that the communication has short lines. And not that when you contact the head of a department, she refers you to a subordinate to communicate with. But that subordinate does not know about the agreements you made with the person you talked to before”* (Interviewee housing association C 2015, 7 May)

Because the Action Plan is still in development interaction is still ongoing (Interviewee municipality J 2015, 5 June). On how these interactions will be maintained in the future Interviewee municipality J (2015, 5 June) says: *“I think, then we return to the first question. To what extent will people keep finding it an issue of importance? That is what I think. If the sense of importance fades away and residents are satisfied with the things that we are going to do. Yes then it will. Collaboration with housing associations will keep happening. But then it will not be specifically about flash floods.”*

2. Municipality – Insurers

There is not a strong sense of interdependency from the municipality towards insurers. Insurers have not been involved in their Action Plan up to now. *“it is a coincidence that I talked to an insurer yesterday because we received a damage claim from a party. So yes when a claim surpasses a certain amount the municipality calls in the insurer. That is why I had contact with an insurer. But besides that not, no.”* (Interviewee municipality J, 5 June). Although there is not a strong sense of interdependency both interviewee B (2015, 1 May) and Interviewee municipality J (2015, 1 May) state it will be valuable to know the financial damage of the downpour on July 28 2014.

The sense of interdependency from insurers on municipality is somewhat greater but it varies between insurers. Results from two different interviews show how the sense of interdependency is connected to the informal institutional context. Interviewee insurance A (2015, 28 April) does not see flash flood adaptation as an urgent issue, does acknowledge the potential of working together with municipalities but states that no interactions has occurred yet. Interviewee insurance F (2015, 19 May) acknowledges growing flash flood risk as an urgent subject and sees municipalities as important actors in making cities better rainproof. *“You can also grasp it as an opportunity by working together with the relevant stakeholders, then I am talking about knowledge institutes, water boards, municipalities and especially residents* (Interviewee insurance F 2015, 19 May). He is actively building a network including multiple municipalities aiming to reduce damage by extreme downpours by working together. *“So we as insurer, both health insurer and indemnity insurer have an interest in that a city becomes green and more resilient”* (Interviewee insurance F 2015, 19 May).

Results from the interview show that interactions between insurers and municipality on flash flood adaptation has been very limited. Also here the relation between interdependencies and interaction described by Kooiman (2003) can be recognized.

- *“It is just very hard with insurers because, most of them are not willing to share the information they have. Definitely not in the beginning when I contacted them”* (Interviewee municipality B 2015, 1 May).
- *“Interviewee municipality B and I noticed that every now and then join conversations on national level and with other cities, that insurers are not very eager to contribute on this subject. Every now and then they do but I do not have the impression that insurers are very active in this domain. But that is my perception. But no, in Arnhem they are not involved at all”* (Interviewee municipality E 2015, 12 May).

There is potential to stimulate interactions between these actors. Interviewee insurance F (2015, 19 May) mentioned multiple ways in which they could support Arnhem in flash flood adaptation. This could be an opportunity to stimulate interaction and the exchange of resources between municipality and insurers.

3. Municipality - Residents

The municipality is strongly dependent on residents because they possess or manage a large part of Arnhem’s surface. *“I think that the public domain is 10% of the total private owned land. That includes housing associations. So probably a large part of the solution lays in the private domain”* (Interviewee municipality B 2015, 1 May). Besides the influence residents have on the land they own or rent, they are very influential on what happens in the public domain. *“Flash flood adaptation demands a good spatial planning, spatial design and good urban development. Here lays an important role for residents. Residents determine what happens in a neighborhood”* (Interviewee municipality B 2015, 1 May). Furthermore residents play a key role in keeping flash flood adaptation a relevant topic in municipal politics. *“Currently I think*

there is enough political interest. Things have been said. Residents expect something. So, again, that makes sure the political interest remains.” (Interviewee municipality J 2015, 5 June).

Results from the survey show that residents feel a strong dependency on the municipality for reducing flash flood risk (figure 24). Statistical analysis in tables 14-16 shows that the sense of interdependency is strongly associated with the perception on the distribution of responsibilities. Residents feel interdependency towards the actors they consider responsible for flash flood adaptation.

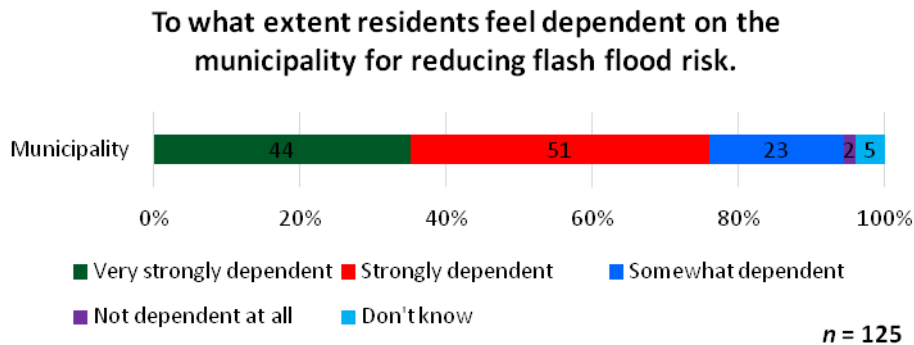


FIGURE 24: SURVEY RESULTS 16, THE EXTENT TO WHICH RESIDENTS FEEL DEPENDENT ON THE MUNICIPALITY FOR REDUCING FLASH FLOOD RISK.

Variable 1	Variable 2	Significance (P)	Association's strength (Gamma)
To what extent residents feel dependent on the municipality for reducing flash flood risk.	To what extent residents feel the municipality is responsible for reducing flash flood risk.	0,000	0,539

TABLE 14: SURVEY RESULTS 17, RESULTS OF THE STATISTICAL ANALYSIS DETERMINING TO WHAT EXTENT RESIDENT'S PERCEPTION ON RESPONSIBILITIES OF THE MUNICIPALITY IN FLASH FLOOD ADAPTATION ASSOCIATES WITH THE RESIDENT'S SENSE OF INTERDEPENDENCY TOWARDS THE MUNICIPALITY FOR FLASH FLOOD ADAPTATION. THE GREEN NUMBER INDICATES A SIGNIFICANT STATISTICAL ASSOCIATION.

The Action Plan has put strong emphasize on interaction with residents. Residents have been involved in determining the biggest bottlenecks in the city after the downpour of July 28th 2014 and will be involved in discussing the measures that will eventually be presented in the Action Plan. There are also definitive plans to stimulate awareness and excitement to get residents involved in flash flood adaptation.

- *“First we assessed everything internally. Then we went to the residents, to the neighborhoods. We send the neighborhoods a letter asking them to invite us when they experienced damage. Then together we will look at how we are going to approach this. Based on the response we also went to visit neighborhoods.” (Interviewee municipality B 2015, 19 May).*
- *“In two neighborhoods we are probably organizing a fun day and to engage with residents to see how we could reduce the soiled surfaces in their gardens. Make them more climate friendly. We will organize a television personality to get the people excited. Give some publicity to it. This will bring residents and*

housing associations closer together. And also politics. Also the neighborhood visits contributed to the collaboration with residents” (Interviewee municipality J 2015, 5 June).

Result from the questionnaire presented in figure 27 show that currently residents are not aware of the municipal Action Plan. This shows that current interaction has not involved a broad audience.

Are you familiar with the municipal Action Plan?

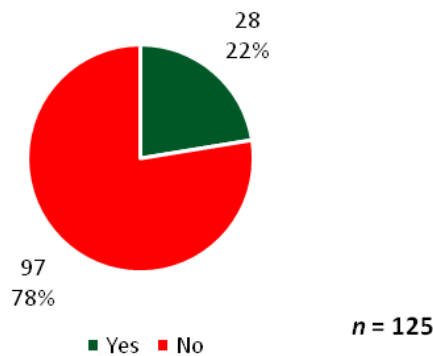


FIGURE 25: SURVEY RESULTS 18, THE AMOUNT OF RESIDENTS WHICH ARE FAMILIAR WITH THE MUNICIPAL ACTION PLAN.

Current interactions between municipality and residents are based on the exchange of informational resources and awareness raising. In the past the municipality has stimulated residents to implement flash flood adaptation measures by offering subsidy. But the municipality is currently not doing that. Interviewee municipality E (2015, 12 May) sees it as the wrong kind of motivation: *“I notice that a subsidy often has the wrong effect. People do something because there is a subsidy...The moment you take away the subsidy the stimulus is gone and it stops. So in Arnhem we try to focus on awareness raising.”*

Literature describes opportunities for splitting sewage water tax and a rain- and surface water tax to create a financial stimulus for flash flood adaptation (VNG, 2007). In Arnhem these taxes are currently combined and based on the assessed market value of a house (WOZ value). Interviewee municipality B states that splitting these taxes is not an option due to variety of sewer systems in Arnhem (map 3) *“To do that you want one uniform system otherwise you will get a very diverse sewage taxation system which nobody will understand....For every different system you will need a different taxation, a different category. That will become very confusing especially with all those different constriction you will have.”* (Interviewee municipality B 2015, 1 May).

Besides the specific focus of the Action Plan on collaboration with residents there is a more general shift in the orientation and distribution of roles and responsibilities in planning and decision making in Arnhem that is relevant to this research. The municipal strategic note “Perspectiefnota 2016-2019” formulates renewed principles on collaboration between municipality and society. Its key principles will be shortly be discussed due to their relevance for the future interaction between municipality and residents:

- It is to anticipate the rapid changing society and optimally utilize the expertise and creativity of residents and partners. The principles in the Perspectiefnota are also to ensure that the budget cuts of at least €20 million can be realized.
- The focus is on fundamental neighborhood approach. Decisions on how budgets are spend are based on what neighborhoods demand. Resident have an important say in how budgets are spent.

- Emphasize is on decentralization, de-institutionalization and differentiation by putting more responsibility in the hands of neighborhoods and their residents and appealing on participation and the self-organizing ability of residents.
- Much more structural interaction between residents, municipality and institutions. Municipality functions as a partner, lets go of its role as main actor, leaves more room for initiatives, and takes a facilitating role. (Gemeente Arnhem, 2015b).

Representatives of the municipality were asked in interviews what would be the effect of the renewed orientation presented in the Perspectiefnota on flash flood adaptation.

- Interviewee municipality E (2015, 12 May): *“Look at what kind of initiative there already are. Many residents or groups want something like urban farming or a small front garden.... When we let these initiative happen, more than we do now, eventually the public domain will turn greener and less sealed. Which is also good for water management. This movement helps and by supporting these initiatives in a positive way, not necessarily with a pot of money but by advising how to do things, I think that is a positive development”.*
- Interviewee municipality B (2015, 1 May): *“I think it allows for taking different kind of measures. Different solutions will be possible... After starting detaching in 2003-2004 we invested a fair amount of money in that and that definitely had effects. We achieved our goals. However, I think that it would have been better to have spent that money by finding solutions above ground, spatial solutions rather than technical ones. With a shift in power from the office to the neighborhoods, I think there will be more of that kind of solutions.... Neighborhoods will more often choose for spatial quality, something I have missed in the past ten years... You move from a central government to a decontrol government. This is something I find positive.”*
- Interviewee municipality J (2015): *“It will mainly depend on what priority residents will give an issue. The Perspectiefnota enforces you to consult with resident and ask what is important to them, rainproof or a nice park for instance. That will be quite a discussion. People who did not experience flash flood damage will want the park. This will all be quite a challenge I think”.*

Results from the survey show that there is potential of working together with residents in flash flood risk management (figure 28). These survey results are in contrast with results by Watermonitor (2009) who found the average Dutch citizens to be considerable less willing to play an active role in flood management (18%-23%).

You are willing to play an active role in preventing flash floods.

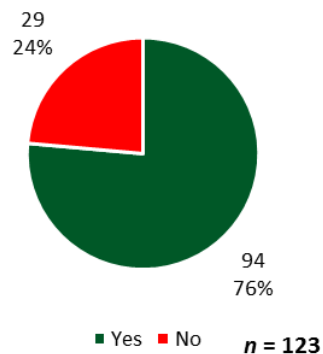


FIGURE 26: SURVEY RESULTS 19, THE AMOUNT OF RESIDENTS WHICH ARE WILLING TO PLAY AN ACTIVE ROLE IN PREVENTING FLASH FLOODS.

4. Housing associations – Insurers

Interviews show a weak sense of interdependency from housing association towards their insurer. This mainly has to do with the fact that housing associations do not have strong ambitions to adapt to flash flood risk in the first place. When there is no strong ambition, the feeling of interdependency on other actors tends to be low. In addition, both Interviewee housing association C (2015, 7 May) and Interviewee housing association I (2015, 22 May) state that as far as they know the downpour of 28th July 2014 did not result in significant damage on their housing stock. So no insurance claims were filed.

Insurer representative Interviewee insurance F did acknowledge the role housing associations play in reducing flash flood risk but states he has not included them in their network yet. *“Housing association are very obvious stakeholder in the chain, in this perspective. I do not have a specific focus on them. We do have a large market share in the housing associations market. They mainly insure their housing stock, rental units and commercial property. So like I said, it is one of the stakeholders in the spectrum, at the moment I do not specifically focus on them.”* (Interviewee insurance F 2015, 19 May)

Results of the interviews showed no interaction between housing associations and insurers in the context of flash flood adaptation. Showing the relationship between interdependencies and interaction as is described by Kooiman (2003).

5. Housing associations – Residents

During interviews with representatives of the housing association there was no indication of any sense of interdependency towards their tenants in flash flood adaptation. Responsibilities between housing association and tenants are clearly separated. *“when a wooden floor puffs up when it gets wet we say bello that is part of your content insurance, take care of that yourself. That is where our responsibility ends so to say. But we do have a responsibility of course to make sure that the water does not enter the house”*. Housing association do not work together with their tenants in flash flood adaptation. *“Well we inform our tenants, but tenants also have a responsibility to inform themselves....But working together with tenants, we do not really do that so much”* (Interviewee housing association C 2015, 7 May).

Figure 27 shows to what extent tenants feel dependent on their housing association for reducing flash flood risk.

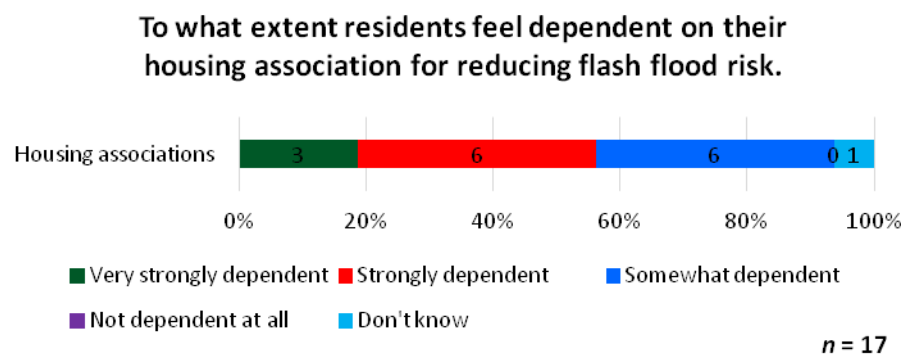


FIGURE 27: SURVEY RESULTS 20, THE EXTENT TO WHICH TENANTS FEEL DEPENDENT ON THEIR HOUSING ASSOCIATION FOR REDUCING FLASH FLOOD RISK.

Variable 1	Variable 2	Significance (P)	Association's strength (Gamma)
To what extent residents feel dependent on their housing association for reducing flash flood risk.	To what extent residents feel housing associations are responsible for reducing flash flood risk.	0,000	0,781

TABLE 15: SURVEY RESULTS 20, RESULTS OF THE STATISTICAL ANALYSIS DETERMINING TO WHAT EXTENT TENANT'S PERCEPTION ON RESPONSIBILITIES OF HOUSING ASSOCIATIONS IN FLASH FLOOD ADAPTATION ASSOCIATES WITH THE TENANT'S SENSE OF INTERDEPENDENCY TOWARDS HOUSING ASSOCIATION FOR FLASH FLOOD ADAPTATION. THE GREEN NUMBER INDICATES A SIGNIFICANT STATISTICAL ASSOCIATION.

The downpour of July 28th 2014 stimulated the interaction between housing associations and tenants in different ways. For one, housing association received around 1200 messages from tenants as result of the downpour (Interviewee municipality B 2015, 1 May). *"We have our own maintenance service. Well there the phone started jumping off the book."* (Interviewee housing association I 2015, 22 May). *"You see when a tenant sees water entering his home they are calling us. It is as simple as that"* (Interviewee housing association C 2015, 7 May). And depending on whether it is the responsibility of the housing association their maintenance team came to repair the damage. Furthermore housing associations joined the neighborhood visits of the municipality (Interviewee municipality J 2015, 5 June) and offered some addresses the possibility to get a removable barrier installed (Interviewee housing association C 2015, 7 May). Interviewee housing association I (2015, 22 May) said they will provide their tenants with information on flash flood adaptation in collaboration with the municipality.

Literature describes multiple other ways in which housing associations can stimulate and facilitate flash flood adaptive behavior of their tenants (chapter 2). Results from the interviews show this is not done by those housing associations:

- *"I do not believe tenants took any measures themselves. They more likely called their landlord... I think we are more likely to take measures. It is not that we do not want tenants to take measures, we are just more likely to do it. We have a policy where tenants can add all kinds of self-built facilities to their house. Flash flood adaptations measures are not included there"*(Interviewee housing association I 2015, 22 May).
- *"I find providing information important. That is about the issue itself and what I mentioned about how they can design their own garden... The content insurance point is an important point though because that insurance is not very expensive and can prevent a lot of trouble. That is pretty much what we do. In my opinion, we should not exhaust our tenants to much with the word climate adaptation"* (Interviewee housing association I 2015, 22 May).
- *"We have a separate procedure for self-built facilities... So basically there is room to take measures yourself... We can also take the measures and integrate it in the rent, but there are regulations attached to that... So it is possible, but I have never seen it done, but it is possible"* (Interviewee housing association C 2015, 7 May).

6. Insurers – Residents

Results of interviews with three representatives of the insurance branch show that the sense of interdependency on residents in flash flood adaptation differs and is connected to the informal institutional context. Interviewee insurance A (2015, 28 April) sees insurers more as a service

provider, and does not see growing flash flood risk as a danger for the sector. “There are probably places in the Netherlands which are so vulnerable to flash floods that if no measures are taken flash flood damage cannot be insured. For the insurers this is not that much of a problem. At the very most it could harm their image. Then you have to say to somebody, sorry I cannot insure you”. From that perspective insurers are not dependent on residents for flash flood adaptation. Interviewee insurance F (2015, 19 May) has a different perspective “I calculated what the effect of the future KNMI scenarios would have on us. On our burden of claims. The results made a lot of people very nervous. Therefore we put it on our strategic agenda to get the knowledge we possess as an organization on the radar of the people that have to get to work. Those are not only the water boards and the municipality but mainly the residents”.

Results from the survey presented in figure 20 show that residents do not feel strongly dependent on insurers for flash flood adaptation. Statistical analyses show the feeling of interdependence has a strong association with resident’s perception on to what extent insurers are responsible to reduce flash flood risk.

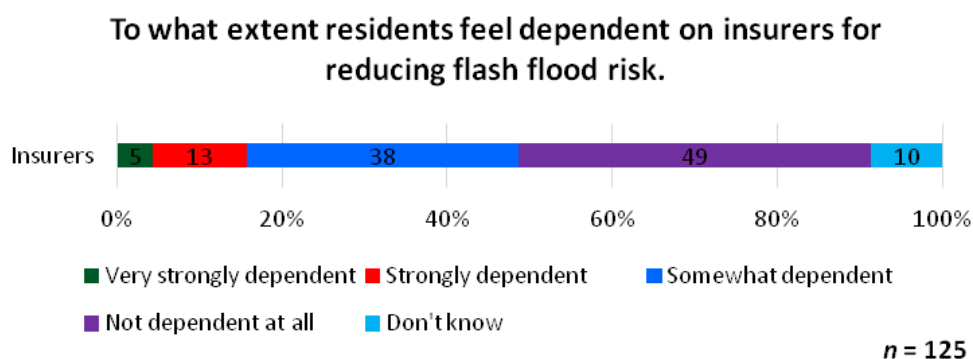


FIGURE 28: SURVEY RESULTS 22, THE EXTENT TO WHICH RESIDENTS FEEL DEPENDENT ON INSURERS FOR REDUCING FLASH FLOOD RISK.

Variable 1	Variable 2	Significance (P)	Association's strength (Gamma)
To what extent residents feel dependent on insurers for reducing flash flood risk.	To what extent residents feel insurers are responsible for reducing flash flood risk.	0,000	0,818

TABLE 16: SURVEY RESULTS 23, RESULTS OF THE STATISTICAL ANALYSIS DETERMINING TO WHAT EXTENT RESIDENT’S PERCEPTION ON RESPONSIBILITIES OF INSURERS IN FLASH FLOOD ADAPTATION ASSOCIATES WITH THE RESIDENT’S SENSE OF INTERDEPENDENCY TOWARDS INSURERS FOR FLASH FLOOD ADAPTATION. THE GREEN NUMBER INDICATES A SIGNIFICANT STATISTICAL ASSOCIATION.

In general insurers are not too eager to get involved in flash flood adaptation at the moment. Overall interaction between insurers and residents in flash flood adaptation is low. Results from the interviews show there are exceptions. Interviewee insurance F is working on multiple projects involving residents in flash flood adaptation. He can be considered an entrepreneur in the insurance sector. Interviewee insurance F (2015, 19 May) sees residents as main actors in flash flood adaptation to mute the expected rise of burden of claims. Therefore he wants to enhance interaction between insurer and resident in multiple ways (Interviewee insurance F, 19 May):

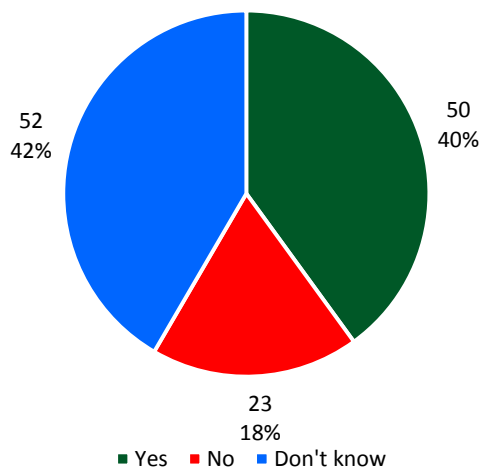
- *“We have a trajectory promoting awareness of the residents through diverse channels. In newsletters, theme days and other ways we try to make residents aware on what is heading towards them”* (Interviewee insurance F 2015, 19 May).
- *“We want to create a game for residents where they can motivate each other. They can show, here we experience problems after extreme downpours in the public domain or in our home or garden, tag the location on the map, make a picture. Make sure you use residents as a sensor. By doing that they receive green coins. They receive points and you get a good perspective, but also potential to organize prevention measures, individually or as a community. With the points they received they get discount on measures that can be found in the online prevention store. That is how we want to stimulate social engagement, awareness and prevention in neighborhoods”* (Interviewee insurance F 2015, 19 May).

Result from the survey shows that residents do not have a strong sense of interdependency towards insurers in flash flood adaptation. Based on governance theory by Kooiman (2003) it can be assumed that there will not be much interaction between residents in the focus area in flash flood adaptation. The survey did not include a question which verify this presumption. In addition results show residents are insured at a wide spread of insurers. Results from 63 respondents show they are insured at 22 different insurers. Furthermore it strikes that 42% does not know if they are insured for flash flood damage.

Literature describes insurers as important actors in climate adaptation because they can stimulate risk reducing behavior of policy holders. Results from the interviews showed that only in case where the flash flood risk is really high, insurers are likely to stimulate policy holders to take measures. *“You see every insurer makes his own consideration in which premium and which requirements they ask. So every insurer can formulate demands towards residents and businesses to take measures”* (Interviewee insurance A 2015, 28 April). But as figure 29 suggests, it is a highly competitive market so *“residents and businesses can also choose where they insure their risk. So as a resident, who for whatever reason does not want to take measures, one can switch to an insurer that does not demand of me to take measures”* (Interviewee insurance A 2015, 28 April).

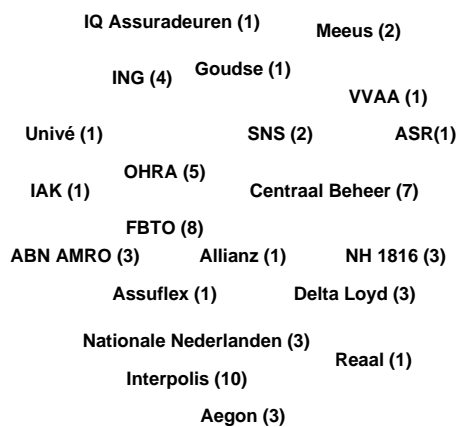
Botzen et al (2009) describe offering financial compensation on insurance premium as potential trigger to stimulate flash flood adaptation amongst residents. But Interviewee insurance A (2015, 28 April) explains along the example of taking measures lowering the risk of theft that from a financial perspective taking measures for discount on the policy premium is generally not very attractive: *“lets say a content insurance for a family is €100, €200 max. This covers multiple risks (see figure 7). Then if you say I invest in better locks so I know the risk of theft will decrease. So okay, risk of theft is maybe 10%-20% of the premium. So out of the €100, €10 is for covering risk of theft. A good lock will cost you €100. And how many will you save on your premium? So this is at least ten years of premium”*. The motivation behind prevention is rather *“the trouble, discomfort, loss of valuable possession that do not have financial value but emotional value”* (Interviewee insurance A 2015, 28 April). Only for individual cases where the risk of flash floods is so high that premiums are not affordable or no insurer wants to insure the risk it can be financially attractive to take adaptation measures. *“Well I had a claim of somebody who said insurers would not want to insure him anymore. So he was talking to us about taking construction measures”* (Interviewee insurance H 2015, 19 May). Interviewee insurance F (2015, 19 May) expects the number of these individual cases to grow in the future.

Are you insured against flash flood damage?



n = 125

Where are you insured against flash flood damage?*



N = 63

FIGURE 29: SURVEY RESULTS 24, THE AMOUNT OF RESIDENTS WHICH ARE INSURED AGAINST FLASH FLOOD DAMAGE AND WHERE THEY ARE INSURED. *THE RESPONSE TO THIS QUESTION ARE DRAWN FROM THE TOTAL DATABASE OF RESPONDENT, DISREGARDING WHETHER THE RESPONDENT LIVES IN THE FOCUS AREA.

5. Conclusions/Discussion & Governance Arrangements

The dual interpretation of governance as a descriptive- and a normative tool has been fundamental for the orientation of this research. Up to this point the focus has been on analyzing and understanding the flash flood adaptation context in Arnhem (governance as a descriptive tool). The findings will be concluded along the secondary research questions of this research. Subsequently the results will be generalized to the broader context of local climate adaptation governance, adding to the academic relevance of this research. Thereafter the obtained insights in the case study will be used to formulate governance arrangements to guide effective flash flood adaptation in Arnhem, and thereby answering the primary research question and relating to the societal relevance of this research (governance as a normative tool).

5.1 Governance of climate adaptation as descriptive tool

This paragraph elaborates on the descriptive aspect flash flood governance by reflecting and interpreting the case study findings and answering secondary research questions 2-5. Insights presented here add to the academic relevance of this research. To better understand the relevance of this research it is valuable to position this thesis in the current planning debate. In general planning theory shows a clear evolution: the shift from technical rationality to communicative rationality. The technical rational approach to planning is functional, content-related, top-down, central steering, straight forward, sectoral and government oriented (de Roo & Porter 2007). The communicative rational approach is intersubjective, interactive, actor-related, bottom-up, decentralized, complex, something which occurs in networks and governance-oriented (de Roo & Porter 2007). This research is in line with the principles of communicative rationality. Within the broad domain of communicative rationality this research can be placed in a specific niche of governance research: the governance of local climate adaptation. This research adds to the knowledge and understanding on the complexity of local climate adaptation governance processes.

The influence of institutional context on the governance of flash flood adaptation in Arnhem

Secondary research question 2: how does institutional context influence the governance of flash flood adaptation in Arnhem?

Institutional context entails both formal and informal institutions forming ‘the rules of the game’. Both formal and informal institutions shape and influence the governance of flash flood adaptation in Arnhem in innate ways. Principles of the new institutionalism perspective disseminates that this shaping and interactive relationship between governance and institutionalism works both ways. Due to the dynamic interplay between formal and informal contexts and governance processes, institutions can be an appropriate target for governance arrangements to influence flash flood adaptation processes. The observed interplay between institutions and governance in the case study research is in line with the

findings of varying researchers such as North (1990), Root et al (2014) and Agrawal (2010) discussed in §2.4.

Formal institutional context

Despite that climate adaptation as such is not integrated in Dutch legislation the formal institutional context contains two motivators for flash flood adaptation: legal responsibility for processing rainwater and legal responsibility for protecting owned property against flash flood damage. The formal institutional context regarding processing rainwater has shown not to be a strong driver for actors to get involved in climate adaptation in the focus area in Arnhem. The 2009 Water Act obliges landowners to initially process rainwater which falls on their parcel, does not apply for most of the focus area because the act does not work in retrospect. This causes a disparity in the local flash flood adaptation governance: housing associations refrain from taking adaptation measures because it is not their legal responsibility while municipality emphasizes shared responsibilities according to the 2009 Water Act. The duty of care which the 2009 Water Act assigns the municipality, formulated as obligation to make an effort, also cannot be considered as a formal institutional motivation for municipalities to get involved in flash flood adaptation since it is not underlain with a minimum norm. The legal responsibility for protecting properties against flash floods has shown to be a driver for residents to implement flash flood adaptation measures. The legal formulation of the municipal duty of care for processing rainwater together with the legal obligation to receive rainwater runoff as a result of natural elevation difference makes it hard for property owners to hold others accountable for flash flood damage on their property. Residents therefore usually end up being accountable themselves. Furthermore, building legislation explicitly states that landowners are responsible making sure their property meets their own wishes they have considering the object. The small amount of residents who are aware of their legal responsibilities to protect their home against flash floods have shown to taken flood proofing measures. Insurers are not obliged to insure flash flood damage and therefore have no formal institutional motivation to get involved in flash flood adaptation governance.

Informal institutional context

Opposed from formal institutions, the informal institutional context has shown to be much more dynamic and diversified and therefore is more susceptible to external influences. This observation is in consonance with how Root et al (2014) describe the nature of informal institutions. The informal institutional context of flash flood adaptation in Arnhem has shown to differ between individual residents, between housing associations, between insurers and within the municipality. Individual's attitude towards flash flood adaptation is found to be an important indicator for all key actors to get involved in flash flood adaptation. Problem recognition and sense of urgency are determined as most important factors within the informal institutional context. Also the perception on the distribution of roles and responsibilities influences flash flood governance processes. The orientation on shared responsibility of both municipalities and insurers has been a key driver for engaging with other key actors in flash flood adaptation. Ward et al (2013) state that agreement on the distribution of responsibilities and tasks is a prerequisite for successful collaboration in complex multi-actor settings. The case study reveals a disparity in perception on the division of responsibilities which could result in a barrier for the progress of flash flood adaptation governance processes. The municipality strongly emphasizes shared responsibility and the roles for housing associations and residents who are seen as key actors for not only taking measures but also for keeping the subject alive and on the political agenda. This is not in line with the perception of

residents and housing associations who are emphasizing the leading role of the municipality in flash flood adaptation. As a result flood adaptation currently depends on the municipality.

The influence of the adaptive capacity of key actors on the governance of flash flood adaptation in Arnhem

Secondary research question 3: how does adaptive capacity of key actors influence the governance of flash flood adaptation in Arnhem?

The capacity of Arnhem to adapt to the growing risk of flash flood risk is determined by the resourcefulness of individual actors and the capacity to act collectively. Each of the two determinants has shown to influence flash flood adaptation governance processes in Arnhem. The results of the case study have reinforced what authors like Adger et al (2004); Smit & Wandel (2006) and Brooks & Adger (2005) state, adaptive capacity is context specific and varies between individuals and locations.

Individual resourcefulness

Individual resourcefulness has found to be both a barrier as a stimulant for flash adaptation governance processes. Lack of individual resourcefulness creates interdependencies and triggers interaction (the exchange of resources) and collaboration but it also hampers the will or possibilities for individuals to implement flash flood adaptation measures. The variety of resourcefulness between the key actors emphasizes the local specific nature of climate adaptation. Different actors will benefit from different types of resources. Individual resourcefulness has shown to influence resident's involvement in flash flood adaptation by taking risk reducing measures. Because a considerable amount (between 59% and 76%) of the residents are withheld from taking adaptation measures due to lack of resourcefulness, capacity building can be considered a valuable strategy to stimulate resident's involvement in climate adaptation.

Capacity of the four key actors to act collectively

The case study has shown that exchange of resources (interaction) through collective action strengthens the adaptive capacity of Arnhem in context of flash flood adaptation. It demonstrates that interaction in a network is important to realize flash flood adaptation, thereby creating interdependencies between the key actors. This is confirmed by the four key actors stating that flash flood adaptation should be done in collaboration. Multiple flash flood adaptation projects in Arnhem have shown that collective action needs a platform around which interactions can emerge. The Action Plan is the platform which currently stimulates collective action. But the manner in which actors are currently acting collectively is not optimal. A lot of the opportunities for collective action in flash flood adaptation found in literature remain unutilized in Arnhem. This is partly due to lack of sense of urgency or problem recognition amongst some of the actors. Also it is unsure to what extent the current network will be maintained when the Action Plan is finished.

The influence of interdependencies and interactions on the governance of flash flood adaptation in Arnhem

Secondary research question 4: how do existing interactions and interdependencies influence the governance of flash flood adaptation in Arnhem?

Governance theory in its most basic form states that interdependencies trigger interaction resulting in governance networks (Kooiman, 2003). This interplay between interdependencies and interactions is clearly recognized in the case study. Understanding the governance of flash flood adaptation starts by capturing and analyzing interdependencies and interactions between the flash flood adaptation actors. It is important to note that interdependencies and interactions vary between different relationships. Every relationship is unique. This research includes “only” four actors, implying “only” six reciprocal relationships. It is important to stress here that the complete flash flood governance network includes many more, and diverse actors. Governance of flash flood adaptation is therefore an inherent complex and dynamic process including a diverse nature of interactions triggered by varying ambitions, interests, beliefs, knowledge and resources (Termeer et al, 2012).

Interdependencies

Like theory describes, interdependencies trigger interactions. Therefore interdependencies can be seen as an important factor in binding and forming flash flood adaptation governance networks. The case study in Arnhem has shown that a sense of interdependency solely is not enough to generate interaction and create a governance network. The informal institutional context (sense of urgency and problem recognition) is important to. Actors need to feel the urge to engage in flash flood adaptation governance to start interacting with actors they are interdependent on as well. This interdependency is the result of individuals not having all the required resources to reach a goal. Interaction is therefore about exchanging resources. Furthermore it was found that the sense of interdependency strongly associates with the perception of responsibilities. Residents feel interdependent on the actors they consider responsible for flash flood adaptation. This suggests that individuals who engage in flash flood adaptation governance network are likely to seek interaction with the parties they consider to carry responsibility for flash flood adaptation. The sense of interdependency of individual actors differs between relationships they have.

Interactions

Interactions in context of governance imply the flow of resources (Kooiman, 2003). Every relation and interaction is unique and can contribute in a specific way to the redistribution of resources. From a resource perspective it is valuable to include more and diverse actors in a governance network. Creating more relations adds to the complexity of the network but also to the potential of resource exchanges and therefore to the potential effectiveness of climate adaptation. Based on analysis of the individual resourcefulness of the key actors it can be concluded that interactions on flash flood adaptation in Arnhem will be primarily based on exchange of informational- and human/technological resources. Considering the current economical context, exchange of financial resources is very unlikely. Current interactions between the four key flash adaptation actors in the context flood adaptation governance in Arnhem is far from optimal. Between some actors there is not any interaction and in most relationships the interaction is very limited. All interaction which is currently occurring on flash flood adaptation between the four key actors in Arnhem can be seen as the direct result of the extreme downpour of 28 July 2014. The municipality can be seen as the driving force behind these interaction. Furthermore the case study Arnhem has shown the importance of a platform around which relations can be created and

interactions to occur. The Action Plan is currently the platform which props up interactions on flash flood adaptation. When this platform disappears the proceeding of interactions on flash flood adaptation is questionable and strongly hinges on initiatives of residents.

The bottlenecks in the current flash flood adaptation governance context in Arnhem

Secondary research question 5: what are the bottlenecks in current flash flood adaptation governance context in Arnhem?

Based on the findings of the case study the following bottlenecks can be formulated.

- The formal institutional context in the focus area does not motivate key actors to engage in flash flood adaptation.
- Lack of problem recognition and sense of urgency makes key actors hesitant to engage in flash flood adaptation.
- Disparity on perception of roles and responsibilities. There is no uniform agreement on the distribution of responsibilities and tasks in flash flood adaptation.
- Lack of financial resources hamper the possibilities of individual actors to invest in flash flood adaptation measures.
- Limited or absent interactions between key flash flood adaptation actors confines the potential exchange of resources.

Understanding the complexity of governance of climate adaptation at local scale

One of the main goals of this thesis, related to the academic relevance of this research, is adding to the understanding of the complex societal dynamics of local adaptation governance processes. Reflecting on the case study results this paragraph reveals four concrete aspects which contribute to the complexity of local governance processes. The next paragraph on governance arrangements show how analyzing these adaptation governance context provides guidance for formulating governance arrangements.

The total domain of climate adaptation in urban context comprises adjusting to growing risk of heat stress, pluvial and fluvial floods (CPC, 2014). Although the preliminary focus of this research is on local flash flood adaptation, findings can to some extent be generalized to broader scope of local climate adaptation governance. As Runhaar et al (2012) shows, adaptation to flood risk and heat stress encounter similar barriers. The findings of this research can be considered valuable. First because of the limited research on local climate adaptation processes (Ward et al, 2013). And second, because the actual adaptation happens at local scale, adaptation is therefore highly dependent on local context (Agrawal, 2010).

Understanding the complex dynamics of local climate adaptation governance processes starts by understanding governance in context of climate adaptation. A framework integrating adaptive capacity (individual resourcefulness and capacity to act collectively), institutionalism (formal institutions and informal institutions) and governance (interdependencies and interaction) has proven to give a comprehensive perspective on the elements shaping and guiding the dynamics of locale climate adaptation governance processes. The first aspect that adds to the complexity of local governance processes is the fact that these three governance drivers are in itself subject to change.

The case study has shown the local specific nature of climate adaptation, adaptive capacity, institutional context and governance and therefore the local specific nature of climate adaptation governance. Each local climate adaptation governance context is therefore uniquely customized by local specific characteristics and drivers. The dynamics observed in Arnhem can therefore not be generalized to other cities. The location specific nature is the second aspect that helps understanding the complexity of local climate adaptation governance.

Analyses of the simplified local flash flood governance network reveal two more aspects adding to the complexity of the social dynamics of local climate adaptation governance. The case study results show that both the nature and the influence of institutional context and adaptive capacity on governance processes is far from unambiguous, it varies between actors and even between individuals in a group of actors. This causes governance dynamics to vary within a network depending on for example the way individuals are related to the institutional context and their individual resourcefulness.

The last aspect of complexity relates to the variation of reciprocal interdependencies and interactions between actors. The simplified local flash flood governance network including 4 actors only has 6 relationships. Results show that each relationship is unique. Unique in its nature of interdependency and unique in its interaction (exchange of resources). In addition each relationship is influenced by changes in the institutional context and adaptive capacity in a unique way. The fact that the total climate adaptation governance network implies many more and divers actors united in horizontal and vertical networks adds to the complexity of climate adaptation governance.

The complex societal dynamics of climate adaptation governance processes can only, as is done above, be generalized to certain extent. Acquiring full understanding of local adaptation governance processes requires dissecting and analyzing a specific climate adaptation governance context. This could be done with help of the theoretical framework used in this research.

5.2 Governance of local flash flood adaptation as normative tool

The second main goal of this thesis, related to the societal relevance of this research, is finding governance solutions to stimulate climate adaptation in Dutch cities which is currently hampered. The governance arrangements presented beneath specifically aim at guiding governance processes to realize effective flash flood adaptation in Arnhem and thereby answer the primary research question: which governance arrangements are most suitable to steer effective adaptation to growing flash flood risk on the local scale of the city of Arnhem? The formulated arrangements can be integrated into specific adaptation strategies aimed to make Arnhem better Rainproof. Although these governance arrangements are specifically designed for Arnhem, they can be used as inspiration for other cities that experience difficulties with implementing adaptation strategies.

Before introducing the governance arrangements it is relevant to mention the two potential pitfalls of a climate adaptation governance approach. These should be considered when translating the arrangements into concrete adaptation strategies. The first pitfall is potential lack of legitimacy of governance processes. Maas et al (2013) and van Buuren et al (2014) describe multiple strategies to safeguard legitimacy of governance processes. The second pitfall, formulated by Termeer et al (2013), is danger to misconstrued expectations on the governance approach. Climate adaptation in itself can be considered a “*wicked problem par excellence*” (Termeer et al, 2013, p.28). In addition governance processes are complex and dynamic.

This fundamental complexity makes it hard, if not impossible to predict to what extent implementing these governance arrangements will result in effective flash flood adaptation.

Governance arrangements to steer effective flash flood adaptation in Arnhem

Which governance arrangements can steer effective adaptation to growing flash flood risk on the local scale of the city of Arnhem?

1. Use the formal institutional context as a tool to stimulate flash flood adaptation

In a significant part of neighborhoods in the focus area private landowners have very limited legal responsibility in processing rainwater. The 2009 Water Act provides the municipality with legal tools (a legal ordinance) to increase landowner's responsibility in processing rainwater on their own parcel (see box 1). Although validating the legal ordinance requires complex context specific integration⁶, integrating responsibilities for private landowners to process rainwater in the formal institutional context will be important to get certain actors involved in flash flood adaptation governance. Housing associations have shown to be strongly oriented on the formal institutional context. Integrating more prominent responsibilities for landowners in the formal institutional context is a long-term process which is attended by redesigning public and private domain and deliberation with province, regional water authorities and other concerned actors⁷. This process should be planned in advance. Based on results from the case study prioritization can be based on neighborhoods in higher parts of the city with a high share of housing association possession. This way makes auditing compliance of legal ordinance less of a hassle. In addition this effort adds to the equivocality in the current ambiguous formal institutional context by stressing shared responsibilities.

The amount of Dutch municipalities that stimulate or oblige landowners to process rainwater on their own land has increased in the past ten years from 12% to 32%.

BOX 1: INCREASING LEGAL RESPONSIBILITY FOR LANDOWNERS TO PROCESS RAINWATER, SOURCE: RIONED (2015).

Another way the formal institutional context can be used to stimulate flash flood adaptation relates to the direct (building legislation explicitly states that landowners are responsible making sure their property meets their own wishes they have considering the object) and indirect (practice has shown that it is hard to hold other actors accountable for flash flood damage) responsibility of property owners to protect their property against flash flood damage. Awareness of this legal responsibility, which currently is very low, has shown to be a trigger for residents to take measures to reduce the potential flash flood damage. Especially the locations where flash floods have shown to lead to damage (map 4) this specific type of awareness could be a stimulant for property owners to get involved in flash flood adaptation.

2. Reshape institutional context to create problem recognition, sense of urgency and agreement on division of roles and responsibilities in flash flood adaptation

This arrangement builds on socially constructed nature of institutions described by new institutionalism. Sense of urgency and problem recognition have shown to be key motivators for actors to get involved in flash flood adaptation governance and start interacting with actors they are interdependent on. The dynamic, socially constructed nature of the informal

Transition management theory offers concrete strategies which can be used for redesigning informal institutional contexts. See Loorbach (2007) and Huiteima & Meijerink (2010).

BOX 2: REDISIGNING INFORMAL INSTITUTIONAL CONTEXTS USING TRANSITION MANAGEMENT.

⁶ Parliamentary Papers II 2005-06, 30 578, nr. 3, p.30-31.

⁷ Parliamentary Papers II 2005-06, 30 578, nr. 3, p.30-31.

institutional context allows leading beliefs, norms and perception to be reconstructed. A shift of the currently dominant perception on the urgency and the need for flash flood adaptation is required for making Arnhem rainproof in the long term. Reshaping informal institutional context is a process that requires dedication and planning (see box 2).

Another aim of reshaping the informal institutional context should be creating agreement on the division of roles and responsibilities in flash flood adaptation since agreement on the distribution of responsibilities and tasks is a prerequisite for successful collaboration governance networks (Ward et al, 2013). Furthermore the results from the case study show that perception on roles and responsibilities in flash flood adaptation influence feelings of interdependency and the orientation of interactions. The currently leading perception that the municipality is the key actor in flash flood adaptation explains the strong orientation on the municipality by both housing associations and residents. Changing this perception and making housing association, but especially residents aware on the important role they play in making Arnhem rainproof could result in a change of orientation and dynamics in flash flood adaptation governance processes. Furthermore, reaching agreements on a more important role for private actors in general is in line with the goals of the Perspectiefnota.

3. Build a broad network to increase effectivity

Currently interactions in flash flood adaptation predominantly occur between municipalities, housing associations and residents. Both research and literature have shown the advantage and the necessity of including more varying actors to this network. A large and diverse network contributes to more potential in resource exchange leading to the building of capacity. This research has shown how insurers can be a valuable actors to include in a flash flood governance network. Besides insurers literature and interviewees refer to amongst others, actors like knowledge institutions, building sector, real estate and retail sector. A second advantage of creating a broad network relates to the principle that to make a city rainproof it is necessary that everybody who develops or maintains the public and private domain is familiar with the principles of reducing flash flood risk. This connects to the principle of mainstreaming flash flood adaptation into different sectors but also into different disciplines. A large flash flood adaptation governance networks will increase the chance that flash flood adaptation measures will be integrated into developments when an actor intervenes in the public or private domain (see box 3). This arrangement is in line with Termeer et al (2012) who state that a polycentric, dynamic governance approach is required guide climate adaptation.

“It is like playing chess on multiple boards. Making a city rainproof you cannot be dependent on a single actor..... I think if you do not focus on a wide diversity of actors you will miss big effects in making a city Rainproof” (Interviewee context D, 2015).

BOX 3: ARGUMENTS IN FAVOR OF BUILDING A BROAD FLASH FLOOD ADAPTATION GOVERNANCE NETWORK.

4. Stimulate interactions in the flash flood adaptation network

The case study has revealed that many benefits which could be yielded from interactions between key flash flood actors remain unutilized in the governance of flash flood adaptation in Arnhem. Interactions are fundamental to flash flood adaptation governance. The case study has shown that

“The Hague region, for example, suffers from water abundance during times of heavy rainfall. Due to the high building density, less room is left for temporary water storage. A solution was found in greenhouse farmers who could provide water storage as a service, by investing in underground water-storage tanks. Everyone in the neighborhood can benefit from this investment because water storage offered by others reduces the risk of one’s land, roads, and even houses being flooded” (Termeer et al, 2011, p.171).

BOX 4: AN EXAMPLE OF HOW INTERACTIONS CAN LEAD TO INNOVATIVE COLLABORATIONS.

interactions are important for relocating resources and for enhancing the capacity to act collectively. Stimulating interactions in a broad flash flood adaptation network enhances both the potential exchange of resources and the potential for innovative collaborations and coalitions (see box 4). Both factors will contribute to a growing adaptive capacity of Arnhem, which has shown to be a prerequisite for the implementation of adaptation strategies (Brooks & Adger, 2005). The results of the analyses on interactions and adaptive capacity within the flash flood adaptation network in Arnhem presented in chapter 4 can be used to guide concrete strategies to enhance interactions.

5. Exploring the economy of flash flood adaptation

Lack of financial resources has determined to be one of the bottlenecks for flash flood adaptation in Arnhem. Therefore it could be valuable to explore the economy of flash flood adaptation. Results by Sušnik et al (2014), discussed on p31, show how a flash flood adaptation result in cost saving in Eindhoven. And due to the statistical relation between volume of precipitation and total amount of damage claims (CVS, 2010; Spekkers et al, 2013) future benefits of flash flood adaptation can only be expected to grow as the frequency, volume and intensity of downpours is increasing. The principle used in Eindhoven, that one flash adaptation strategy saves costs for every extreme downpour has been used on a large scale in Copenhagen (see box 5). Finding financial triggers for private parties to invest in flash flood adaptation is another example of exploring the economy of flash flood adaptation: investing in green infiltration zones could increase the property value of a surrounding neighborhood. The cost effectiveness of flash flood adaptation is a third aspect relating to the economy of flash flood adaptation. Coupling flash flood adaptation measures with planned spatial developments is an example of cost effective flash flood adaptation. At the moment there is still limited knowledge on the economy of flash flood adaptation in Arnhem. Finding concrete financial benefits of flash flood adaptation measures is expected to be an important motivation for both public and private parties to invest in flash flood adaptation.

An extreme rainfall event in Copenhagen on 2 July 2011 where over 150 millimeter fell in two hours resulted in approximately 1 billion euros in insurance claims. After this event city council decided to tackle this problem once and for all. Based on calculation Copenhagen expects damages of extreme downpours to be 2-2.1 billion euro over the next 100 years. As a response Copenhagen implemented a flash flood adaptation plan costing 800 mill-1.1 bill to prevent those future damages from happening under the knowledge they would save money in the long run.

BOX 5: COPENHAGEN UTILIZING THE ECONOMY OF FLASH FLOOD ADAPTATION TO REALIZE A HUGE CLIMATE ADAPTATION PROJECT, SOURCE: CITY OF COPENHAGEN (2012); LEONARDBSEN (2012, 4 SEPTEMBER).

6. Diversify the scope of flash flood adaptation

One example of diversifying is distinguishing between temporal scales. Making a city rainproof requires arrangements aimed at both short-term and long-term intervention (Termeer et al, 2011). Short-term focus on solving the most urgent bottlenecks, long term perspective is required to make a city rainproof. Current emphasis of the municipal Action Plan is on short-term interventions in the public domain.

A second example of diversifying is expanding the range of messages you communicate. The case study has shown how flash flood adaptation is location specific. The adaptive capacity, institutional context, interactions and interdependencies vary amongst and between

Private actors are expected to have the most important role in preventing damages of flash floods by taking flood proofing measures.

BOX 6: WHY STIMULATING FLOOD PROOFING IS A KEY STRATEGY IN FLASH FLOOD ADAPTATION, SOURCE: LEONARDBSEN (2012, 4 SEPTEMBER).

individual actors. This variety will grow when more actors are included in the flash flood adaptation governance network. Such a variety between actors includes a diverse way in which actors could participate in flash flood adaptation governance. Providing these diverse actors with the information which is relevant for them requires a diversity in messages. The case study has shown that housing associations for example are interested to learn about the financial triggers for flash flood adaptation, residents on the other hand will profit more from knowledge on which measures they can take to efficiently and effectively reduce flash flood risk. Diversifying your message allows you to appeal to a broader audience (Interviewee context D, 2015). This research gives an example of diversifying flash flood adaptation in scale: building/parcel street/neighborhood, and type: reducing runoff/increasing storage, flood proofing (table 2). With their communication towards residents the Action Plan currently put emphasize on runoff reduction and increasing storage capacity. It might be valuable to focus more on stimulating the implementation flood proofing measures in areas which are more vulnerable to flash floods (see box 6).

7. Create a lasting platform around which flash flood adaptation governance can occur

The case study shows that a platform is essential for stimulating collective action and interaction in flash flood adaptation. Currently collective action and interaction on flash flood adaptation is evolving around the municipal Action Plan. But due to the low sense of urgency and lack of problem recognition amongst private actors and lack of financial resources of the municipality there is a lot of uncertainty to which extent these interactions will be maintained as soon as the Action Plan is concluded. Besides maintaining current interactions and collective action a platform can function as a base camp to implement the above mentioned arrangements to enhance the effectivity of flash flood adaptation at local scale.

An example of such a platform is Amsterdam Rainproof. Amsterdam Rainproof is a platform that activates and stimulates different stakeholders to improve water management in Amsterdam.

'The way we set this up is a kind of platform, network approach where we include all aspects of making a city Rainproof and try to provide all parties with relevant information.' (Interviewee context D, 2015).

BOX 7: AN EXAMPLE OF A FLASH FLOOD MANAGEMENT PLATFORM: AMSTERDAM RAINPROOF.

Making a city rainproof requires long-term dedication and collaboration amongst a wide field of actors. Such a platform could combine the dedicated and the mainstreaming approach by dedicating itself to mainstreaming flash flood adaptation principles into a broad network of public and private actors (see box 7). From this perspective the municipality should be the initiator and catalyst of a flash flood adaptation platform oriented on the long term dedication. This way the municipality acts as facilitator and stimulates private actors in flash flood adaptation. This is in line with the principles of the *Perspectiefnota*. As time passes and more private and public actors are aware and anticipation growing flash flood risk the platform can slowly be unrolled.

6. Reflection

This research is grounded on achieving two main goals. The first, relates to the academic relevance of this thesis, is adding to the understanding on the complexity of local climate adaptation governance processes. The second goal, relates to the social relevance of this thesis, is formulating governance arrangements which steer local governance processes to achieve effective flash flood adaptation in Arnhem. This chapter evaluates to what extent the two goals have been achieved and reflects on the process of the research.

Achieving the goal of understanding the complexity of local climate adaptation governance processes took up the largest share of this thesis. The literature research, theoretical framework and data collection was primarily about finding the right scope and data to achieve this goal. The theoretical framework has shown to be a valuable tool for comprehensively analyzing the influence of the main drivers in climate adaptation governance processes. Flash flood adaptation, adaptive capacity, governance and institutionalism provide a comprehensive conceptualization for utilizing governance as a descriptive and a normative tool for respectively understanding and steering flash flood adaptation governance. Reflecting on the framework it can be said it had advantages and disadvantages.

Due to its extensive scope the framework requires contextual, actor specific data, on a wide spectrum of topics. Because of the limited time and resources, data collection therefore had to remain somewhat superficial. The researcher was not able to go into great detail on every aspect of the theoretical framework. A second influence of the broad approach and the actor specific orientation was the tailor-made interviews. Although this approach obtained actor specific information it made it more challenging to converge evidence. Due to this, some of the evidence presented in results are not very strong. This is the downside of the broad theoretical orientation of this research. Having conducted more interviews and finding a more standardized interview guide would have strengthened the outcomes of this research.

The advantage applying the comprehensive framework is that it creates a better and more holistic understanding on the complexity of local governance processes. With the objective of completing goal one in mind, the decision to focus more on the breadth instead of the depth was a good one. The four concrete factors creating complexity in governance processes discussed in the conclusion demonstrate the accomplishment of the first thesis goal. Although it has to be stressed here that the results give insight in one particular aspect of the governance of local climate adaptation. The primary focus was on adaptation to growing risk associated with intense downpours, the issue of heat stress is not considered in this research.

Insights which the descriptive governance analysis revealed provided excellent objectives for the governance arrangement. Reflecting on these arrangements two things can be said. First, even on local scale it is hard to be specific. As a result the arrangements remain somewhat general. Specifying each arrangement requires far more detailed and specific knowledge. The formulated arrangements can therefore not be considered instant adaptation strategies. They are more guiding principles which can be used for shaping specific adaptation strategies. Second, the effectiveness of the governance arrangements

is impossible to determine. Due to the inherent *wickedness* of climate adaptation governance the potential success of the arrangements cannot be assessed. This inherent *wickedness* has gotten relatively limited attention in this research. A more detailed discussion on this aspect of climate adaptation could have been a valuable support for explaining the insecurity around these governance arrangement. Despite these points of reflection the researcher finds that the second goal can be considered achieved. The fact that the point of inherent *wickedness* is cited, the arrangements are embedded in theoretical and empirical evidence, and the arrangements are supported by examples or quotes adds to the legitimacy and credibility of the governance arrangements.

In addition to what is discussed, reflecting on the research process, two aspects stand out which had significant influence on the end results. The first aspect relates to the combination of this research with an internship at the municipality of Arnhem. Through this internship the researcher obtained interview contacts, access to expertise and data which were of great value to this research. The second aspect is the low response rate to the survey. The low response resulted in less powerful results (confidence level of 91%). Achieving a population size which allowed statistical generalization would require significant additional effort. Furthermore the share of tenants from housing associations within the total response was very low. This lessened the possibilities to analyze the relation between tenants and housing associations. Luckily the interviews provided the researcher with enough data on this topic.

The theoretical framework and the literature research can be recognized as a strong fundament of this research adding to the external validity of the research. The use of multiple data sources, acquiring data through multiple research methods and integrating feedback moments from both a researcher and practitioner added to the construct validity of this research. And due to the transparent way in which the results are presented and structured the chain of evidence has been maintained adding to the reliability of the results. These three aspects have added to achieving convincing results. A side note to this is the wide orientation of the research. Due to this orientation the researcher did not go into depth at moments where this would have been possible. This creates potential for future research to elaborate on in adding to the understanding of local climate adaptation governance. Some suggestions for future research are:

- A comparative research to determine how different locational contexts shape governance processes.
- Exploring local climate adaptation governance processes in the domain of urban heat stress.
- Translating governance arrangements into concrete adaptation strategies.
- Researching self-organization in climate adaptation.
- More detailed research on how adaptive capacity and institutionalism shape climate adaptation governance processes.
- Research on the economy of climate adaptation.

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