RESPONSIBLE CLIMATE CHANGE ADAPTATION

EXPLORING, ANALYSING AND EVALUATING PUBLIC AND PRIVATE RESPONSIBILITIES FOR URBAN ADAPTATION TO CLIMATE CHANGE

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COLOFON

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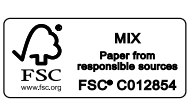

RESPONSIBLE CLIMATE CHANGE ADAPTATION

EXPLORING, ANALYSING AND EVALUATING PUBLIC AND PRIVATE RESPONSIBILITIES FOR URBAN ADAPTATION TO CLIMATE CHANGE

Verantwoorde Klimaatadaptatie

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voor stedelijke aanpassing aan klimaatverandering

(met een samenvatting in het Nederlands)

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door

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geboren op 19 februari 1964 te Noordwijk aan Zee.

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Onderzoek KNMI: klimaatverandering zet door

Nooit meer Elfstedentocht...

maar wel topwijn van eigen bodem

DE BILT Vergeet de Elfstedentocht, koop een stevige paraplu. En in lange, warme en droge zomers kun je in de tuin zitten met een topwijn van Nederlandse bodem. Volgens de klimaatveranderingen die het KNMI voorspelt, wordt de Amsterdamse winter van 2050, zoals die op dit moment in Bordeaux is.

MARTIJN VAN BEETEN

Wetenschappers roepen het al jaren, maar de verwachte klimaatverandering zet door. De temperatuur stijgt, de zeespiegel ook. Dat zijn de belangrijkste conclusies van het rapport van het KNMI. De winter wordt zachter, de zomer warmer en droger. In alle andere seizoenen gaat het regenen, vaker en heviger. Meer onweer, meer hagel, meer overlast.

Tijdens extreme regenbuien kan het maximale aantal millimeter neerslag, nu rond de 130 millimeter, toenemen tot 180 millimeter. Flinke overlast, van vollopende kelders tot files, kunnen daarvan het gevolg zijn. Wat dat betreft had het KNMI een perfecte dag uitgekozen om haar rapport te presenteren.

Code geel, door hevige neerslag. En veel meer files dan in een normale maandagavondspits.

Het KNMI voorspelt dat de opwarming van de aarde uiteraard ook in Nederland zal doorgaan. In 2050 is het tussen de 1 en 2,3 graden warmer, in 2085 tussen 1,3 en 3,7 graden. De zeespiegel van de Noordzee zal in 2050 tussen de 15 en 40 centimeter zijn gestegen, in 2085 is dat 25 tot 80 centimeter.

Met onder meer het Deltaprogramma worden al maatregelen genomen om Nederland te beschermen tegen overstromingen en te zorgen voor voldoende zoetwater. „Het nieuwe rapport van het KNMI onderstreept de noodzaak hiermee door te gaan," zegt staatssecretaris Wilma Mansveld van Infrastructuur en Milieu in een reactie.

Een Elfstedentocht moet snel komen, anders kunnen we het wel vergeten, zo lijkt het. Nu is de kans 15 procent dat er ooit nog een opvolger komt voor Henk Angenent, de winnaar in 1997. In 2050 ligt die kans maximaal op 2 procent en volgens het voor de schattingen zwartste scenario slechts 0,3 procent.

Er staat wel iets tegenover. Meer recreatiedagen, door de warmere zomers. En een langer

> **Dit rapport onderstreept de noodzaak van maatregelen**
> –Mansveld (staatssecretaris)

groei- en bloeiseizoen voor de boeren. Al is *er*, door extremere neerslag en de droge zomers, een grotere kans op verloren gewassen.

Dat laatste geldt ook voor de wijnboeren, die in Nederland steeds meer opduiken. Zij watertanden al van de voorspelling dat de Nederlandse winter in 2050 zal zijn, zoals die nu in Bordeaux is. De heroemde Franse wijnstad dus.

„Het ziet er goed uit," zegt Diederik Bekker, eigenaar van het Betuws Wijndomein en voorzitter van het Wijngaardeniers Gilde. „We worden al steeds beter in het maken van wijnen, de druivenstokken worden ouder en als ook het klimaat een handje helpt, gaat de kwaliteit nog verder omhoog. We winnen nu al gouden medailles op internationale concoursen, dat kan alleen maar beter worden. Alleen die hevige neerslag, als dat hagel wordt, kan problemen geven."

Door de temperatuurstijging is in de toekomst minder gas nodig om huizen te verwarmen. In de zomer, als de temperatuur flink en langdurig kan stijgen, is juist weer meer energie nodig om de huizen te koelen met extra energie.

Zeker in de steden, die dan zelfs 's nachts amper zullen afkoelen onder de 20 graden. De warmte kan daar moeilijker weg. Dit kan leiden tot hittestress.

AD Amersfoortse Courant 27-05-2014

1 INTRODUCTION

Despite mitigation efforts to reduce greenhouse gas emissions, climate change is already being witnessed. The decade 2000-2010 was the warmest decade on record with 2010 being the warmest year ever recorded (WMO, 2013). It is also said that climate change may increase the occurrence and intensity of extreme events such as heat waves, extreme precipitation and severe storms (IPCC, 2012; WMO, 2013; IPCC, 2014). The climate is expected to continue changing in the next decades as a result of past and future emissions. Climate change is projected to have considerable socio-economic, ecological and health impacts, from increased flood risk and coastal zone erosion to water shortages, reductions of agricultural yields in some areas and increases of yields in other areas, biodiversity loss and an increase in heat-related deaths, to mention a few (e.g. EEA, 2008; EC, 2013; IPCC, 2013a). It has been widely claimed that cities are particularly vulnerable to the effects of climate change, and to extreme weather events (IFRC, 2010; IPCC, 2013b). They represent enormous concentrations of human, financial, and cultural capital. "Action in urban centres is essential to successful global climate change adaptation." (IPCC 2013b, p. 3). Think, for instance, of the huge impacts of storm events like Sandy and Katrina in the United States in terms of material damage, and of the 2003 heat wave in Paris in terms of 15,000 excess deaths.

To deal with these impacts, climate change adaptation planning and action is required. According to the adaptation literature the development of adaptation polices and the implementation of adaptation measures is, however, hampered because the responsibilities for climate adaptation often remain rather vague, fragmented and/or ambiguous (Storbjörk, 2007; Amundsen et al., 2010; Biesbroek et al., 2010; Dovers and Hezri, 2010; Carter, 2011; Preston et al., 2011; EUROSAI, 2012; Runhaar et al., 2012; Gilissen, 2013; Termeer et al., 2013; Wamsler and Brink, 2014), and this easily leads to stalemate and a lack of climate adaptation action (Urwin and Jordan, 2008; Fünfgeld, 2010; EUROSAI, 2012; Williams et al., 2013). This is problematic because it could result in under-adaptation and increased climate risks. A lack of sufficient adaptation action taken now could also result in a substantial rise in costs for adaptation in the medium or long term (Kabat et al., 2005; Stern, 2007; EC 2009; EEA, 2012). This raises fairness issues in terms of intergenerational equity: the anticipated exponential costs for adaptation over time are being transferred to future generations. Public actors such as national or local governments can take on the responsibility for adaptation action now to secure sufficient levels of adaptation for present and future generations (e.g. Stern, 2007; Osberghaus et al., 2010). On the other hand, if governments are over-ambitious, it may lead to over-adaptation and inefficiencies and this could be seen as an illegitimate use of resources. Leaving certain responsibilities with private actors such as businesses and citizens may be more efficient (e.g. Mendelsohn, 2006; Stern, 2007), but private actors may exclude other actors and may act to the detriment of others, again leading to legitimacy and fairness issues.

The above shows that the issue of the division of responsibilities for adaptation to climate change matters. First of all, because vague responsibilities could lead to non- or under-adaptation. Secondly, because it matters who takes responsibility: each allocation of responsibility has consequences in terms of effectiveness, efficiency, legitimacy, fairness, accountability, etc. And thirdly, because the

divisions of responsibility affect the types of policy instruments employed, which in turn influences the effectiveness, legitimacy etc. Public actors have other instruments at their disposal than private actors. In turn, different instruments may enhance the implementation of adaptation to different degrees, influencing the effectiveness. A legal instrument such as a technical requirement, for instance, may stimulate higher levels of adaptation action than a communicative instrument, but generally only public actors can instigate legal instruments. On the other hand, a legal instrument may be perceived as less legitimate than a communicative instrument, and so on. In this dissertation it is argued that both the clear allocation of responsibilities and the selected employment of policy instruments may be crucial for the development and implementation of adaptation planning and action. At the same time the issue of responsibility divisions for climate adaptation between public and private actors raises questions. Who takes on a certain responsibility? How are responsibilities delegated to certain actors (for instance through policy instruments)? Why do certain responsibilities lie with certain actors, and other responsibilities with other actors? There may be different rationales for allocating responsibility to public rather than private actors, and these rationales may also differ depending on the adaptation issue at hand.

Consequently, in the literature on the governance of adaptation a debate has emerged on the issue of public versus private responsibilities for adaptation to climate change. Scholars from various scientific disciplines have theoretically elaborated on different rationales for allocating responsibilities to public and to private actors (e.g. Berkhout, 2005; Mendelsohn, 2006; Stern, 2007; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010). There is also a substantial increase in the number of empirical studies on the governance of adaptation, but those studies do not necessarily focus on the issue of responsibility divisions as such and/or are mostly conducted on a case by case basis (e.g. Storbjörk, 2007; Lundqvist and Von Borgstede, 2008; Amundsen et al., 2010; Fünfgeld, 2010; Wamsler and Brink, 2014). The issue of the division of responsibilities still remains rather unexplored, and a systematic overview of emerging governance arrangements between public and private actors, based on a broad set of rationales, is lacking.

Through the systematic analysis and evaluation of emerging governance arrangements for climate adaptation, this dissertation aims to contribute to the literature on the governance of adaptation by structuring the debate on public and private responsibilities, their underlying rationales, and their performance. Furthermore, this dissertation aims to help inform policy makers on how to get adaptation action off the ground. This is done through a multiple, cross-national comparative case study research, covering governance arrangements for three key urban adaptation issues: storm-water retention due to extreme rainfall, water safety due to increased river discharge levels and sea level rise, and heat prevention due to extreme heat events. Urban areas are the focus of this dissertation, because the multiple climate impacts and vulnerabilities of urban areas make climate adaptation action in cities very important (Hunt and Watkiss, 2011), while the multitude of public and private interests, sectors and actors in urban areas may be challenging for the clear allocation of responsibilities for climate adaptation action.

Section 1.1 provides the background of the study and underpins the focus of this dissertation on the issue of the division of responsibilities for adaptation to climate change. Section 1.2 provides further argumentation for the scope of the research on urban governance arrangements. Section 1.3 elaborates on the research objective; section 1.4 on the research design; section 1.5 on case selection; and section 1.6 on the methods for data collection. This chapter is concluded in section 1.7 with an outline of the dissertation.

1.1. BACKGROUND AND PROBLEM OUTLINE

1.1.1. THE EMERGENCE OF A NEW POLICY FIELD

While many definitions of adaptation to climate change are in circulation, one of the most commonly used definitions is from the Intergovernmental Panel on Climate Change, which defines adaptation as "The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects." (IPCC, 2014, p. 5). For a long time adaptation to climate change was seen as a taboo because it was widely believed to frustrate mitigation objectives (Pielke et al., 2007). Since the beginning of the 2000s adaptation to climate change has gradually been recognised as a policy objective. The planning of adaptation has emerged at various levels, such as for instance at the level of the European Union (Rayner and Jordan, 2010; EC, 2013), and at the national level as witnessed by National Adaptation Strategies that have been formulated, albeit mostly for countries in the developed world (Biesbroek et al., 2010; Berrang-Ford et al., 2011; Preston et al., 2011). The intended planning of adaptation policies, programmes and actions is commonly referred to as 'planned adaptation' as opposed to 'autonomous adaptation', which takes place independently by individual private actors (Reilly and Schimmelpfennig, 2000; Brooks & Adger, 2005; Füssel, 2007; Stern, 2007). Relying solely on autonomous adaptation brings with it the risk of under- or mal-adaptation, because the interests of private actors do not necessarily coincide with the societal interests for adaptation. Therefore, planned adaptation is also necessary (e.g. Füssel, 2007).

Yet, planned adaptation is hampered by vague, ambiguous, and fragmented responsibilities according to recent studies (e.g. Urwin and Jordan, 2008; Fünfgeld, 2010; EUROSAI, 2012; Williams et al., 2013). It is therefore argued that a clear allocation of responsibilities matters for getting climate change planning and action off the ground. Literature also suggests that the need for clear responsibilities is also fuelled by the fact that climate adaptation is not considered to be business as usual: adaptation requires additional non-structural, innovative measures in the built environment on top of the usual default solutions (e.g. Burton, 2004; Hallegatte, 2009; EEA, 2012). To deal with the increased frequency and intensity of rain fall, for instance, it may not suffice or be viable to increase the sewage capacity in the short term. Novel measures, such as green roofs, permeable paving, temporary underground storage, rain barrels etc. may be needed to deal with the excess rainfall (Tennekes et al., 2014). In addition, it is often stated that adaptation should be mainstreamed in related policy fields such as water management, urban planning and health and disaster risk management (e.g. Adger et al., 2005; Füssel, 2007; Kok and De Coninck, 2007; Berrang-Ford et al., 2011; Fröhlich and Knieling, 2013). In both cases, the involvement of additional sectors and actors, such as citizens, project developers etc. is needed to implement climate adaptation action, resulting in a further mixing and blurring of responsibilities. Moreover, new adaptation issues created for instance by the desire to build in un-embanked areas (such as former harbour districts) and new multifunctional adaptation measures (such as multifunctional dikes and green roofs) are inherently faced with mixed interests and responsibilities.

These issues in the adaptation practice have inspired a broad scientific debate on the governance of adaptation to climate change in general (e.g. Van Nieuwaal et al., 2009; Rayner and Jordan, 2010; Bauer et al., 2012; Termeer et al., 2013) and the issue of public and private responsibilities in particular (e.g. Berkhout, 2005; Mendelsohn, 2006; Stern, 2007; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010). Climate change is one of the key drivers of global environmental change. The climate debate is also embedded in the wider environmental governance debate. First the general scientific debate on environmental governance in light of public and private responsibilities is briefly discussed, before elaborating further on the debate of public and private responsibilities for adaptation to climate change.

1.1.2. *THE SCIENTIFIC DEBATE ON ENVIRONMENTAL GOVERNANCE*

Since ancient Greek times the issue of the boundary between *the public* and *the private* has been a topic of debate and this boundary has regularly shifted over time (Moore, 1984). In social policy the dichotomy of 'public versus private' rests on the opposite poles of public as the public realm and the domain of the state, and private as the domain of the market which includes the private sector and private interests (Clarke, 2004). Dubbink (2003) distinguishes between the public versus the private domain (the public domain is where the state is entitled to act, and the private domain where the individual may act), and between public versus private issues (public issues concern all, whereas private issues concern the individual). In liberal democratic societies the classical conception has been that public issues are the exclusive responsibility of the public domain, i.e. governments, and private issues are the responsibility of the private domain (Dubbink, 2003).

While the public domain of the state has significantly expanded throughout the 19th and most of the 20th century (the state has become a 'fettered giant', Dubbink, 2003, p. 79), since the 1980s the dominance of the state and its exclusive responsibility for public issues has been increasingly challenged by a wave of privatisation. Clarke (2004) argues that neo-liberalism has resulted in a shift from the public to the private in two ways: a shift between sectors and a shift between spheres. The first concerns the shift from the public to the private sector, which can either be commercial/for-profit or not-for-profit and voluntary (the domain distinction as illustrated by Dubbink, 2003). This is witnessed in the wide-spread privatisation of several utility services, for instance the handling of waste management by commercial companies. The second shift relates to the shift from the public sphere (as part of a government or a business) to the private sphere (as in familial and domestic) in the sense of individuals or households, as is witnessed in for instance the 'community care' of the elderly in the UK. Likewise Dubbink (2003) holds that the automatic link between public issues and the public domain is increasingly contested: the responsibility for public issues can in principle also be shared with or transferred to the private domain (ibid). The shift from public to private responsibilities for public issues is also observed, analysed and theorised in the governance literature, a movement commonly referred to as the 'shift from government to governance' (e.g. Jessop, 1998; Van Kersbergen and Waarden, 2001; Jordan et al., 2005; Rhodes, 2007). While many different definitions of the concept of governance exist, they all seem to agree that it refers to the development of governing styles in which the boundaries between and within public and private sectors have become blurred (e.g. Stoker, 1998; Rhodes, 2007). Different governance theorists all have their own views on how the responsibility for public issues should be divided between the three spheres of society, i.e. the state, the market and civil society (e.g. Rhodes, 1996; Kooiman, 2002; Dubbink, 2003; Kjær, 2004; Kickert, 2008). In the environmental governance literature scholars tend to agree that the inherent uncertainties and complexities of environmental issues, and the ambiguities in terms of

environmental goals and dispersion of power among a diversity of actors necessitate a governance approach in which responsibilities for environmental issues are shared among relevant public and private actors (e.g. Lemos and Agrawal, 2006; Meadowcroft, 2007; Driessen et al., 2012). An important research agenda in environmental governance, therefore, entails the documentation, analysis and evaluation of new types of governance arrangements that tend to employ interaction, deliberation and collaboration between state, market and civil society; thereby increasingly crossing the public-private divide (e.g. Lemos and Agrawal, 2006; Driessen et al., 2012). Relevant research questions relate to which governance arrangements emerge and why; and how these arrangements perform in relation to their expected outcomes, as well as in relation to traditional government.

This PhD research will contribute to the above debate. The governance of climate change adaptation provides a fruitful object of empirical study: the emergence of new public and private governance arrangements can be closely monitored, analysed and evaluated. Furthermore, reasons can be given for why certain arrangements emerged through an ex-ante evaluation of their underlying considerations. Adaptation to climate change is a new and emerging environmental policy field, in which the boundaries between public and private are not yet completely defined and in which public and private responsibilities tend to become mixed, thus creating opportunities for novel governance arrangements instead of the more traditional government. Think for instance of the replacement of traditional embankments (a typical government responsibility) by multifunctional dikes in which retail and/or recreation functions are integrated (in which case responsibilities are mixed between the public and private sectors) (Mees and Driessen, 2011; Kok et al., 2013; Van Broekhoven et al., 2014). Furthermore, adaptation to climate change shares many of the challenges that are attributed to environmental governance more generally, i.e. uncertainty, spatial diversity, social complexity and controversy (Lorenzoni et al., 2007; Termeer et al., 2011; Fröhlich and Knieling, 2013; Van Buuren et al., 2014). Thus, an empirical study of governance arrangements for adaptation to climate change may inform the body of knowledge on the analysis and evaluation of modes in environmental governance more generally.

1.1.3. *THE SCIENTIFIC DEBATE ON THE GOVERNANCE OF ADAPTATION TO CLIMATE CHANGE*

In the literature it is often argued that governments have an important role to play in supporting and enabling adaptation to climate change (Berkhout, 2005; Stern, 2007). On the other hand, other scholars have also argued that the governance of adaptation requires the action of both public and private actors (e.g. Allman et al., 2004; Füssel, 2007; Storbjörk, 2007; Hinkel et al., 2010). This is because adaptation to climate change is characterised by high degrees of complexity, controversy, spatial diversity and uncertainty, and therefore requires difficult, non-evident and often contradictory solutions as well as large scale environmental and social change, involving many actors in society (Lorenzoni et al., 2007; Van Nieuwaal et al., 2009; Driessen et al., 2013).

There may be different reasons for public and/or private actors assuming responsibilities for climate adaptation. A general consideration for public responsibility and hence government action has to do with market failure which leads to non-adaptation, mal-adaptation (unintended actions which are counterproductive, such as the building in flood plains as a result of insurance coverage of house owners) or under-adaptation (at lower than optimal levels of action, so that considerable climate risk remains). For instance, in the absence of an insurance market that covers damages of climate

impacts, governments can stimulate the uptake of insurance; they can use a legal policy instrument to mandate insurance for extreme events, or even provide the insurance (for instance crop insurance for farmers) (Mendelsohn, 2006; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010). Likewise, uncertainty is viewed as a key challenge to the governance of adaptation (e.g. Van Vuuren et al., 2011). Governments may generate and distribute knowledge on climate impacts as public goods (Berkhout, 2005; Stern, 2007; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010), in cases where private actors do not have access to sufficient information to make autonomous adaptation happen. Another justification for government action is related to matters of national security: in many countries the building of dikes and levees are seen as typical tasks belonging to the public domain, as well as emergency planning (Berkhout, 2005; Brooks and Adger, 2005; Aakre and Rübbelke, 2010a; Heltberg et al., 2009; Osberghaus et al., 2010). Another consideration for government intervention is fairness in terms of the distributional consequences of climate impacts or adaptation action. A key governance challenge is that climate impacts are spatially diverse and might impact certain groups or regions more severely than others. Furthermore, adaptation measures for one group or region might also have negative consequences for other groups or regions. In such cases governments can decide to compensate those groups or households more vulnerable to or affected by climate impacts or adaptation measures (Berkhout, 2005; Stern, 2007; Osberghaus et al., 2010). The above illustration of public responsibilities is far from complete, but serves to demonstrate different considerations (or reasons) for government action in the governance of adaptation.

By contrast, a general consideration for private responsibility is that private action is more efficient (Berkhout, 2005; Mendelsohn, 2006; Stern, 2007). Efficiency gain is the most cited advantage of market steering. It is one of the primary reasons for the rise in the private provision of public goods (see for instance Bennet & Johnson, 1979; Pack, 1987; Blank, 2000). Another advantage of market steering is its innovative power, also referred to as dynamic efficiency: it encourages investments into new products and production methods. For instance, insurance can stimulate the uptake of adaptive building measures to reduce the impacts of floods to private buildings by differentiating the insurance fees (an example of the employment of an economic policy instrument by a private actor). Furthermore, the provision of public adaptation goods by one or more private actors, also referred to as 'privately provided public adaptation goods' (cf. Tompkins and Eakin, 2012), might prove to be quite necessary for, and rather effective in attaining sufficient levels of these adaptation goods, given that the majority of buildings (for instance green roofs on buildings can help moderate urban temperatures) and land (for instance farm lands can become temporary water retention areas in times of flooding) are private property.

A widely proclaimed benefit of the involvement of private parties in public policy in general, is that it raises societal support for and hence the legitimacy of a policy. In particular, joint public-private responsibilities that are facilitated through an extensive process of participation and deliberation with the actors that have a stake in the policy issue, are viewed to increase the legitimacy of public policy generally speaking (e.g. Webler and Renn, 1995; Dryzek, 2000; Driessen et al, 2001; Smith, 2003) as well as in adaptation policies (Hulme et al., 2007; Paavola, 2008; Adger et al., 2009). A municipality, water board and project developer could, for instance, jointly agree on the application of adaptive building to a specific new development in a flood-prone area, and ratify this in a contractual agreement. Furthermore, it is argued by some that the sharing of responsibilities among public and private stakeholders enables joint fact-finding, stimulates social learning processes and ultimately enhances the adaptive capacity of society to cope with climate change (Pahl-Wostl, 2009; Gupta et al., 2010; Hinkel et al., 2010).

The above discussion illustrates that different considerations may lead to quite different responsibility divisions between public and private actors, and therefore may lead to the use of different policy instruments in support of these responsibilities (Jordan et al., 2005). There are likely to be several alternative arrangements between public and private actors, and these may vary between different adaptation issues and also over time. This depends in part on which consideration is most relevant for which problem, and why. Those questions are addressed in this PhD research. Before turning to the research objective, argumentation is given for why it is of particular relevance to study emerging local governance arrangements in urban areas, the scope of this dissertation.

1.2. THE IMPORTANCE OF ADAPTATION AT THE URBAN LEVEL

The local urban level is a very relevant scale for the governance of adaptation, because adaptation often requires the implementation of measures in the built environment and most local authorities are responsible for physical planning (Lundqvist and Von Borgstede, 2008; Urwin and Jordan, 2008; Amundsen et al., 2010). Additionally, it is viewed as an appropriate scale for climate action, because it corresponds with local administrative boundaries and better connects with the risks and opportunities of local public and private actors (Hunt and Watkiss, 2011). A key reason for a specific focus on urban areas is that cities are relatively vulnerable to the impacts of climate change (Pelling, 2003; Wilby, 2007; IPCC 2013b) as stated before. In a largely urbanized world they represent huge amounts of human, cultural, infrastructural and financial capital (e.g. Birkmann et al., 2010; Hunt and Watkiss, 2011; EEA 2012; IPCC, 2013b), and with an ongoing urbanisation (by 2050 75% of the global population is expected to live in urban areas) their share will even further increase. Water safety is a key urban adaptation issue resulting from sea level rise, increased discharge levels from rivers and storm surges (e.g. EEA, 2012; IPCC, 2013b). Some of the most urbanised areas of the world are located in low elevation coastal zones and deltas, making them rather susceptible to flood risk (McGranahan et al., 2007). For instance, in Europe damage of over € 35 billion from 9 major floods occurred between 2000 and 2005 (Barredo, 2007). A recent study expects an annual loss of up to € 23.5 billion by 2050 due to floods, which is five-fold compared to the last decade in Europe (Jongman et al., 2014). Storm-water retention is another key urban adaptation issue (e.g. EEA, 2012; IPCC, 2013b). Cities are relatively vulnerable to surface water flooding due to the increase of artificial surfaces and decrease of green space which prevents excessive rainfall from entering into the ground (e.g. Gill et al., 2007; Willems et al., 2012). A third key issue is heat prevention (e.g. EEA, 2012; IPCC, 2013b). In addition to preventing rainfall from soaking into the ground, artificial surfaces enable the build-up and trapping of heat, making cities much hotter than the rural environment (Wilby, 2003; Gill et al., 2007). To make matters worse, cities are already faced with inherent vulnerabilities: urban areas are faced with worse environmental conditions than rural areas and climate change is claimed to exacerbate this situation (Lindley et al., 2007; Friel et al., 2011). The effects of the urban heat island, for example, are aggravated by the projected increase of hot days and heat waves. The impacts of heat waves are already felt today, as seen by the 70,000 excess deaths during the heat wave of 2003 in Western Europe (Robine et al., 2008), and the 55,000 deaths during the heat wave in 2010 in Eastern Europe (Barriopedro et al., 2011). It is expected that ongoing climate change, by threatening cities as important economic engines and hubs, will threaten Europe's overall economy and quality of life (EEA, 2012, p. 6). In line with this urgency, the attention for the role of cities in climate governance has rapidly increased (e.g.

Bulkeley and Betsil, 2013), and awareness for the need for urban adaptation to climate change has also increased (Wilby, 2007; Carmin et al., 2009; Bulkeley, 2013; EEA, 2012). In a growing number of leading cities adaptation planning has been documented in recent empirical studies (e.g. Berrang-Ford et al., 2011; Carter, 2011; Mees and Driessen, 2011; Bulkeley, 2013; Bulkeley and Betsil, 2013; Wamsler et al., 2013; Reckien et al, 2014).

Another key reason for a specific focus is that some of the earlier mentioned governance challenges of climate adaptation are particularly prominent in urban areas. One such major challenge for urban areas is the spatial diversity. The impacts of climate change are spatially diverse: the impacts on society can considerably vary from one locality to the other (e.g. Hess et al., 2008; Biesbroek et al., 2009a; Aaheim et al., 2010; Carter, 2011). Heavy rainfall, for instance, is likely to cause more flooding in densely built neighbourhoods than in neighbourhoods with an abundance of (open) green space. In addition, the vulnerability of different localities and local populations also varies considerably (Smit and Wandel, 2006; Carter, 2011). Heat waves are likely to create more health impacts on elderly people who are less able to regulate their body temperature. It is argued that the variety in impacts as well as in vulnerabilities necessitates a customized approach tailored to the local circumstances (Saavreda and Budd, 2009; Carter, 2011; Romero Lankao and Qin, 2011; Zimmerman and Faris, 2011). Perhaps the most important challenge, certainly in light of the debate on public versus private responsibilities, is the social complexity. In the local urban environment the interests of a plethora of public and private sectors and actors come together. Setting clear responsibilities in a multi-sector and -actor environment is challenging. When responsibilities linger, there is a tendency to fall back on existing institutional arrangements in the related policy sectors of water management and urban planning, and these may be less fit to deal with the specifics of climate adaptation (Birkmann et al., 2010; Keessen et al., 2013; Tennekes et al., 2014).

1.3. RESEARCH OBJECTIVE AND QUESTIONS

In the previous sections the point was made that it is very relevant to study the issue of public and private responsibilities for climate adaptation because:

- a lack of a clear division of responsibilities could lead to non- or under-adaptation;
- each division of responsibilities has different consequences in terms of effectiveness, efficiency, legitimacy, fairness, accountability, etc.;
- each division of responsibilities influences the use of different policy instruments for climate adaptation, which in turn influences the effectiveness, legitimacy, fairness, etc.

Furthermore, the relevance of studying the issue of public and private responsibilities for climate adaptation *in urban areas* was demonstrated because:

- urban areas are particularly vulnerable to climate change, with key adaptation issues such as water safety, storm-water retention, and heat prevention. Given the ongoing worldwide urbanisation, the bill for adapting urban areas is expected to be(come) very high;
- several challenges to the governance of adaptation and the division of responsibilities are particularly present in urban areas.

As stated in the first paragraph, in the adaptation literature a debate has emerged on the issue of public and private responsibilities. Scholars from various scientific disciplines have theoretically elaborated on different rationales for allocating responsibilities to public and to private actors (e.g. Berkhout, 2005; Mendelsohn, 2006; Stern, 2007; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010). A recent UN report stated: "Most of the literature on climate change adaptation and cities is focusing on what should be done, not on what is being done (because too little is being done)" (UN Habitat, 2011, p. 145). The number of empirical studies on the governance of (urban) adaptation has significantly increased recently, but these studies are not necessarily focussed on the issue of responsibility divisions. A systematic empirical analysis for a variety of climate adaptation issues, of responsibilities and their underlying rationales has not yet been conducted. The normative consequences of different divisions of responsibility have also not yet been well explored. This research will contribute to filling this gap by studying existing arrangements for urban adaptation to climate change as well as promising alternatives for those arrangements.

The research objective of this dissertation is:

> ***To explore, analyse and evaluate existing and alternative public and/or private governance arrangements for the three key urban climate adaptation issues of storm-water retention, water safety, and heat prevention.***

In doing so, this dissertation aims to make a scientific contribution to the literature on the governance of adaptation to climate change. The research systematically studies what is happening on the ground in terms of responsibility divisions among the relevant local public and private stakeholders, and links the empirics with the normative principles of legitimacy, fairness, legitimacy, etc. It does so by studying multiple cases based on three key urban adaptation issues, i.e. storm-water retention, water safety, and heat prevention. This dissertation also aims to contribute to the (environmental) governance literature more generally. Research on the issue of responsibility divisions for a novel and complex environmental policy field such as urban climate adaptation may inform the debate in environmental governance by addressing i) whether and to what extent the shift from government to governance takes place, and ii) whether this shift enhances the performance in terms of effectiveness, legitimacy, fairness, etc. Furthermore, this dissertation aims to be practically relevant for (local) policy makers who are dealing with issues of responsibility divisions. As stated before, it is argued that the clear allocation of responsibilities to public and private actors and their consequential employment of policy instruments can help to get adaptation planning and action off the ground. This dissertation may help policy makers by providing a number of considerations for the deliberate and well-informed allocation of responsibilities and for the selection of policy instruments, and by providing an empirical analysis of how other city governments have dealt with this issue.

Based on the research objective six research questions have been formulated to guide the empirical work. Research questions 1-3 structure the *analytical* part of the research; these questions focus on mapping and explaining responsibility divisions. Research question 4 is *evaluative* in nature; it deals with the performance of the responsibility divisions. Research questions 5 and 6 are *design-oriented* in nature; they deal with the exploration of alternative governance arrangements in terms of responsibility divisions and policy instruments.

RQ1. Which considerations might underlie the divisions of responsibility among public, private or public-private actor constellations, and what explains why and when particular considerations become relevant to the division of responsibilities?

The aim of this theoretical research question is the development of a conceptual framework with which the divisions of responsibilities for urban climate adaptation can be identified, explained and evaluated. The conceptual framework shows the hypothesised relations between the specific governance challenges for (urban) adaptation, the considerations for the allocation of responsibilities, and the division of responsibilities across the different stages of the policy process, as derived from a literature review. The framework identifies a holistic set of six considerations, derived from legal, economic and policy sciences. These six considerations serve as explanatory factors for the allocation of certain responsibilities to certain actors. The conceptual framework is elaborated upon in Chapter 2, and forms the basis for all the empirical chapters (2 to 6).

RQ2. Which divisions of responsibilities between public and/or private actors exist or are envisaged for the three key urban climate adaptation issues of storm-water retention, water safety, and heat prevention?

The aim of this empirical research question is to map and analyse patterns of what happens on the ground in terms of public and private responsibilities. To make sense of the concept of responsibilities, a practical approach is taken that resonates with the world of policy practitioners. This means that the concept of responsibility is used in an instrumental manner: by studying who does (or is authorized to do) what in the different stages of the policy process of relevance to adaptation. For each of the four stages of policy-making, policy implementation, policy evaluation and policy maintenance several roles are determined (these are further elaborated upon in Chapter 2); and it is determined which public and/or private actors execute those roles. This research question is addressed in the three empirical chapters (3, 4, and 5), by conducting an analysis of responsibilities for the realisation of three different urban adaptation measures. These three adaptation measures are selected to represent innovative solutions for three key urban climate adaptation issues: green roofs for storm-water retention (the mitigation of excessive rainfall); adaptive building for water safety (the mitigation of river floods and sea-level rise); and health care and built environment measures for heat prevention (the mitigation of excessive heat).

RQ3. What explains why certain responsibilities are taken on by, or assigned to certain public and/or private actors?

The allocation of responsibilities to certain public and/or private actors may differ per adaptation issue, per spatial scale within the local urban level (building, neighbourhood, city-wide), per policy stage etc. In order to explain why certain public and/or private responsibilities for adaptation emerge, it is important to understand which considerations are driving a certain allocation of responsibility, since these may also differ per issue, scale, policy stage etc. It is argued that the allocation of a certain responsibility is driven, either explicitly or more routine-wise and implicitly, by one or more considerations. The division of responsibilities is thus explained by unravelling the different considerations that may underlie these responsibilities, using the analytical framework developed in Chapter 2. This empirical research question is addressed in the three empirical Chapters 3, 4, and 5.

RQ4. *For each of the three adaptation issues, which consideration is most relevant and how do the divisions of responsibility perform against this consideration?*

Recurrent research questions in the debate on environmental governance beyond the state are: i) does it work, i.e. how effective are different types of governance arrangements?; and ii) what are the normative consequences of these arrangements in terms of fairness, legitimacy, accountability, efficiency, etc. (e.g. Lemos and Agrawal, 2006)? The six considerations are important criteria with which the success of the governance arrangements can be measured. This research question is addressed differently in each of the three empirical chapters. First, based on the adaptation literature, the most relevant consideration for each of the three adaptation issues of water retention, water safety and heat stress is deduced. Consequently, the division of responsibilities of each of the three cases is evaluated against this relevant consideration.

RQ5. *How can policy instruments be selected to support public and/or private responsibilities for the realisation of urban adaptation measures?*

The responsibilities of certain actors for the implementation of adaptation measures can be supported through the employment of policy instruments. Local urban policy makers, for instance, are able to incentivize private adaptation action through use of certain policy instruments (Berkhout, 2005; Fankhauser et al., 2008; Wilby and Vaughan, 2011). Alternatively they can use the market by stimulating private actors to employ policy instruments to regulate the market (Fankhauser et al., 2008), or use governance networks (Vabo and Røiseland, 2012). This dissertation places the employment of policy instruments as an essential element of a governance arrangement in support of certain public and/or private responsibilities. Both the dimension of actors/politics and the dimension of content/instruments are commonly used in typologies of governance arrangements (e.g. Treib et al., 2007; Driessen et al., 2012). Chapter 6 addresses this research question conceptually, by proposing a method for the deliberate selection of policy instrument mixes, and empirically by applying the developed method to the three empirical cases of adaptation measures covered in Chapters 3, 4, and 5.

RQ6. *In view of the projected acceleration of climate impacts, which arrangements provide promising alternatives to the existing governance arrangements?*

This research question is addressed in Chapter 7, which provides the synthesis of the major findings of the research. In light of the acceleration of climate impacts in the course of this century, for each of the three cases the relevance of considering alternative arrangements is discussed before elaborating upon the different alternative arrangements themselves. Taking the city of Rotterdam in The Netherlands as a base-case (see section 1.5) several alternatives are elaborated upon for the three different cases of adaptation measures. These are derived from the design-oriented application of the conceptual framework, as discussed in Chapter 2, and from the method for policy instrument selection, as discussed in Chapter 6. Wherever applicable, the examples of arrangements of foreign cities included in the three empirical studies (see section 1.5), help to demonstrate these alternatives.

1.4. RESEARCH STRATEGY

The strategy employed is that of the multiple, comparative case study design (see Figure 1.1). The use of multiple cases enables an exploration of the range of governance arrangements for urban climate adaptation across different urban adaptation issues. A comparative case study design enables the analysis of patterns of commonalities and differences. It allows the holistic study of a small number of cases to gain understanding of the causal processes behind observed similarities and differences (Pickvance, 2001), and as such supplies the empirical basis for building and refining theories (Burnham et al., 2008). It is a research design commonly used in policy/political science to deliver applied, real-life, in-depth, contextual knowledge (Burnham et al., 2008). The multiple, comparative design is set up to allow a comparison across three adaptation measures for three important urban climate adaptation issues (cross-issue comparison), as well as a comparison among different urban governance arrangements in different cities (cross-city comparison). For the exploration, analysis and evaluation of alternative arrangements in different economic, political and cultural contexts, an international comparative approach is used which enables a comparison of cities in various western democratic countries in Europe and North America. An international comparison also makes the research interesting for a wide scientific and societal audience beyond The Netherlands. We will now turn to the selection of cases and case units within these cases.

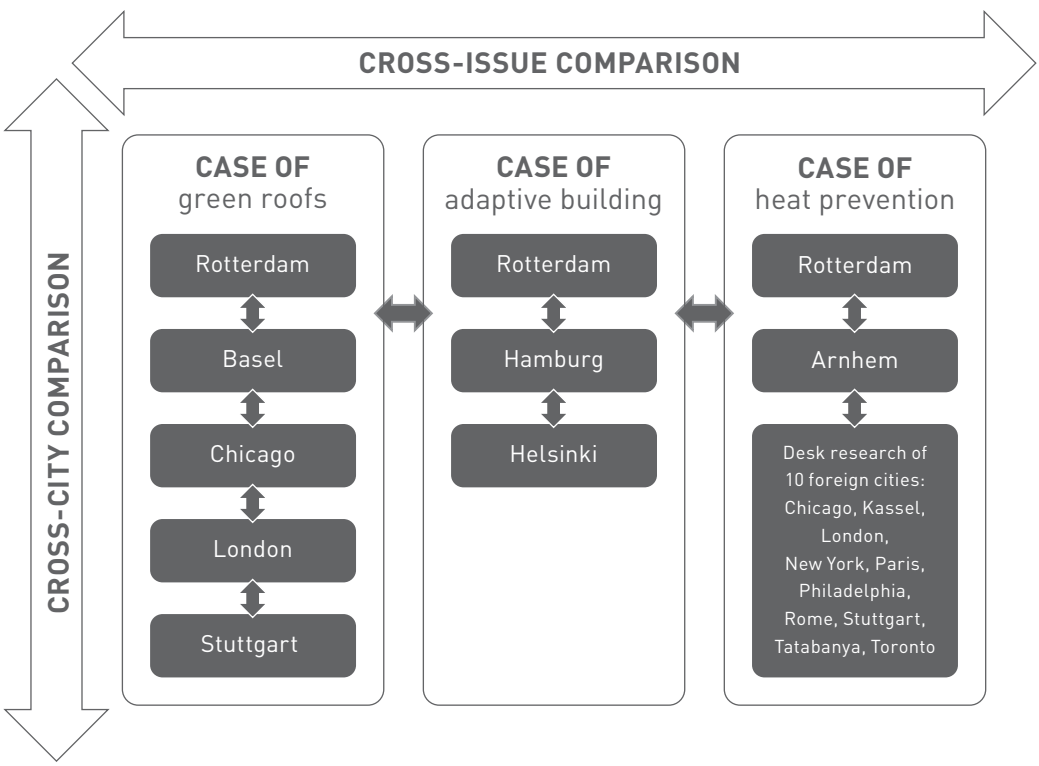

Figure 1.1: Illustration of the multiple, comparative case study design

1.5. CASE SELECTION

The three cases represent urban adaptation measures that cover three important urban climate adaptation issues with potentially high impacts (see Table 1.1). The three cases are selected based on the following similarities:

- They represent cases of local level governance of urban adaptation to climate change;
- They represent adaptation measures that are not the default adaptation option, but innovative alternatives: green roofs instead of an increase of sewage capacity; adaptive building instead of dikes; local heat prevention measures in health care and in the built environment instead of a national heat response plan (Tennekes et al., 2014). The assumption is that responsibilities for these innovative measures are less stipulated: they entail the involvement of additional actors and they are not yet embedded in existing institutional arrangements of, for instance, the water sector or urban planning. Therefore they may require a re-orientation of the responsibilities of both public and private actors;
- They represent cases where public and private benefits come together, thus enabling different divisions of responsibilities between the relevant public and private sectors.

Furthermore, the selection of adaptation measures is based on the key difference that they represent solutions for different adaptation issues at different spatial scales (building, neighbourhood, city-wide). The assumption is that this will mean that each adaptation measure has a different set of key governance challenges, which in turn will activate different considerations for responsibility divisions among the public and private actors, ultimately resulting in a variety of different governance arrangements.

	Green roofs	Adaptive building	Heat prevention measures
Adaptation issue	Storm-water retention: Surface water flooding from excessive rainfall	Water safety: Flooding from high discharge levels, storm surges and sea level rise	Heat prevention: Morbidity and mortality of vulnerable citizens from extreme heat events
Spatial scale	Level of individual buildings	Level of neighbourhoods	City level
Base-case unit	Rotterdam	Rotterdam	Rotterdam
Comparative case units	Basel, Chicago, London, Stuttgart	Hamburg, Helsinki	Arnhem (workshop) 10 foreign cities (desk research): Chicago, Kassel, London, New York, Paris, Philadelphia, Rome, Stuttgart, Tatabanya, and Toronto
Data collection methods	Policy documents content analysis In-depth interviews: stakeholders (n=53) experts (n=1)	Policy documents content analysis In-depth interviews: stakeholders (n=36) experts (n=4)	Policy documents content analysis Two multi-stakeholder workshops (n=63) One focus group (n=14) Expert interviews (n=3)
Data verification method	Stakeholder dissemination and discussion workshop	Verification by respondents through case study reports (available online)	Verification by respondents through reports of the results of the multi-stakeholder workshops (available online)

Table 1.1: Overview of empirical cases

The selection of case *units*, i.e. the governance arrangements as established in various cities for the three cases of adaptation measures (see Table 1.1), is based on the following similarities:

- The selected cities are considered to be early adopters in the respective adaptation measure, which means that they are leaders in the policy and implementation of the adaptation measure in their respective countries. The implementation of adaptation to climate change does not yet widely occur. Early adopters at least offer empirical material to study. An elaboration of the argumentation for the selection of the specific cities per research project can be found in the three empirical chapters.
- The selected cities are located in Europe and North-America. It is assumed that in these parts of the world the nature and scale of the adaptation issues is quite similar (compared to, for instance, South Asia and Africa). Additionally, the understanding and knowledge of the key adaptation issues is assumed to be quite comparable.
- The city of Rotterdam in The Netherlands is used as a base-case unit for each of the three cases of adaptation measures. This allows for a cross-issue comparison of cases (adaptation measures) within the same institutional context. Rotterdam is viewed as vulnerable due to its location close to the sea and rivers, and due to its large harbour and heavy industrial activities. Rotterdam is the one of the most active cities in the field of adaptation to climate change in The Netherlands (Mees and Driessen, 2011), and is one of the hotspots of the Dutch Knowledge for Climate Research Programme, which has provided most of the funding of this research. It was also a specific aim to generate knowledge for Rotterdam and the other hotspots of the programme.

1.6. RESEARCH METHODS AND DATA COLLECTION

Multiple qualitative methods were applied for data collection. The triangulation of methods and data is a common way to increase the validity of qualitative research. Across the three case studies the following research methods were used:

- *Desk research:* this entailed a content analysis of policy documents, websites, literature, reports etc. and was used in all three cases. This analysis provided insight into the more formalised responsibilities of public and private actors, and into the context of the cases. In total over 100 documents were analysed.
- *Interviews:* in-depth semi-structured interviews formed the primary form of data collection for two of the three cases (in total 97 interviews). The interviews were structured along a topic list. Per interviewee the questions were adjusted in line with the background of the interviewee and with his/her responses. Most interviews lasted around 1.5 hours and were recorded and transcribed. The interviews provided on the ground insight into the perceptions of responsibilities of different stakeholders, and of the considerations underlying these responsibilities.
- *Interactive research:* two multi-stakeholder workshops and one focus group were conducted for the case of heat prevention measures, as an alternative form of data collection to the interviews. As of yet Dutch cities do not have a local governance arrangement for dealing with extreme heat. Therefore, interactive methods with a diverse set of relevant public and private stakeholders were better suited to explore potential divisions of responsibilities among public and private actors.

Further details of the methods used for each of the three cases are described in the empirical Chapters 3, 4, and 5. Table 1.1 gives an overview of the selected cases and their respective case units and research methods. In total 20 governance arrangements in 15 cities in 10 countries formed the empirical basis of the research.

1.7. STRUCTURE OF THE DISSERTATION

The structure of the dissertation is visualised in Figure 1.2. Chapter 2 provides the conceptual framework, which is applied for the empirical analysis of the three cases of adaptation measures. The results of these empirical studies are provided in Chapters 3, 4, and 5. Chapter 6 proposes a method for the deliberate selection of policy instruments for climate adaptation. This deliberate selection is informed by the same considerations and governance challenges that are used for the analysis of responsibility divisions. The method is illustrated by its application to the three empirical cases. Chapter 7 provides a synthesis of the research results from the cross-issue and cross-city comparison of the three cases and the 20 case units. It is structured along the six research questions. Based on the synthesis of Chapter 7, in Chapter 8 the overall conclusion is given and reflections and avenues for further research are provided. Chapters 2 to 6 have been published in international scientific journals as separate articles, and therefore there is some inherent overlap between these chapters. Some minor editorial changes were made to enhance the consistency (e.g. spelling, referencing) and the readability (e.g. numbering of tables and figures) of the dissertation.

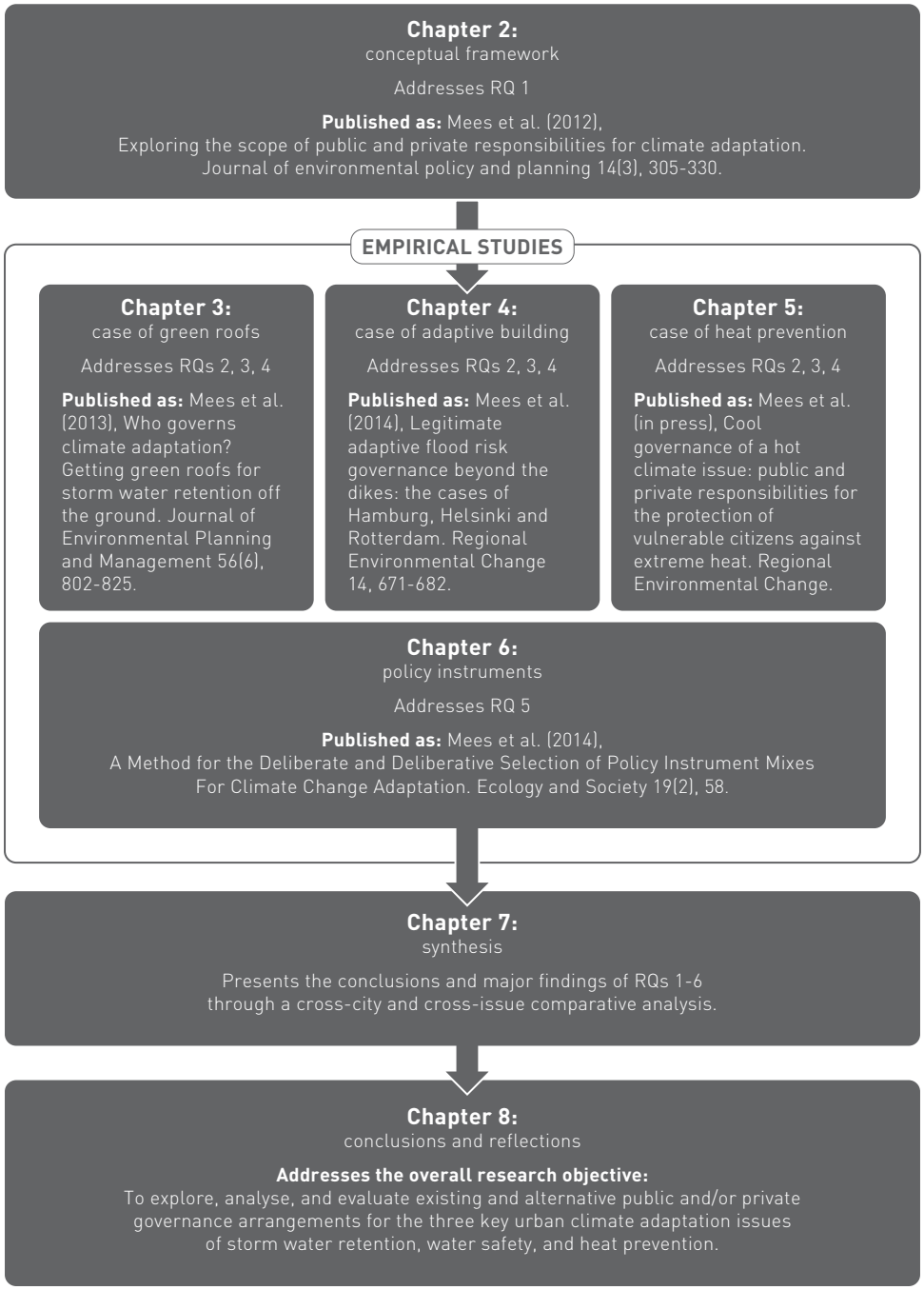

Figure 1.2: Structure of the dissertation

6 Binnenland

Waar blijft de regen met al die stenen?

Klimaat

Het regent harder en vaker. En de steden verstenen.

Er zijn slimmigheden nodig tegen wateroverlast.

Door onze redacteur
Arjen Schreuder

ROTTERDAM. Het regent niet maar het basketbalterrein ligt nog steeds vol water. Regenwater dat eerder is gevallen. Water dat niet in de riolering is gestroomd maar hier is bewaard, op een diep gelegen plein tussen twee schouwburgen, kantoren, appartementen en een kerk in het centrum van Rotterdam. Zodat het riool niet overbelast werd, putten niet overstroomden en straten blaak kwamen te staan.

Het zogenoemde waterplein werd eind vorig jaar in gebruik genomen en heeft zijn nut inmiddels bewezen. „Toen ik hier vijftien jaar geleden kwam werken, was er al discussie over de vraag of wij als hoogheemraadschap moesten investeren om toenemende buien de baas te worden, of dat die verhalen over klimaatverandering een luchtballon waren", zegt Toon van der Klugt, locodijkgraaf van het hoogheemraadschap van Schieland en de Krimpenerwaard in Rotterdam. „Als we den jaar geleden niet waren begonnen, dan hadden we nu grote wateroverlast gehad."

Het Benthemplein, dat een dikke vier miljoen euro heeft gekost, trekt als grootste waterplein van Europa veel bekijks. Het plein oogt als een zwembad voor reuzen. Het stroomt na hevige piekbuien vol met water via goten in de omgeving. Twee andere, iets hoger gelegen bassins lopen al vol bij kleinere buien. Op dit plein kan 1.700 kubieke meter water worden opgevangen. „Dat is voor dit deel van de stad genoeg om de ergste piek op te vangen, en overlast te voorkomen."

Waterpleinen en andere slimmigheden zijn geen overbodige luxe. Het aantal buien en de intensiteit van extreme regenbuien is sinds de jaren zestig van de vorige eeuw met 12 centimeter is gestegen en dat die stijging voorlopig doorgaat. Maar het aantal winterstormen aan de Zuid-Engelse kust is sinds 1871 niet noemenswaardig gestegen. Wel lijkt de intensiteit toe te nemen, zeker die van de krachtigste stormen. En in de neerslag zijn weinig patronen te ontdekken, juist omdat het Engelse weer zo wisselvallig is. Door die onzekerheden zou het volgens de MET Office „een uitdaging" zijn om de huidige extremen rechtstreeks te koppelen aan de opwarming van de aarde, ook al zijn er veel aanwijzingen die in die richting wijzen. Het rapport eindigt dan ook met een dringend pleidooi voor meer onderzoek, want zonder die kennis is het moeilijk om te weten welke investeringen nodig zijn voor kustverdediging en bestrijding van overstromingen.

Steeds vaker gaat het klimaatdebat over adaptatie, aanpassing aan veranderende weersomstandigheden, al was het maar omdat de wereld het niet eens kan worden over maatregelen om de opwarming te voorkomen.

Adaptatie is concreter, maar ook gecompliceerder, zoals in het Britse debat blijkt. In een poging om elkaar te slim af te zijn, doen politici nu allerlei valse beloftes, schreef Paul Bates, hydroloog aan de universiteit van Bristol deze week in *The Guardian*.

Zo zei Eric Pickles, minister van Lokale Overheden, dat hij spijt had dat de regering het advies van het milieuagentschap had opgevolgd, om de rivieren niet uit te baggeren. Volgens hydroloog Bates zou uitbaggeren de problemen echter alleen maar hebben verergerd. Het regenwater zou veel sneller naar lager gelegen gebieden zijn gestroomd en daar nog grotere problemen hebben veroorzaakt.

Nigel Lawson, voormalig minister van Financiën en lid van het Hogerhuis namens de Conservatieven, zei afgelopen week dat de overstromingen juist een waarschuwing zijn voor de regering om het platteland niet verder te vervullen met windmolens en zonnepanelen. De Britten hebben „goedkope en betrouwbare" energie nodig. Alleen dan zal het land bestand zijn „tegen alles waar de natuur ons mee opzadelt".

Ondergelopen straten in Kockengen, na de hevige regen van 28 juli. Het waterschap zette noodpompen in.

FOTO ANP

vergroten. Maar dat is veel te duur. De enige optie is het riool te ontzien. Door water op te vangen op daken, zoals op het dak van het hoogheemraadschap van Schieland gebeurt, maar ook op kantoren van de Zuidas in Amsterdam. Door parken en speelplaatsen maar ook particuliere tuinen lager aan te leggen zodat ze af en toe onder water kunnen lopen, en het water pas later in het riool terecht komt.

Nog beter is het om het water nooit in het riool te laten stromen. Door regenwater rechtstreeks af te voeren naar vaarten en sloten. En vooral door tuinen groener te maken. „Zodat het water daar komt waar het hoort, namelijk in de grond", zegt Iverna Zaalberg, die als ontwerper en „tuincoach" de actie Stop de Verstening is begonnen. Veel tuinen zijn betegeld. Dat scheelt onderhoud, zo wordt gedacht, en je kunt er een auto op parkeren.

En: „Achter het huis moeten je loungemeubilair en je buitenkeuken

Een regenton in elke tuin helpt al flink. Dat scheelt miljoenen voor het riool

natuurlijk ook op een schoon en droog plekje staan", constateert met spijt Operatie Steenbreek, een samenwerkingsverband van wetenschappers, natuurliefhebbers en vijf gemeenten dat de tuinen weer groen wil maken. „Het zou me niet verbazen als in de loop der jaren de verstening met 10 procent is toegenomen", zegt een van de medewerkers, Joop Spijker van kennisinstituut Alterra in Wageningen. Het woord „regelbelasting" wil hij niet in de mond nemen, maar hij wijst er wel op dat je in andere landen betaalt voor de mate waarin je het riool belast.

Spijker hoopt dat steden hun ruimte bijvoorbeeld

NRC WEEKEND 7
ZATERDAG 15 FEBRUARI & ZONDAG 16 FEBRUARI 2014

In het nieuws

Zware regenval voedt klimaatdebat

Overstromingen Britten discussiëren over verband tussen extreem weer en klimaatverandering

Door onze redacteur
Paul Luttikhuis

AMSTERDAM. Labourleider Ed Miliband weet het zeker: er is voor de Britten meer extreem weer in aantocht. Ook al kun je klimaatverandering niet de schuld geven van alle individuele gebeurtenissen, niets doen is in Milibands ogen een verkeerde vorm van nuchterheid. „Als er één ding is dat we weten over de gevolgen van extreem weer, dan is het dat de kosten - financiële, menselijke en andere kosten - van niets doen veel hoger zijn dan de kosten van actie ondernemen."

Lang niet alle Britten zijn het met Miliband eens. Ruim een derde denkt dat extreem weer nu eenmaal af en toe voorkomt. Slechts iets meer dan de helft vermoedt een verband met klimaatverandering.

Premier Cameron legt net als Miliband een link met klimaatverandering. „Maar hoe dan ook, het is verstandig om te investeren in een betere bescherming tegen overstromingen", zei Cameron.

De MET Office, het Britse KNMI, legde deze week in het rapport "The Recent Storms and Floods in the UK" haarfijn uit hoe het kon dat de harde noordwestenwind al sinds december met veel geweld tegen de kusten van Zuid-Engeland, Wales en Ierland aan beukt, dat het gebied te kampen kreeg met de natste januari sinds de waarnemingen in 1766 begonnen, en dat aan die periode van zware stormen en regenval maar geen einde lijkt te komen.

Prins William (midden) helpt met het stapelen van zandzakken in het zuiden van Groot-Brittannië.

FOTO REUTERS

1] NRC Handelsblad 15-08-2014

2] NRC Handelsblad 15&16-02-2014

2 EXPLORING THE SCOPE OF PUBLIC AND PRIVATE RESPONSIBILITIES FOR CLIMATE ADAPTATION

ABSTRACT Although in practice the division of responsibilities in adaptation to climate change is often not explicitly decided upon, governments appear to be primary actors in adaptation planning. However, literature suggests that the governance of adaptation requires roles for both public and private actors so that responsibilities can be shared and all of society's resources can be fully exploited. Active involvement of all societal actors might overcome problems of inefficiency and raise the legitimacy of adaptation action. This article presents a framework that enables the characterisation and explanation of existing governance arrangements in terms of responsibility divisions among public and/or private actors, and that facilitates the search for alternative responsibility divisions and their associated advantages and disadvantages. The framework is illustrated with an example of a governance arrangement for green roofs as an adaptation measure for storm water retention in Rotterdam, the Netherlands. The merit of the framework is that it promotes the conscious deliberation of considerations in the public–private divide, taking into account some specific challenges to the governance of climate adaptation. It may, therefore, support well-informed decisions on responsibility divisions in climate adaptation by local governments.

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2.1. INTRODUCTION

Since the late 1990s, adaptation to the impacts of climate change has gradually been recognized as a policy objective in addition to mitigation. Adaptation planning is emerging as a new area of public policy across various geopolitical scales (Biesbroek et al., 2010; Preston et al., 2011). Nevertheless, a recent study shows that demarcations of responsibilities are often lacking in adaptation policy documents (Preston et al., 2011). This is problematic because vagueness of roles and responsibilities is regularly cited as a barrier to the governance of adaptation (Biesbroek et al., 2010; Dovers and Hezri, 2010; Fünfgeld, 2010; Storbjörk, 2010; Carter, 2011). However, although, in practice, adaptation planning often appears to be government-led (Johnson and Priest, 2008; Storbjörk, 2010; Mees and Driessen, 2011; Wilson and Termeer, 2011), the involvement of public and private actors in adaptation is widely endorsed by scientists and policy-makers (Füssel, 2007; Agrawala and Fankhauser, 2008; EC 2009). If an explicit allocation of responsibilities facilitates the governance of adaptation, the question arises as to what kind of sharing of responsibilities is feasible and desirable among public and/or private actors for adaptation to climate induced risks.

One could argue that adaptation action can be left with the market, because the benefits of adaptation are relatively localized and private, compared to mitigation efforts that aim to reduce CO_2 emissions from which all benefit (Berkhout, 2005; Agrawala and Fankhauser, 2008). The theoretical rationale for public adaptation policies and hence the roles of governments is generally related to market failure, which leads to non-action, mal-adaptation, under- or over-adaptation. For instance, the market might not have access to sufficient information for adaptation action. Governments can step in to generate and distribute such knowledge (Berkhout, 2005; Stern, 2007; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010). A clear case for government action is related to matters of national security, for instance, water safety and coastal protection. The building of dikes is seen as a typical public responsibility, as well as emergency planning and compensation for catastrophic losses in case of extreme floods (Berkhout, 2005; Brooks and Adger, 2005; Heltberg et al., 2009; Aakre and Rübbelke, 2010a; Aakre et al., 2010; Osberghaus et al., 2010). Another reason for an active role for the state is the equitable regulation of the distributional consequences of climate change (Eakin and Lemos, 2006). Governments can decide to compensate those households more vulnerable to or affected by climate impacts or adaptation measures (Berkhout, 2005; Stern, 2007; Osberghaus et al., 2010). Nevertheless, too much government dominance could lead to inefficiency of adaptation policies (Berkhout, 2005; Mendelsohn, 2006; Stern, 2007; Driessen and Van Rijswick, 2011). Private sector involvement is often thought to increase the efficiency of environmental policy-making (Lemos and Agrawal, 2006). Economists have argued that a free, well-functioning market may lead to increased levels of prosperity and maximum efficiency. Efficiency gain is one of the most cited advantages of market steering. Another advantage of markets is their innovative power: they encourage investments into new products and production methods (Baarsma et al., 2010). A further widely proclaimed benefit of private involvement in public policy is that it raises societal support for a policy. Participation, deliberation and co-determination of those actors which have a stake in the policy issue tend to increase the legitimacy of public policy (Dryzek, 2000; Smith, 2003). Private involvement in environmental policy-making can take many forms, often resulting in hybrid governance arrangements which cross the public-private divide, such as policy networks, co-management, public-private partnerships and private-social partnerships (Lemos and Agrawal, 2006; Weber et al., 2011). According to Lemos and Agrawal (2006, p. 315), climate change is the typical example of a complex multi-scalar environmental problem, requiring 'a diversity of actors across the state-society divide'. Hybrid forms of governance for climate mitigation have been emerging for some time (see, e.g. Pattberg and Stripple, 2008), and are entering the field of climate adaptation as well (see, e.g. Juhola and Westerhoff, 2011).

The above shows that some scientists provide rationales for dominant public arrangements for climate adaptation, while other scientists provide rationales for alternative governance arrangements in which private actors have some form of responsibility. This article attempts to contribute to the governance literature on climate adaptation, by systematically mapping the considerations in the public–private divide relevant for climate adaptation, and exploring the contextual factors enabling or constraining these considerations. In the Netherlands, the government has a primary responsibility for water safety and flood risk management. This might be because it guarantees appropriate safety levels and ensures equal protection for all citizens. On the other hand, in the USA, the role of the private sector is more pronounced in line with the neoliberal agenda. Private actors have a substantial role in providing and taking out insurance against flood risk, although governments, for instance, still determine safety standards and requirements in building codes (Loucks et al., 2008; Meijerink and Dicke, 2008). Here, efficiency (assuming market forces will create efficient solutions for insuring or climate-proofing buildings) might have been the dominant rationale for choosing such an arrangement of responsibilities between public and private actors. Hence different considerations may lead to different governance arrangements for similar adaptation issues, and these considerations may be context-dependent as the example above illustrates.

By exploring the rationales for public–private arrangements in adaptation, this article attempts to address the following research questions: Which considerations might underlie the divisions of responsibilities among public, private or public–private actor constellations; and what explains why and when particular considerations become relevant to the division of responsibilities? In doing so, we build a conceptual framework to analyse and clarify existing arrangements for climate adaptation. The framework may also assist policy practitioners and other stakeholders in designing new, alternative arrangements. We first elaborate upon the framework and its analytical elements, and then illustrate how it can be applied through an analysis of the green roof governance arrangement in Rotterdam. We conclude with a brief discussion on the merits and limitations of the framework, and suggestions for future research.

2.2. CONCEPTUAL FRAMEWORK

Responsibility is a fuzzy concept that can be interpreted in many ways. We take an instrumental approach to responsibility as opposed to more normative conceptions (see, e.g. Miller, 2007), by looking at the roles actors can fulfil, simply put 'who does what', in different stages of the policy cycle (Dunn, 1994; Birkland, 2011). The reason for making a distinction in stages is in recognition of the fact that responsibilities can vary substantially across these stages; for instance, agenda setting can be undertaken by other actors than those responsible for the implementation of a policy or the monitoring of progress for that matter. Moreover, these stages are quite traceable in policy processes and are familiar terms for stakeholders. We recognize that linear processes along these stages hardly exist and that multiple interactions and feedback loops occur among these stages in today's complex society. However, the stages' heuristic offers a more suitable approach for our purpose of analysing responsibilities, compared to alternative theories of policy processes which mainly aim to explain how a policy (change) has come about (see Sabatier, 2007 for an elaborate discussion of various theories which attempt to explain initiation and adoption of, and changes in policies).

Inspired by the commonly used Plan–Do–Check–Act (PDCA) cycle (the so-called Deming cycle), we have distinguished the stages of 'PLAN', 'DO', 'CHECK' and 'MAINTENANCE' as presented in Table 2.1.

POLICY STAGE	ROLES	EXAMPLES FOR CLIMATE ADAPTATION
Policy making (PLAN)	Agenda setting	Convincing politicians of the need to do adaptation planning and/or to integrate adaptation into other policy areas
	Knowledge creation	Acquiring information on climate effects, on their impacts on various sectors in society, on the impacts of various adaptation measures and their costs
	Initiation of policy	Bringing together stakeholders to initiate discussions, including those affected by and/ or particularly vulnerable to climate impacts
	Target setting	Setting targets for acceptable flood security levels, for water storage capacities, reduction of heat stress, etc.
Policy implementation (DO)	Strategy making	Developing strategies for mitigating flood risk (e.g. dikes, adaptive building, evacuation plans) and the policy instrument mix to stimulate adaptation action
	Information provision and dissemination	Active sharing of relevant information to the public, for instance about safety levels, evacuation routes, heat refuge centres, etc.
	Financing of measures	Bearing the cost of adaptation measures, compensating the damages inflicted by climate impacts or adaptation measures
	Physical implementation	Implementing adaptation measures, such as building a dike, digging a canal, installing a green roof, etc.
Policy evaluation (CHECK)	Monitoring of results against targets	Monitoring implementation progress of adaptation measures and their intended impacts through physical inspections, geographic information system, satellite imagery, etc.
	Enforcement through sanctions/ incentives	Establishing fines for not retrofitting one's home for storm water retention, or developing fee reductions for storm water retention, etc.
	Policy adjustment	Making relevant changes to the policy based on the evaluation and/or deciding on the termination of policy
Policy maintenance (MAINTENANCE)	Maintenance after instalment	Inspecting dikes and repairing when necessary, regular training of evacuation plans, keeping buildings waterproof, etc.

Table 2.1: Instrumental translation of responsibility, based on the Deming PDCA cycle and Dunn (1994)

The 'Plan' stage represents the process of policy-making in which one decides what should be achieved. The 'Do' stage concerns the process of policy instrument selection and implementation. It is about defining the strategy of how certain targets are achieved and the actual implementation and financing of adaptation measures. The 'Check' stage is about the evaluation of policies; whether policy targets are being met and if not, what kind of enforcement mechanisms are developed to change behaviour in the desired direction and/or adjustment of policy. The last stage of maintenance is applicable to the daily management situation after instalment of measures. For each stage in the policy cycle roles are divided according to three options: (1) public responsibility, assuming a primary role for public actors, (2) private responsibility, assuming a primary role for private actors, and (3) public–private responsibility, assuming a joint effort with more or less equal responsibility among public and private actors in the form of policy networks, partnerships, co-management, etc. Thus, a mapping of responsibilities can be made for each role per stage.

It is likely that each particular set of responsibilities is driven by a rationale, or put differently it is influenced by certain considerations that stakeholders made (consciously or not). Inspired by the 'JEP triangle' of Nelissen (2002), we have derived considerations from three scientific disciplines traditionally involved in the public–private divide, and this results in an analytical approach as visualized in Figure 2.1. The juridical perspective takes the influence of laws, regulations, principles and norms on the public–private divide as the focal point. Here, rather, top-down steering through regulations and policies is emphasised. Two key considerations have been derived: 'rule of law' and 'fairness'. The economic perspective takes the balance and distribution of costs and benefits as the main influence on the public–private divide. Coordination and steering occurs preferably through market mechanisms of price and competition. Its considerations are 'efficiency' and 'securing adaptation action'. The political perspective is based on the influence of reciprocity between competing interests and trust on the public–private divide. Here the steering strategy is based on deliberative policy networks. It is represented by the considerations of 'legitimacy' and 'accountability'. These multiple perspectives show competing forms of functional rationalities. This implies that there are inherent tensions between the considerations, and therefore inevitable trade-offs are to be made. The framework may help to make these trade-offs explicit and to make well-informed choices among competing considerations. The extent to which certain considerations dominate is likely to vary from case to case, depending on the context of the policy issue.

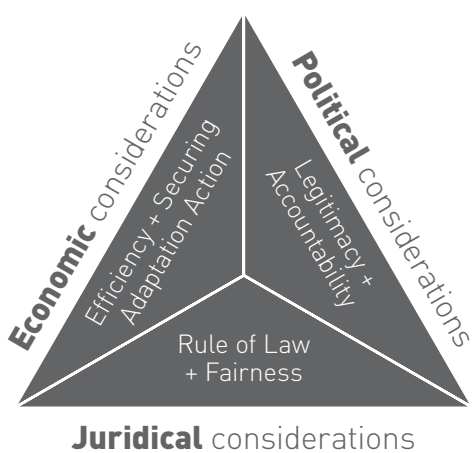

Figure 2.1: Considerations framework inspired by Nelissen (2002)

In turn, these considerations might be influenced by contextual factors. These can be macro-level economic, political or cultural factors that influence the public–private divide. For instance, considerations might be influenced by general governance paradigms of the neoliberal agenda. In recent decades, we have seen a shift from centralized to decentralized; from public to private responsibility; from regulation to deregulation; from a large to a small(er) government (Harvey, 2005). Although these shifts are widespread, the intensity is generally influenced by the political context. Established institutions, policy processes and routines might also influence considerations of the public–private divide. In policy sciences, this phenomenon is referred to as process sequencing, '. . . a situation whereby normal policy-making involves fairly common, routine, non- innovative changes at the margin of existing policies utilizing existing policy processes, institutions, and regimes' (Howlett, 2009, p. 251). A final type of contextual factors is discussed separately in the next section. These warrant attention because the adaptation literature stresses their relevance in posing particular challenges to the public-private divide in the governance of adaptation[1].

Our conceptual framework of responsibilities as presented in Figure 2.2 has two functions. The explanation-oriented approach takes existing public–private arrangements as a starting point, and helps to clarify how and why responsibilities were divided. By applying this framework as an analytical device in empirical studies, we hope it provides insight into patterns of responsibilities for climate adaptation and the scope for alternative governance arrangements. For instance: which actors tend to have primary responsibility at which stage, and for which type of adaptation issue; which considerations tend to dominate in choices of the public–private divide; which type of contextual factors have most influence on these considerations. Alternatively, it could help to depict how certain considerations are instrumental in framing adaptation and its key challenging factors (hence the two-way arrow between contextual factors and considerations in Figure 2.2). The design-oriented approach might function as a tool to help local governments and stakeholders in developing alternative governance arrangements, taking a more conscious note of contextual factors and considerations of the public–private divide.

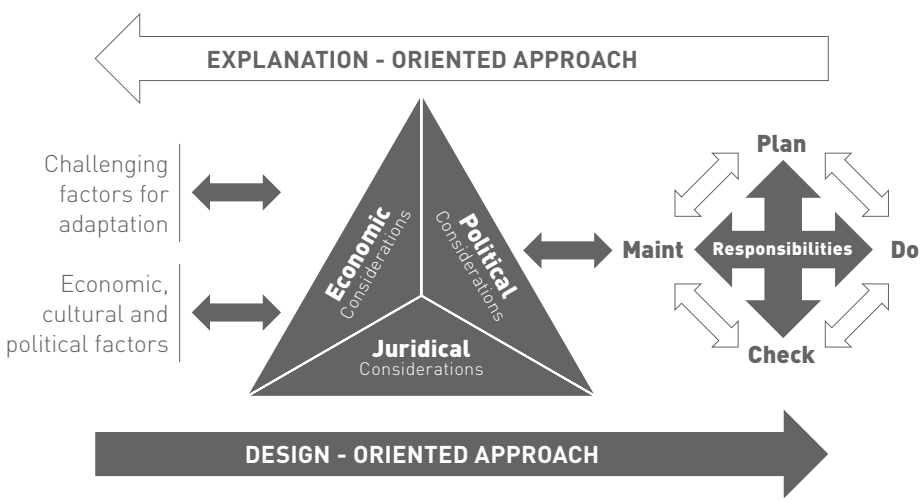

Figure 2.2: Conceptual framework of responsibilities

2.3. CHALLENGING FACTORS FOR THE GOVERNANCE OF ADAPTATION

Certain issues are often cited in literature to be particularly challenging to the governance of adaptation; even though some might be quite common issues in public policy. Combined, these factors make the governance of adaptation a challenging collective problem in which large numbers of actors have a stake.

The first issue of uncertainty manifests itself strongly; adaptation might even contain more uncertainties than mitigation because detailed information is required at the local level (Van Vuuren et al., 2011). Uncertainty is acknowledged as a barrier to effective adaptation action (Füssel, 2007; Urwin and Jordan, 2008; Biesbroek et al., 2009b). Most referred to in literature are: (i) Uncertainties of the climate system, its interdependencies and feedback mechanisms; (ii) Uncertainties regarding the impacts and their magnitude and distribution in society in time and space; (iii) Uncertainties relating to the effectiveness of adaptation action (see, for instance, Adger et al., 2005; Biesbroek et al., 2009b; Dessai et al., 2009; Van Vuuren et al., 2011). An obvious strategy to reduce uncertainty is to generate more knowledge through climate predictions, scenario building, etc., although this strategy is increasingly contested for adaptation (Dessai et al., 2009; Van der Sluijs, 2010). Instead, it is argued that we should focus on coping with uncertainties, by designing flexible and reversible adaptation strategies that can accommodate different futures and can be quickly adapted as new understanding becomes available (Adger et al., 2009; Biesbroek et al., 2009b; Hallegatte, 2009). Interaction among different actors and stakeholders from science, policy and other backgrounds could be regarded as another strategy to cope with uncertainty since it may raise awareness, foster the sharing of risk perceptions, help understand others' perspectives and lead to mutual understandings (Veraart et al., 2010; Raadgever et al., 2011). Uncertainty is aggravated by the long-term character of climate change. Many climate impacts are expected to occur far beyond current policy life cycles. It requires decisions to be taken now on behalf of future generations, and thinking about the trade-offs between taking action now to be on the safe side, and being prudent so as to avoid over-investment. It is one of the key institutional barriers to the governance of adaptation as expressed by policy-makers, especially in view of the short-termism of politics (Biesbroek et al., 2009b; Dovers and Hezri, 2010).

The second issue of spatial diversity has to do with the variety of climate effects across regions, as well as the variety in vulnerability of populations (Aaheim et al., 2010). Local circumstances can exacerbate climate impacts, for example, heavy rainfall is likely to cause a nuisance in cities because of the high impermeability of the urban surface. There are no 'one-size-fits-all' solutions to deal with this diversity of climate impacts. Tailor-made solutions specific to the local circumstances of individuals and communities might be needed (Saavreda and Budd, 2009).

The third issue of controversies relates to the different value systems and discourses in society, and this reflects upon the issue of adaptation; opposing perceptions of the problem and its solution might exist. For instance, some policy-makers strive for '100 percent climate proof', while others are prepared to accept residual risk; some think we should act now, others believe we should wait until more evidence becomes available; some are in favour of more technocratic solutions, while others are proponents of more reflexive approaches. These examples show that the problem definitions and adaptation goals are often ambiguous and reflect conflicts of interests and diverging value systems (Wilson, 2006; Adger et al., 2009; Hinkel et al., 2010).

The fourth issue is the social complexity of adaptation. Adaptation touches all levels of governance; it requires actions from the local to the global scale. Furthermore, adaptation touches upon established institutions of water management, spatial planning, public health, environmental policy, nature conservation, etc. (Wilson, 2006). Considering its trans-disciplinary character, it is often argued that adaptation should not be dealt with as a stand-alone issue, but 'mainstreamed', i.e. integrated into the programmes and processes of other policy fields (Adger et al., 2005; Füssel, 2007; Urwin and Jordan, 2008; Biesbroek et al., 2010; Berrang-Ford et al., 2011). The institutional ambiguity and fragmentation as a result of this social complexity suggest there are no clear problem owners, and this may easily lead to inaction because the power to act is not assigned. In the next section, we demonstrate how these factors might influence considerations in the public–private divide.

2.4. CONSIDERATIONS

The conceptual framework supports the analysis of considerations for the division of responsibilities across different policy stages (Plan, Do, Check, Maintenance) and adaptation policy issues (such as, for instance, water safety, water storage, fresh water supply, heat stress, etc.). The three perspectives present an analytical distinction; in reality, most governance arrangements are likely to be influenced by multiple considerations, leading to a mixture of responsibilities. We will now elaborate upon each consideration, and give examples of how the challenging factors for adaptation might influence these considerations.

2.4.1. *JURIDICAL CONSIDERATIONS*

Rule of law. This consideration is about abiding by existing (inter)national regulations to which the adaptation issue/measure is subject. Responsibilities might be defined in regulatory institutions such as 'duties of care' in constitutions and rules in European Union (EU) or national environmental, water or nature conservation directives/laws. For instance, Article 21 of the Dutch constitution requires the government to ensure the liveability of the country and the protection and enhancement of the environment. According to legal experts, this could be interpreted to include a duty for developing adaptation policy and undertaking adaptation action (Driessen and Van Rijswick, 2011). EU or national regulations might prescribe certain roles for governments in guaranteeing safety against flooding and sufficient fresh water supply. On the other hand, new and more flexible local regulations might be developed for adaptation purposes. The extent to which the consideration of rule of law comes into play depends on the juridical and political context which determines how existing regulations should be interpreted, and the extent of desire to develop new regulations to accommodate for the novelty of adaptation measures (such as building in non-embanked areas), new actor constellations, or new values related to adaptation goals. A challenging factor that might influence this consideration is the extent of social complexity. The more this is the case, the more the need for regulations/policies in which responsibilities are allocated as unambiguously as possible.

Fairness. Fairness relates to a reasonable distribution of responsibilities, risks, costs and benefits between and among generations. In the case of adaptation, it is not only about a fair distribution of burdens (who takes action, which dominates the mitigation discussions), but also about a fair distribution of benefits (who are the beneficiaries of adaptation action). The consideration of fairness is subject to several (inter) national environmental principles of relevance to adaptation issues (Beder, 2006; Driessen and Van Rijswick, 2011). The so-called 'precautionary principle', the 'compensation principle' and the 'principle of common but differentiated responsibilities' often translate into responsibilities for governments, either for a fair application of these principles in society or in specific roles in the governance of adaptation.

The precautionary principle is extremely relevant to adaptation due to the absence of full scientific knowledge of climate risks. It highlights the inherent tension between preventative governmental intervention and taking one's own responsibility as a citizen; between acting now to be on the safe side and being prudent so that new knowledge can be used as and when it is available. The factor that activates this principle is the extent of uncertainty around climate change, combined with the extent to which climate effects are expected to be felt in the long-term; the further into the future the effects are anticipated, the higher the level of uncertainty. We hypothesise that the more uncertain and long-term climate impacts are, the more public action is justified for the protection of the interests of future generations. As long as the costs of taking action now are expected to be lower than the avoided costs of damages in the future, governments have a legitimate right to act according to this principle.

The spatial diversity of climate impacts might influence both the compensation principle and the principle of common but differentiated responsibilities. Regarding the first principle, we hypothesise that the more that specific regions, groups or generations are unevenly affected by climate impacts, the more governments have a responsibility to arrange compensation. Regarding the second principle, the diversity of impacts might cause particular groups or regions to become more vulnerable to flood or heat stress than others. This vulnerability might be caused by socioeconomic factors (for instance lower-income groups are less equipped to protect themselves against water or heat stress), health factors (for instance elderly and children are less capable of handling extreme fluctuations of temperature), or by environmental factors (for instance urban citizens are more exposed to rainwater flooding). We hypothesise that the more vulnerable specific groups/regions are, the more some form of government intervention is needed to guarantee a fair division of responsibilities according to carrying capacities. The extent of government intervention might still vary from country to country (Aakre et al., 2010a).

2.4.2. *ECONOMIC CONSIDERATIONS*

Efficiency. Economics focuses on the efficiency of the allocation of scarce resources. Here, efficiency can refer to production of goods against lowest costs ('technical efficiency'); to an optimum allocation of resources based on societal preferences ('allocative efficiency'), or to the innovation of new products, materials and production methods ('dynamic efficiency') (Baarsma et al., 2010). When a set of assumptions holds, policy-makers can leave it to the markets to ensure efficiency. Some of these assumptions include that all resources (man-made, but also natural resources including clean air) are privately owned, that there are no externalities associated with any activity, that markets are perfectly competitive, etc.

Uncertainty and spatial diversity of climate impacts influence the consideration of efficiency. In the case of uncertainty, we hypothesise that the higher the level of uncertainty, the more the need for adaptation strategies to be flexible and diverse (Gupta et al., 2010), and hence the need for engagement by entrepreneurs willing to risk their time and money to develop new solutions. Regarding spatial diversity, we hypothesise that the more these impacts are localised and diverse, the more the solutions need to be tailor-made, and hence the more efficient it is to involve these citizens and firms as important stakeholders in the generation, decision-making and implementation of those customised solutions. It also diminishes the need for governments to be paternalistic in prescribing one-size- fits-all solutions.

Securing adaptation action. A second important economic consideration is effectiveness (achievement of pre-defined targets). For the purpose of this framework, it has been labelled 'securing adaptation action', i.e. attainment of optimal levels of action to achieve certain adaptation targets. In reality, this often comes down to the provision of a public good, a typical consideration justifying public action. It concerns the provision of goods characterised by market failures (Bator, 1958). Market failure presents itself when financial, technological or spatial implications of adaptation measures constrain private actors, when there is a (perceived) lack of private benefits of adaptation goods, or when there is a considerable time-lag between the bearing of costs and the reaping of benefits, for instance, in cases of adjustments to buildings which require high upfront investments (Stern, 2007). Market failure also occurs in the case of negative externalities of adaptation measures for surrounding areas or future generations. Governments can 'secure' adaptation action either by providing adaptation measures themselves or by compensating private parties for the costs of adaptation action. Similar to the considerations of Fairness and Efficiency, the extent of uncertainty around climate change influences this consideration. We hypothesise that the higher the uncertainty about future benefits/avoided costs, the more it acts as a barrier to private action (Mendelsohn, 2000; Adger et al., 2009; Gifford, 2011) and the higher the risk of not reaching adaptation targets, and hence the need for governments to initiate (and implement) adaptation policies on behalf of society.

2.4.3. *POLITICAL CONSIDERATIONS*

Legitimacy. Societal support raises the legitimacy of adaptation policy, and commitment to the implementation of adaptation measures. It is deemed critical to the governance of adaptation because of the diversity of climate discourses (Stevenson and Dryzek, 2010), contradicting value systems, ambition levels and adaptation solutions (Hinkel et al., 2010). Our interpretation of legitimacy is political, and relates to the approval of an adaptation policy (process) by those directly involved or affected by an adaptation measure[2]. Again uncertainty may play a role in this consideration. We hypothesise that the higher the level of uncertainties around climate change, the more there is a need to involve all stakeholders, including scientists and lay experts, in joint fact-finding and the co-creation of knowledge in order to pool brain power and creativity, and to bring vernacular knowledge into the process. Furthermore, controversies may influence this consideration. We hypothesise that the more that values are contradictory, the more adaptation goals and solutions are conflicting, the more there is a need for 'throughput legitimacy, i.e. stakeholders' access to and influence on the policy process (Paavola and Adger, 2006) and for 'output legitimacy', i.e. consent of stakeholders to the ultimate decisions regarding adaptation policies and their implementation (Bekkers and Edwards, 2007). Finally, social complexity may also play a role. We hypothesise that the more adaptation planning touches upon different levels, sectors and actors in society, the more participatory and inclusive the decision-making process should be, so that all voices are equally heard (Smith, 2003). Adger et al. (2009) advocate deliberative processes with a large variety of stakeholders for adaptation action.

Accountability. Accountability entails that policy-makers of the state, private sector and civil society are accountable to their stakeholders and the public at large, i.e. to those who are affected by the policy (UNESCAP, 2011). Accountability requires clarity of responsibilities among parties involved (Botchway, 2001; Lockwood, 2010), while institutional ambiguity is often apparent in the governance of adaptation due to social complexity. It blocks clear mandates for specific adaptation tasks. We hypothesise that the higher the institutional ambiguity, the more the need for a (public) neutral body to assign and communicate clearly on responsibilities. Accountability also requires transparency: one should have access to all relevant information regarding the content and the process of policy-making, so that stakeholders and the general public can indeed hold policy-makers accountable. Therefore, networks that share public and private responsibilities might be required, since these are often cited for their contribution to fostering communication, information and knowledge dissemination (e.g. Driessen et al., 2001; Glasbergen and Driessen, 2005; Bodin and Crona, 2009).

2.4.4. *LINKS BETWEEN CHALLENGING FACTORS AND CONSIDERATIONS*

Table 2.2 provides an overview of the hypothesised relationships between the factors that pose challenges to the governance of adaptation and the considerations, based on those relations most prevalent in adaptation literature and as elaborated upon in the previous section. It demonstrates that several challenging factors suggest shared responsibilities across a wide range of actors from the public and private spheres, although this may vary along the stages of the policy process. This is in line with the trend towards the hybridisation of environmental governance as sketched in the introduction, based on the premise that hybrid forms of governance might be more suitable to deal with the complexities, interdependencies and controversies of many environmental issues.

Challenging factors for the governance of adaptation	Considerations in public-private divide influenced by these factors	Hypothesised relationship between the factor and the consideration	Responsibility divisions in the policy cycle
Uncertainty: lack of predictability regarding climate change, its impacts on society and the costs and benefits of adaptation solutions. This situation is further aggravated by the long-term effects of climate change	Fairness: extent to which the precautionary principle is applicable	The more uncertain and long-term climate impacts are, the fairer it is that governments initiate adaptation policy on behalf of their citizens, in particular by representing the interests of future generations (inter-generational equity)	Public responsibility, particularly in Plan and Check stages
	Efficiency: extent to which dynamic efficiency, i.e. innovation, is needed	The more uncertainties, the more the need for innovative entrepreneurs in order to bring variety and creativity, and to generate flexible and adaptive adaptation strategies	Private responsibility, particularly in Do and Maintenance stages
	Securing adaptation action	The more uncertainties around climate change, the less likely households and firms adapt; governments may need to step in to secure sufficient adaptation levels	Public responsibility, particularly in Plan and Do stages
	Legitimacy (input & throughput)	The more uncertainties, the more the need to involve all relevant actors, including scientists and lay experts in joint fact finding and co-creation of knowledge to support adaptation policy and action	Public-Private responsibility, particularly in Plan stage
Spatial diversity: the impacts of climate change are location and context specific	Fairness	The more certain groups/regions are vulnerable to climate change or unevenly affected, the more government intervention is needed to guarantee a fair division of responsibilities and risks according to carrying capacities of actors	Public responsibility, particularly in Plan stage
	Efficiency: extent to which customised and localised solutions are needed	The more the impacts of climate change require tailor-made solutions, the more efficient it is to involve individual citizens/firms	Private responsibility, all stages
Controversy: contradicting value systems, goals and adaptation solutions	Legitimacy (throughput & output)	The more there are contradictions, the more support is needed from stakeholders for problem framing, underlying values of adaptation action, decision-making processes, and the implementation of adaptation measures	Public-Private responsibility, all stages
Social complexity: multi-sector, multi-level and multi-actor character, leading to institutional ambiguity and fragmentation	Legitimacy (input & throughput)	The more adaptation planning touches upon different sectors, levels and actors in society, the more participatory and inclusive the decision-making process needs to be in order to gain societal support	Public-Private responsibility, particularly in Plan stage
	Rule of law	The more there is institutional ambiguity, the more the need for regulations in which responsibilities are allocated as unambiguously as possible	Public responsibility, particularly in Plan stage
	Accountability	The more there is institutional ambiguity, the more the need for a (public) neutral body to assign and communicate clearly on responsibilities	Public responsibility, particularly in Plan stage

Table 2.2: Challenges to the governance of adaptation in relation to considerations of the public–private divide

2.5. ILLUSTRATION: GREEN ROOF POLICY

The application of the framework is illustrated by a study of the governance arrangement for green roofs in Rotterdam, the Netherlands. Green roofs help reduce surface water flooding. They are considered a 'no-regrets' adaptation measure because of their societal benefits in terms of eco-system services, thereby contributing to urban sustainability (Oberndorfer et al., 2007). They also provide private benefits through prolongation of roof life, insulation from heat, and enhancement of real estate value. The municipality of Rotterdam was the first Dutch local authority to recognise the potential of green roofs for retaining increased rainfall in densely built city districts. This is why green roofs are a spearhead of the Rotterdam Adaptation Strategy (RCP, 2010). The city employs an economic policy instrument to induce private actors to take on the responsibility for green roof instalments. In 2008, an incentive programme for green roofs was introduced which provides a subsidy of €30 per square metre to commercial and non-commercial property owners covering roughly half of the installation costs.

The framework provided a basis for analysis and clarification of the choices in responsibilities. A content analysis of official policy documents (see Appendix 1) and an interview with a legal expert provided insights into formal responsibilities for local urban water management. The exploration of considerations underlying the division of responsibilities and identification of the main drivers for these considerations were extracted via 12 in-depth semi-structured interviews of about 1.5-2 h each with 15 public and private stakeholders, representing different perspectives and interests (see Appendix 2). The interviews were recorded and transcribed. The analysis of this arrangement is only meant to illustrate how the framework can be applied; the green roof arrangement is all but representative of the empirical field. An overview of the roles fulfilled by different actors, and the underlying considerations and factors that influenced this division of responsibilities is provided in Table 2.3. Here, we will limit ourselves to highlighting the main findings.

2.5.1. *PUBLIC RESPONSIBILITIES*

The local authorities in Rotterdam have a primary role in agenda setting, knowledge creation and initiation of the green roof policy, in other words, they tend to dominate in the Plan stage. Their main consideration is that sufficient adaptation action (i.e. green roof instalments) is secured to increase the water storage capacity in the city. Private actors are faced with uncertainties regarding the benefits of green roofs, while the upfront installation costs are high, leading to uncertain and potentially long payback times. Therefore, they refrain from taking action, and the local authorities try to overcome this through the subsidy programme. This is in line with the third hypothesis in Table 2.2. Rule of law is another consideration that the local authorities take into account. This is because the Dutch Water Act assigns a duty of care for rainwater to municipalities (VNG, 2007; WW, 2008); they are responsible for the management of the sewage system and for the prevention of water nuisance on public grounds[3]. Furthermore, fairness is also considered; given the uncertainties regarding future climate impacts, the precautionary principle is taken into account in the targets set for the creation of additional water storage capacity in the city by 2030 (Rotterdam, 2007) in order to make the city 'climate proof' for current and future generations. This corresponds with the first hypothesis in Table 2.2. Together, these three considerations provided the rationale for the municipality of Rotterdam to take on responsibility early on in the policy process.

In the Do stage, the responsibility of the municipality remains rather dominant. It decides on the use of green roofs as a key strategy to make Rotterdam climate proof. Moreover, the local authorities chose to use an economic instrument in the form of a subsidy. The main rationale for this is efficiency. In many parts of Rotterdam, the costs of digging extra facilities to store additional water (and to remove existing buildings) would simply be exorbitant (Rotterdam, 2007). Green roofs offer a low-cost and innovative solution to raise water storage capacity, while achieving many societal co-benefits at the same time; hence they are a quick way to introduce 'visible sustainability', as one policy officer mentioned. Secondly, by tempting private actors with a subsidy, part of the installation costs of green roofs is financed by the private sector. In this stage, the municipality also takes responsibility for greening its own public property as a means to increase adaptation action as well as to set the example.

In the Check stage, the municipality's responsibility is focused on monitoring activities: the tracking of green roof installations and checking of granted subsidies. The considerations behind these activities are fairness and accountability; to ensure that all private actors receiving a subsidy keep their end of the bargain without exception, that publicly spent money is traced back to actual green roof installations, and that the transparency of public money spent on green roofs is guaranteed through subsidy contracts.

2.5.2. *PRIVATE RESPONSIBILITIES*

In the Plan stage, some private responsibility is shown by the green roof industry in its lobbying and research activities (which are obviously meant to prove and monetise the benefits of green roofs for its own gain; hence the research output is not always trusted). Nevertheless, the responsibilities of private actors increase in the Do, Check and Maintenance stages. It is the municipality's policy to leave knowledge development and innovations with the market (Rotterdam, 2011). Efficiency is a dominant consideration for the municipality to leave these responsibilities with the private sector, so that economies of scale and scope arise. Economies of scope exist through the co-benefits of green roofs which make them cost-effective. They generate multiple public and private benefits, and this is important for both public and private actors. Economies of scale occur through the creation of market demand pushed by the lobby work of the green roof industry. Furthermore, private responsibility is witnessed in cooperation efforts within the green roof industry and with horticulturists, in developing quality standards and maintenance contracts as a form of private regulation.

2.5.3. *PUBLIC-PRIVATE RESPONSIBILITIES*

Shared public-private responsibilities are absent; none of the roles is fulfilled via a truly joint public-private effort. Based on the feedback of respondents, this appears to be related to the limited influence of the consideration of legitimacy (and to a lesser extent accountability) on the public-private divide. Three explanations elaborated upon below, are (i) a limited influence of the adaptation challenges of uncertainty, controversy and social complexity on the perceived need for input and throughput legitimacy; (ii) a stronger influence of existing organisational and policy routines on the public-private divide; and (iii) the fact that legitimacy and accountability are already implicitly 'guaranteed' through a broad political support for green roofs in Rotterdam. Regarding the first point, these challenges can be considered to be moderate compared to other adaptation issues[4]. There is certainly some uncertainty regarding the water retention properties of green roofs under varying circumstances, and their monetised benefits. On the other hand, the controversies around green roofs as a solution appear to be modest in light of the fact that they are regarded as no-regrets measures. Nevertheless, social

complexities appear to be omnipresent due to the involvement of many public and private actors with diverging interests, institutional fragmentation (green roofs touch upon existing policy fields of water management, urban planning and greening), and the ambivalent nature of responsibilities for urban water retention under Dutch water law. Within the private sphere, interests may also diverge; the so-called split-incentive barrier means that the costs of green roof instalments are often borne by investors/housing corporations, while the benefits accrue to tenants, and there is little possibility for redressing these costs (by raising the rent). However, the influence of these adaptation challenges appears to have been overshadowed by the second point: the considerable influence of organisational and policy routines on the public–private divide. According to some respondents, the municipality has a certain standard way of working, and differences in organisational cultures tend to constrain the municipality from closely collaborating with the private sector. In the interviews, it became rather clear that, while actors initiated collaboration within their own (public or private) spheres, they did not really seek to do so with the 'other side'. Regarding the third point, there is great political support for the climate adaptation strategy, and the implementation of green roof planning as a spearhead of that strategy (RCP, 2010). This political support is fuelled by the intention of the city to be a frontrunner in climate adaptation and to market its expertise to other delta cities in the world (Mees and Driessen, 2011). Moreover, there is a high sense of urgency in Rotterdam, stemming specifically from a real shortage of water retention capacity, and more generally from the vulnerability attached to a low-lying delta city.

Table 2.3: Responsibilities in the green roof arrangement for Rotterdam

Stage/Role	Who and nature of responsibility	Predominant considerations	Rationale for considerations/contextual factors
Plan			
Agenda setting	Municipality: selling water issues as opportunities to increase the attractiveness of the city to the public, and green roofs as a visible & feasible solution to increase the water retention capacity	**Efficiency**	Economies of scope for green roofs: they are a quick way to introduce 'visible sustainability'
	Green roof industry: creating awareness for green roofs, lobbying & advising architects and municipalities	**Efficiency**	Market demand creates economies of scale
Knowledge creation	Municipality: conducting research: Cost-Benefit Analysis, stock-taking of foreign practices (resulting in a leaflet "Rotterdam Groen van Boven" published in 2006)	**Securing adaptation action**	Unfamiliarity with and uncertainty about the costs and benefits of green roofs lead to inaction of private actors
	Green roof industry: conducting research on the properties and benefits of green roofs, in particular related to water retention capacity	**Efficiency**	Green roofs have many co-benefits, without which green roofs would not be cost-effective
Initiation of policy	Municipality: Waterplan2 (flood management plan issued in 2007), a separate green roof policy is under development	**Rule of law**	Duty of care for prevention of surface water flooding on public grounds
Target setting	Municipality: mapping of quantities and target areas for water retention in Waterplan2, and designation of green roofs as a water retention measure for densely built areas in the city centre with high levels of hard surface	**Fairness**	Uncertainty encouraged the municipality to take the precautionary principle into account in making Rotterdam 'climate proof' by 2030
Do			
Strategy making	Municipality: decision to use green roofs as one of the solutions for water retention; choice to use an economic incentive to induce action: subsidy programme for green roofs introduced in 2008	**Efficiency**	They are less costly than hard infrastructural measures; they are a quick way to introduce 'visible sustainability'; costs of green roofs can be spread out among the public and private sector
Information provision & dissemination	Municipality: passive information provision on subsidy via telephone/mail and via a demo-roof; pro-active efforts to raise awareness in target areas	**Securing adaptation action**	Unfamiliarity with green roofs and the subsidy programme lead to inaction of private actors
	Green roof industry: provision of technical details, education on green roofs (eg. Eco-engineering/Groenweb)	**Efficiency**	Creation of market demand to get economies of scale
Financing	Property owners (housing corporations, investors, individual house owners)	**Efficiency**	Green roofs have many co-benefits, without which green roofs would not be cost-effective
	Municipality: subsidy for private actors in the form of 30 Euros per square metre installed	**Securing adaptation action**	High up-front installation costs discourage instalment by private actors (long ROI)
Physical implementation	Municipality: implementation of green roofs on city-owned buildings (outsourced to suppliers)	**Securing adaptation action**	Deficit of instalments on privately owned buildings
	Property owners: implementation of green roofs on privately owned buildings (outsourced to suppliers)	**Efficiency**	Green roofs have many co-benefits, without which green roofs would not be cost-effective
Check			
Monitoring	Municipality: tracking of green roof installations and checking of green roof subsidies through invoices (no physical inspection)	**Fairness & Accountability**	Monitoring progress of implementation against targets; checking of granted subsidies
	Municipality/Water boards: study planned to monitor effects of green roofs in one district of the city	**Securing adaptation action**	Overcoming information deficit, based on which private actors refrain from action
	Green roof industry: voluntary norms for product attributes, derived from German standards (current situation); and creation of Dutch (NEN) norms for product attributes (currently under development)	**Efficiency**	Creation of market demand
Enforcement	Not taken on as a responsibility	**Efficiency**	Too much administrative hassle/man power needed
Maintenance			
Maintenance	All property owners (incl municipality for city-owned buildings): outsourced to green roof suppliers	**Efficiency**	Green roof suppliers integrate maintenance through contracts

2.5.4. *DISCUSSION OF THE GREEN ROOF POLICY*

The current green roof arrangement in Rotterdam can be characterised as a combination of pure government and pure market-based arrangements across the various stages of the policy process, rather than other types of arrangements which cross the public-private divide. The economic considerations of securing adaptation action and efficiency dominate the Rotterdam green roof arrangement. The importance of these considerations versus legitimacy has limited the urge of actors to seek more participation and deliberation in the policy process. Inviting other actors with diverging interests into the policy process is likely to bring existing policy routines up for discussion, to slow down decision-making and to raise transaction costs, thereby decreasing effectiveness and efficiency. The dominance of the efficiency rationale might also result in trade-offs related to fairness. It can be very efficient to decrease municipal costs for water storage by inducing private citizens and businesses to install green roofs. However, the subsidy is borne by all tax payers who thus indirectly contribute to the private benefits of recipients of the green roof subsidy. Moreover, disadvantaged districts may still remain relatively vulnerable to urban flooding because their residents are unable to afford a green roof despite the subsidy. So, while this arrangement was created for valid reasons, given the current state of early adoption of the green roof technology (predominantly securing adaptation action to reach water retention targets and creating efficiencies to bring installation costs down and raise benefits), it has potential trade-offs in terms of throughput legitimacy and fairness. Nevertheless, the green roof arrangement is still perceived as legitimate because the green roof policy has been decided upon and approved by elected officials in the local council based on broad societal support. The Rotterdam green roof case thus suggests that the extent to which considerations are taken into account is a selective process in everyday practice, embedded in existing organisational routines. It also suggests that some considerations are taken into account only implicitly, as it appears to be the case with legitimacy.

2.6. CONCLUSION

Climate adaptation is a relatively new policy domain, bringing about issues relating to responsibility divisions between the public and private sector. Scientific literature on the public-private divide in climate adaptation is still rather fragmented and limited in scope. Many scholars tend to focus on issues of market failure and equity in relation to public responsibility (Berkhout, 2005; Eakin and Lemos, 2006; Mendelsohn, 2006; Adger et al., 2009; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010), and, for instance, a recent article by Tompkins and Eakin (2012) explores the potential for the private provision of adaptation goods as well as the institutional mechanisms required for this. With the conceptual framework presented in this article, we present a comprehensive tool to discuss issues of the public-private divide in climate adaptation. In particular, the framework helps to systematically explore and identify a range of considerations in the public-private divide based on three competing rationales of public policy, i.e. the juridical, economic and political perspective. The framework is meant to analyse existing public-private arrangements for climate adaptation at the sub-national level. Such an analysis helps to identify the dominating considerations underlying certain divisions of responsibilities, why this might have occurred, and what the potential positive and negative consequences of these choices could be in the specific context of an adaptation issue. In applying this so-called 'explanation-oriented approach' of our framework to the case of green roofs as a specific adaptation measure in Rotterdam, we have revealed that the extent to which various considerations are taken into account is indeed a selective process, leading to inevitable trade-offs in decisions on responsibilities. It also shows that, in practice, responsibilities might be constrained by institutional settings and policy routines, limiting the conscious (re)consideration of responsibility

divisions among public and/or private actors (in line with theories of path dependency as described by, for instance, Pierson, 2000 and Howlett, 2009). Such an analysis might ultimately foster a conscious search for alternative governance arrangements.

Alternative governance arrangements might be developed by applying the so-called 'design-oriented approach' of our conceptual framework. It facilitates a conscious deliberation process of alternative responsibility divisions and thus helps overcome institutional lock-ins. It is certainly not meant to create an 'ideal' governance arrangement by suggesting that all six considerations should be equally weighted. The framework is only meant to give explicit attention to each consideration, thereby fostering well-informed choices in the public–private divide. Such an alternative to the green roof arrangement discussed in the previous section could entail a more pronounced role for governments by introducing a performance target for rainwater retention through the national building code/ local by-law. The government consequently monitors the extent to which these targets are met, and might opt for a penalty system in case of non-compliance. Here, considerations of fairness (each developer is subject to the same regulation), accountability (responsibility divisions are clear; both public and private actors can be held accountable) and efficiency (it stimulates innovation and variety in adaptation solutions; developers decide which water retention measure best suits their circumstances) could underlie such an arrangement of responsibilities. It is apparent that the extent to which certain considerations matter in a governance arrangement may differ from case to case, depending on the context of the adaptation issue. These considerations may also change over time, as the context of the governance issue alters. Thus, the framework might assist policy practitioners in discussing and designing novel governance arrangements for novel adaptation issues, such as, for instance, the development of adaptive flood risk measures in un-embanked areas. We argue that the more controversial and complex an adaptation issue, the more desirable it is to make well-informed choices in the public–private divide.

On the continuum from government to governance, every type of governance arrangement has its advantages and disadvantages, and this affects its effectiveness (does it work?) and its fairness and legitimacy (what are the normative consequences?). In providing a tool to systematically explore the scope of arrangements for specific adaptation issues, our framework could be a useful starting point for future empirical research on governance arrangements for climate adaptation as a relatively new environmental policy domain. Attention should be paid to exploring arrangements in different macroeconomic, political and cultural contexts, as each context might trigger specific considerations and hence might require its own appropriate mix of responsibilities. Therefore, international research comparing governance arrangements in various countries/regions is encouraged. Empirical research can also help unravel the inherent tensions among considerations, and in particular how these are resolved in practice. And finally further research may help widen the applicability of the framework to the analysis of multi-level governance issues (the division of responsibilities among different levels of public actors), as well as to the evaluation of the performance of governance arrangements (in which case, the considerations act as assessment criteria).

END NOTES

1] *Literature suggests there are many other factors of relevance to adaptation such as sense of urgency, availability of resources, political will, etc. (for an overview, see Runhaar et al., 2012). However, these are cited to act as stimulus or barrier to agenda setting and adaptation action rather than directly influencing the public–private divide.*

2] *According to Peter (2010) consent is one source of political legitimacy. Another source of legitimacy is obtained through traditional interest representation by democratically elected people. A more legal interpretation resembles the rule of the law, one of our juridical considerations. An overview of the various interpretations of legitimacy is given by Bekkers and Edwards (2007).*

3] *The same law also places responsibilities on property owners for the adequate processing of rainwater on their property, as long as this can be 'reasonably' expected from them. Since this version of the law is relatively new, jurisprudence still needs to be built on how these responsibilities of municipalities and property owners translate into practice.*

4] *Flood safety issues stemming from sea level rise and increased river discharge levels face equal uncertainties, but the risks in terms of material and immaterial damage are substantially higher. In this case controversies might be high, for instance regarding the levels of residual flood risk stakeholders are willing to accept.*












3 WHO GOVERNS CLIMATE ADAPTATION?
GETTING GREEN ROOFS FOR STORM-WATER RETENTION OFF THE GROUND

ABSTRACT Green roofs are an innovative solution for urban storm-water management. This paper examines governance arrangements for green roofs as a 'no-regrets' climate adaptation measure in five cities. We analysed who governs green roofs, why and with what outcome. Our results show that hierarchical and market arrangements co-exist in the various stages of the policy process. Cities with a higher prevalence of hierarchical arrangements have substantially higher implementation rates for green roofs. Although private sector involvement is crucial for raising efficiencies, a significant level of public responsibility taken by local governments appears to be salient for unleashing the potential of green roofs.

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Photos courtesy of Optigroen (www.optiegroen.nl), photography Gunter Mann

3.1. INTRODUCTION

Adaptation to the impacts of climate change has gradually emerged as a new public policy field (Biesbroek et al., 2010; Preston et al., 2011). The governance of adaptation is inherently a multi-level challenge, requiring action from the global to the local level (Adger et al., 2005; Urwin and Jordan, 2008). The local/regional level is particularly emphasised because of the spatial diversity of climate-induced risks and the belief that these risks should be dealt with by those directly affected, and because many adaptation solutions require changes in the physical environment, which is usually the responsibility of local/regional governments (e.g. Stjorbjörk, 2007; Lundqvist and Von Borgstede, 2008; Biesbroek et al., 2009a; Saavreda and Budd, 2009). Urban areas are generally regarded as relatively vulnerable to the impacts of climate change because of their accumulation of social, cultural and financial capital, their common location in delta regions, and their already overburdened environments (e.g. Lindley et al., 2007; Carter, 2011; Corfee-Morlot et al., 2011; Romero Lankao and Qin, 2011). Cities are more prone to surface water flooding from ever-increasing levels of impervious surfaces and decreasing levels of green space, and this is expected to be exacerbated by increased precipitation rates (Mees and Driessen, 2011). Although increasing adaptation activity is being witnessed in Western cities (e.g. Tang et al., 2010; Carter, 2011; Mees and Driessen, 2011), in practice local government activities often come down to 'no-regrets' measures that serve multiple societal goals (Matzarakis and Endler, 2010; Tompkins et al., 2010; Berrang-Ford et al., 2011; Runhaar et al., 2012).

Green roofs (also known as vegetation or living roofs) are an example of such a no-regrets adaptation measure, and have therefore become increasingly popular in European cities and more recently in North America (Oberndorfer et al., 2007; Dvorak and Volder, 2010). They offer several public eco-system services (enhancing biodiversity, contributing to urban pollution abatement and better air quality, and mitigating the urban heat island effect), thereby contributing to overall urban sustainability. Green roofs are able to store rainwater and reduce surface water run-off and sewage overflows from increased precipitation rates (Oberndorfer et al., 2007)[5]. They form an innovative alternative to more conventional storm-water measures such as sewage networks and drainage canals. Green roofs also deliver private benefits to property owners (e.g. energy savings, thermal comfort, aesthetics)[6].

Given the extent of private property, city governments need to involve the private sector to secure sufficient instalments of green roofs for storm-water retention purposes, in particular in areas where densities are high, (green) space is scarce and the capacity of the traditional sewage systems has reached its limits. Furthermore, involvement of the private sector might raise efficiency levels, as many economists and governance scholars assert (e.g. Lemos and Agrawal, 2006; Baarsma et al., 2010). But what types of governance arrangements between public and private actors are actually employed to stimulate the uptake of green roofs? In this paper we address how the implementation of green roofs is governed in practice, by whom, for what reason, and with what outcome. The majority of articles touching upon the public- private divide in climate adaptation is conceptual, and tends to employ a theoretical-economic perspective (see for instance Berkhout, 2005; Mendelsohn, 2006; Stern, 2007; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010). Our focus is on an empirical exploration and analysis of governance arrangements for climate adaptation. This is done through an in-depth comparative case study of five Western frontrunner cities active in green roof policies, but with different arrangements: Basel, Chicago, London, Rotterdam and Stuttgart. Our aim is to generate knowledge on the governance of adaptation as such, and specifically for green roofs as

a popular no-regrets adaptation measure. In doing so we hope our findings will contribute to the environmental governance literature in general. While there is an ongoing scientific debate about the shift from government to governance, as well as its consequences, several empirical studies show that this shift does not necessarily occur in practice in all policy domains (Howlett et al., 2009; Weber et al., 2011; Driessen et al., 2012). Our empirical research will provide insights into whether such a shift actually occurs in green roof arrangements. The second section discusses the analytical framework used; the third section describes the research method and case selection. The fourth section gives a brief overview of the five case studies. The fifth section provides the results, while the final section discusses the main conclusions in light of the environmental governance literature.

3.2. GOVERNANCE ARRANGEMENTS IN THEORY

3.2.1. ENVIRONMENTAL GOVERNANCE ARRANGEMENTS

Governance as a new way of steering has become a popular concept in social sciences. (Environmental) governance theorists and political scientists have expressed their views on how the state, market and civil society should share responsibility for public issues. They agree that it concerns governing styles in which the boundaries between public and private sectors are blurred (Stoker, 1998, p. 17). There appears to be a general consensus about the need for involvement of non-state actors in environmental governance. However, there is some debate about which governance modes or arrangements (both referring to some form of organisation between state and non-state actors) are feasible and effective in dealing with the complexity, uncertainty and ambiguity that characterise many environmental issues, including adaptation to climate change. In addition, there is debate about the normative consequences of these arrangements in terms of fairness, legitimacy, etc. On the one hand they are said to increase commitment to the implementation of environmental measures; on the other hand they are alleged to cause an implementation deficit because they lack authoritative power (e.g. Driessen and Glasbergen, 2000; Lemos and Agrawal, 2006). Likewise, they are believed to raise legitimacy and accountability because of the inclusion of a plurality of environmental values, while others believe they create a democratic deficit because of exclusive representations and the potential dominance of powerful interests (e.g. Bogason and Musso, 2006; Lemos and Agrawal, 2006; Juhola and Westerhof, 2011).

Governance arrangements can range from top-down government on the one end of the scale to societal self-governance on the other end. Between these extremes, various configurations can be observed, referred to as hybrid (denoting various types of co-operation among the three spheres of state, market and civil society, cf. Lemos and Agrawal, 2006) or interactive (denoting a more specific type of co-operation between public and private actors in the form of non-hierarchical policy networks, cf. Kjær, 2004). Different classifications of ideal-typical governance arrangements along varying dimensions have been presented in literature (see e.g. Treib et al., 2007; Hysing, 2009; Arnouts et al., 2012; Driessen et al., 2012). In line with several authors (Treib et al., 2007; Driessen et al., 2012), for this research we classify a governance arrangement according to (1) the division of responsibilities among state and non-state actors along the stages of the policy process (also denoted as the actor base/ politics); (2) the steering strategy employed to guide actors (denoted as the institutional structure/polity); and (3) the policy instruments used to support adaptation action (denoted as the content/policy). We interpret responsibilities simply as tasks that an organisation or actor has, whether

public, private or a public-private constellation, and for which it can be held accountable. Wherever this is instrumental for the analysis, we will make a distinction between self-initiated responsibilities (autonomously taken on by an actor), and mandated responsibilities (enforced through regulations). Concerning steering strategies, most governance scholars distinguish between hierarchical governance (or hierarchies, top-down government), interactive governance (or networks), and market governance (or self- governance) (see e.g. Thompson et al., 1991; Kjær, 2004). Hierarchical governance arrangements tend to depend on chains of command and control with power as the medium of exchange. Public actors, i.e. government bodies at various levels and sectors, are responsible for policy making. Market arrangements apply prices as the medium of exchange. In this case the private sector regulates itself; private actors assume responsibility and initiate policy to regulate competition (and to pre-empt public policy). Interactive arrangements depend on dialogue, deliberation and collaboration between public and private stakeholders with trust and reciprocity as a medium of exchange (Kjær, 2004). Here responsibility is more of a joint public-private effort. Finally, we classify policy instruments according to legal, economic and communicative instruments, depending on the type of incentives used to influence behaviour; respectively, regulations (sticks), financial incentives (carrots), and information and education (sermons) (see e.g. Glasbergen 1992; Bemelmans-Videc et al., 1998). Each instrument type can be utilised for each steering strategy, although specific combinations often tend to go together (hierarchical steering and legal instruments; market steering and economic instruments; network steering and communicative instruments). We have used the above classifications to analyse the governance arrangements for green roofs (see Table 3.1). It is important to note that these arrangements are not static; they might vary per stage in the policy process from policy making, policy implementation, and policy evaluation to policy maintenance.

Dimension	Hierarchical governance	Interactive governance	Market governance
Actor base	Predominantly public responsibilities	Shared responsibilities among public and private actors	Predominantly private responsibilities
Steering strategy	Predominantly hierarchical	Steering through policy networks	Predominantly through market steering
Policy instruments	All instruments (legal, economic and communication) with preference for regulations	Mostly communicative instruments and negotiated agreements	Mostly economic and voluntary instruments
Considerations	Predominantly Securing adaptation action (as specification of effectiveness), Fairness and Rule of Law	Predominantly Legitimacy, Accountability	Predominantly Efficiency

Table 3.1: Ideal-typical governance arrangements and their key considerations

3.2.2. *RATIONALES FOR GOVERNANCE ARRANGEMENTS*

If we aim to explain why different governance arrangements emerge and dominate an environmental issue such as climate adaptation, we need to understand their underlying rationales. We assume that differences in governance arrangements are influenced by different rationales underlying the public-private divide. In other words, the decisions for public and/or private responsibilities are built upon different considerations underlying that decision. The dominance of one or a few considerations might have consequences for responsibility divisions among public and/or private actors and the chosen steering strategy and policy instruments. Inspired by the JEP (Juridical-Economic-Political) triangle of Nelissen (2002), which applies a multiple perspective for analysing governance arrangements, we have derived considerations from three scientific disciplines that have traditionally dealt with the public-private divide. The resulting competing juridical, economic and political considerations are portrayed in Figure 2.1.

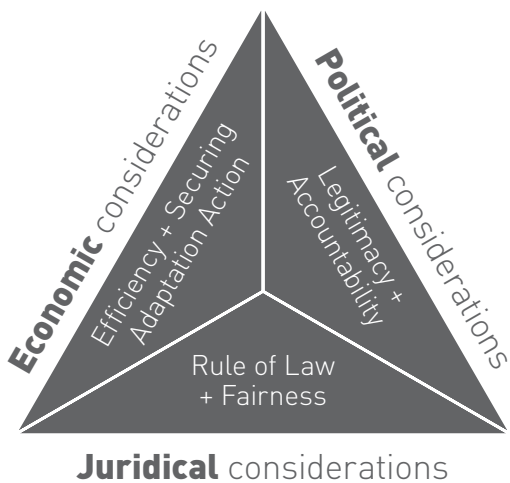


Figure 2.1: Considerations framework inspired by Nelissen (2002)

The juridical perspective takes the influence of laws, regulations, principles and norms on the public-private divide as the focal point. Two key considerations have been derived: 'rule of law' and 'fairness'. Rule of law is about conforming to extant law; about abiding by regulations to which the adaptation issue is subject (Driessen and Van Rijswick, 2011). National regulations and constitutions often assign duties of care to public authorities, certainly in cases of national security, as is witnessed in many countries for flood management. Fairness relates to a reasonable distribution of costs, benefits, risks and responsibilities (Aakre and Rübbelke, 2010b). In particular, a fair division of adaptation goods among beneficiaries is important, much more so than in mitigation from which everyone benefits. Fairness often leads to public responsibilities for a fair application of the precautionary principle (intergenerational equity) and compensation principle (spatial and socio-economic equity), to safeguard an equitable distribution of burden sharing in society (e.g. Eakin and Lemos, 2006; Osberghaus et al., 2010).

The economic perspective sees the balance and distribution of costs and benefits as the main influence on the public-private divide (Mendelsohn, 2006; Aakre and Rübbelke, 2010a). The first economic consideration is 'efficiency'. Efficiency is about the optimum allocation of scarce resources, about supplying an adaptation good at the lowest cost, and as such is a key rationale underlying economic policy instruments. This is based on the premise of economists that markets are generally more efficient in allocating scarce resources and in spurring innovations (e.g. Baarsma et al., 2010). The second economic consideration refers to effectiveness, which is about the attainment of pre-defined goals. For this research effectiveness is framed as 'securing adaptation action', which refers to the supply of sufficient levels of an adaptation good (in our case green roof instalments). In instances of market failure, governments might need to step in by providing the adaptation good themselves, or by stimulating private adaptation action (e.g. Berkhout, 2005; Mendelsohn, 2006; Aakre and Rübbelke, 2010a).

The political perspective is based on trust and reciprocity to bridge the public-private divide (Adger et al., 2009; Hobson and Niemeyer, 2011). It is represented by the considerations of 'legitimacy' and 'accountability'. Legitimacy is about the support of stakeholders and society at large for an adaptation goal, solution and the decision-making process itself. This is based on the idea that a broadened democracy can be realised by involving different actors beyond the state[7]. In this view the social complexity of adaptation issues requires interactive arrangements through deliberative processes with the extensive participation of a wide range of stakeholders, including those affected by climate change (e.g. Hulme et al., 2007; Adger et al., 2009). Accountability is about clarity of responsibilities and transparency of information on the content and process of policy making. It requires transparency in decision-making processes and open access to, and sharing of, information among actors so that they can be held accountable; it might therefore require interactive governance arrangements, since networks are often claimed to foster communication, information and knowledge dissemination (e.g. Bogason and Musso, 2006; Bodin and Crona, 2009). The predominant considerations of the three ideal-typical governance arrangements are included in Table 3.1.

Of the six considerations, we expect 'securing adaptation action' to be particularly relevant for green roof arrangements, owing to the occurrence of market failure (to link up with economic theorists). There is a considerable degree of uncertainty deterring private actors from installing green roofs. Uncertainty is generally acknowledged as a key barrier to effective adaptation action (Füssel, 2007; Urwin and Jordan, 2008; Biesbroek et al., 2009b). With green roofs this uncertainty revolves around the limited knowledge of their properties, costs and monetised benefits, and hence uncertainties with respect to the returns on investments, given the upfront costs of installation. Green roofs thus represent a case of positive externality; those who implement them are generally unable to retrieve the benefits they generate for society as a whole. They require the stimulation of positive behaviour. Therefore, our hypothesis is that there will be some degree of public responsibility in order to provide sufficient levels of green roof instalments. Furthermore, we hypothesise that a hierarchical governance arrangement, which is able to employ more coercive steering by using legal instruments as a principal resource to guide adaptation action, will lead to higher levels of green roof installations (Glasbergen, 1992).

3.3. RESEARCH METHOD

We argue that a comparative case study approach is useful for our research, because the use of several cases helps us to explore and clarify differences in governance arrangements for climate adaptation, and provides greater weight to the conclusions (Pickvance, 2001; Campbell, 2003; Burnham et al., 2008). One common use of comparative analysis, as described by Pickvance (2001, p. 15) is "to examine a small number of empirical cases holistically to grasp the causal processes leading to observed similarities and differences". The comparison among five cities allows us to find patterns of similarities and differences among governance arrangements for green roofs. The cities were strategically selected for a number of commonalities and one key difference. In terms of commonalities, first of all they face similar vulnerabilities to surface water flooding due to their high densities, and storm-water management has been a key reason for introducing a green roof policy (in addition to other policy objectives). Second, they are considered leaders in green roof implementation in their countries in terms of square metres realised, and/or in their ambition for green roof instalments (Taylor, 2007; Brenneisen, 2010; Carter and Fowler, 2008; Carter, 2011; Mees and Driessen, 2011). Third, they have the authority to independently develop green roof policies in their jurisdictions. This means that they have the freedom to initiate and develop green roof policies independently from national governments (although national regulations might support or stimulate local governments to develop policy). Finally, they are all Western democratic cities subject to similar neo-liberal tendencies in recent decades, albeit to different degrees. Therefore, responsibilities are often not set in stone and are rather diffuse in practice. The most relevant difference is that the cities vary in the types, duration and breadth of policy instruments used to promote the uptake of green roofs, a characteristic we were able to discover via desk research (see the fourth section for a brief overview). We assumed that these represented key differences in governance arrangements and their underlying considerations.

We used two methodological approaches as described by Urwin and Jordan (2008). What they denote as a 'top-down' perspective was conducted through a content analysis using various sources, such as official policy documents for green roofs and/or storm-water management, staff reports from local administrations, and non-peer-reviewed research reports on green roofs. These documents gave insight into rules and policies that give direction and set objectives that should lead to adaptive action on the ground. The content analysis also yielded insights into the formal responsibilities for local (rain) water management, and allowed us to scan the different policies employed, based upon which we made the final selection of case studies. This was complemented by a 'bottom-up' perspective, provided by conducting interviews with key public and private stakeholders in each city. This yielded additional insights into how policy goals are translated on the ground, by drawing upon the expertise and experience of these stakeholders. Furthermore, it generated knowledge with respect to the considerations underlying the governance arrangements. The interviews were conducted face-to-face with the exception of three, which were conducted by telephone. The interviews were recorded and transcribed. A stakeholder analysis was done to obtain an overview of the most relevant stakeholder types. Consequently respondents were recruited using the snowball technique; these consisted of representatives of policy officers in various public administration sectors (such as water and environmental management, and spatial planning), and of real estate companies/developers, housing corporations, architects, green roof industry associations, and finally green roof consultants and politicians (interviews with 58 respondents in total, see Table 3.2 and Appendix 3). We used a semi-structured interview guide which aimed to obtain insight into responsibilities and considerations via spontaneous expressions of the respondents, after which specific questions were addressed to verify and classify the considerations according to the framework. We deduced the dominant considerations from the responses of the interviewees based on our consolidated interpretations.

There were no major differences in answers obtained. Moreover, the results were validated with several key respondents via verification of case study reports, and via an interactive workshop in one city (Rotterdam).

CITY	PUBLIC	PRIVATE
Basel	4	8
Chicago	7	4
London	7	4
Rotterdam	8	8
Stuttgart	5	3
Total	**31**	**27**

Table 3.2: Overview of respondents per city

3.4. GREEN ROOF POLICIES OF BASEL, CHICAGO, LONDON, ROTTERDAM AND STUTTGART

Since the mid-1990s the Canton of Basel has employed several policies during consecutive periods of time to promote green roofs. Two large subsidy programmes were developed for green roofs; according to respondents, these seem to have brought down the costs of instalments, and served as a testing period for green roof suppliers and architects to gain experience in the field. The mandatory requirement for green roofs on new and renovated buildings through the local building code, which came into force in 2002, was accepted after this test period without major resistance and has been a major driving force for greening Basel's flat roofs ever since (Brenneisen, 2010; BPG, 2011). Current attention focuses on the quality of green roofs, in particular for biodiversity reasons; prescriptions require a minimum depth of substrate layer (of 10 cm) and a specific 'Basel mix' of soil and seeds, adapted for native plant species. Nevertheless, green roofs remain important for storm-water management, and hence a 50% reduction of storm-water charges is given if a property has a green roof.

The City of Chicago commenced its green roof policy in 2001, when the Mayor pushed for the installation of a demonstration roof on the City Hall. Green roofs are part of Chicago's Climate Change Action Plan for both storm-water and heat stress management (CCAP, 2008). They are promoted through performance-based regulations for storm-water management, energy efficiency and landscaping (CECC, 2008; CLO, 2000; CSWO, 2006), and through a mandatory requirement for all new buildings that receive city funding and that are subject to review (CSDP, 2003). Direct financial incentives play a modest role in the adoption of green roofs in Chicago. There are indirect financial incentives: a density bonus (developers are allowed to build more units per square footage if their building has a green roof), and the Green Permit Program (CGPP, 2010). The latter involves a fast-track permissions process and a fee reduction for developers if they install a green roof.

Compared to the other cities, London has a rather restrained policy. Since 2004 a green roof policy has been integrated into the Greater London Authority's London Plan, which encourages major developments to incorporate living roofs where feasible (LP, 2008, p. 210). In practice this means that developers need to justify why they do not install green roofs. Local authorities have the authority to require green roofs as 'material consideration' in planning applications, which most tend to do on a case-by-case basis.

Since 2006 the City of Rotterdam has integrated targets and policies for green roofs as a storm-water management measure in three municipal strategy documents, and has agreed upon these targets with the regional water boards (RCV, 2007; Rotterdam, 2007; RCP, 2010). An incentive programme with substantial budgets available has been running since 2008; a subsidy of €30 per square metre is provided to businesses and citizens, which should cover about half of the installation costs. In support of this, a communication campaign was launched, as well as a demonstration roof which acts as a visitor centre.

Although in Stuttgart green roofs were installed throughout the twentieth century, actual green roof policy only came into existence in 1986. Stuttgart employs a range of policy instruments to promote green roofs. First, based on the federal building code (FGBC, 2011) German municipalities are authorised to make green roofs mandatory on all new builds with flat roofs via binding land-use plans, which Stuttgart in effect implements for those parts of the city subject to local development plans. In other areas green roofs on new buildings are stimulated via a density bonus for developers on a case-by-case basis. Second, green roofs on existing buildings are financially stimulated through a subsidy programme, which ran for 15 consecutive years until 2009, and through a 50% reduction of the storm-water fee. Third, both the public authorities and the green roof industry itself engage extensively in education and information campaigns to promote green roofs. See Table 3.3 for an overview of the policy mixes per city.

3.5. GOVERNANCE ARRANGEMENTS IN PRACTICE

3.5.1. *SCOPE OF GREEN ROOF ARRANGEMENTS*

Table 3.4 provides an overview of governance arrangements throughout the policy process and their underlying rationales for the five cities studied. It shows the common hierarchical and market governance arrangements co-existing in the cities. This reflects experiences in urban water management, which is dominated by combined approaches of hierarchical and market-based governance (Van de Meene et al., 2011). Hierarchical arrangements are prevalent in each city in the early stages of the policy process: a wide adoption of the green roof technology among private actors does not happen autonomously, and hence local authorities aim to secure sufficient levels of adaptation action by initiating some form of green roof policy. This corresponds with our first hypothesis in the second section of the paper. Market arrangements as a form of self-regulation among private actors are more prevalent in the policy implementation, evaluation and maintenance stages, driven by the rationale of efficiency. With the exception of one city (Basel), interactive arrangements with joint responsibilities are lacking. A major difference across the cities is that, in Basel and Stuttgart, hierarchical arrangements with dominant public responsibilities, hierarchical steering and the utilisation of legal instruments are witnessed throughout the policy process. This is instigated by a stronger prevalence of the considerations of securing (adaptation) action and fairness. We will now explore the hierarchical, market and interactive arrangements identified in more detail, and will clarify them in terms of their underlying considerations.

Table 3.3: Overview of policy mixes in the five case studies

Policy instruments	Basel	Chicago	London	Rotterdam	Stuttgart
LEGAL INSTRUMENTS (STICKS)					
Technology based regulation (e.g. building codes)	Green roofs are mandatory for every unused flat roof according to the building code of the Basel Canton (Par.72 of the Bau und Planungsgesetz since 2002); additional regulation prescribes quality standards	Mandatory green roofs for new buildings which receive city funding (Sustainable Development Policy since 2003)	No requirement, but based on the green roof policy in the London Plan developers should provide reasons for not installing a green roof for new developments (since 2004)	None	Mandatory for flat roofs on new buildings for areas with binding land-use plans (Federal Building Code; Local development Plans since 1986)
Performance based regulation (e.g. LEEDS)	None	Green roofs count as a measure for achieving targets for stormwater retention, energy conservation and beautifying landscapes according to several ordinances of the Chicago Municipal Code (Stormwater Ordinance since 2006, Energy Conservation Code since 2008 and Landscape Ordinance since 2000)	None	None	None
ECONOMIC INSTRUMENTS (CARROTS)					
Direct financial	1) 50% reduction of storm-water fee in case of a green roof 2) Two subsidy programmes: one in 1995/1996 of 0,8 mio Swfr. (20 Swfr/m2 for all buildings), and one in 2005/2006 of 1,2 mio Swfr. (30-40 Swfr/m2 only for existing buildings)	Limited budgets available through: 1) Green Roof Grant Program 2005-2007 2) Green Roof Improvement Fund 2006-2009 3) Illinois Green Roof Grant Program 2009	None	Since 2008 to date a substantial budget of around 1 mio Euro/ year is available through subsidy programme for both new and existing buildings (30 Euros/m2)	1) Between 1986 and 2009 a modest budget was available for subsidizing green roofs not subject to the mandatory requirement 2) Storm-water fee reduction
Indirect financial	None	1) Density bonus 2) Expedited permit process: fast permitting & permit fee reduction (Green Permit Program since 2004)	None	None	Density bonus on a case by case basis
COMMUNICATION INSTRUMENTS (SERMONS)					
Information & education	1) Public promotion during the subsidy programmes with a "best looking green roof contest" 2) Various public leaflets 3) Ongoing education & information through the Swiss Green Building Council, and development of a quality label for green roof suppliers	1) Public demonstration roof on city hall 2) Public Green Tech Resource Center for information to citizens	Ongoing education/ information through living roofs.org (green roof consultancy)	1) Public demonstration roof combined with an information centre since 2010 2) Public communication campaign 2009-2011 (posters, leaflets) 3) Ongoing efforts of the green roof industry (association), among which development of quality standards	1) Various public demonstration roofs 2) Public "green hotline" and consultation 3) Various private partnerships and green roof industry engage in information and education programmes, and development of quality standards/ industry norms

Table 3.4: Overview of governance arrangements and their underlying considerations

Actors	Considerations	Roles per stage	Rationale for considerations
HIERARCHICAL GOVERNANCE			
Local authorities	Economic: Securing adaptation action	Policy making: agenda setting, knowledge creation & policy initiation	Lack of sufficient incentives for private actors to take water retention measures/install green roofs; uncertainty regarding climate effects, impacts and the cost-benefit ratio of green roofs
		Policy implementation: financing & implementation of green roofs	Deficit of instalments on privately owned buildings; showcasing green roofs on important city buildings; high upfront costs for private actors, refraining them from action
		Policy evaluation: quality control (Basel only)	Without quality control developers/green roof suppliers would cut costs on quality; a higher quality of substrate reduces maintenance costs later on
	Juridical: Fairness	Policy making: policy initiation & target setting	Uncertainty regarding the extent of urban flooding and effect of storm water measures encourages public actors to take the precautionary principle into account on behalf of present and future generations
		Policy evaluation: monitoring (all cities) & enforcement (Basel and Stuttgart)	Guarantee of a level playing field: no preferential treatment; the same burden for everyone (Basel and Stuttgart); those that receive benefits from public policy should maintain their end of the bargain (Chicago/Rotterdam)
	Political: Legitimacy	Policy making: knowledge creation & strategy making (Basel & Stuttgart)	Consultation processes with scientists, green roof suppliers, and consultants
	Juridical: Rule of law	Policy making: policy initiation (Basel, London, Rotterdam)	Acts that place duties for flood management on local authorities (Bundes Gewässerschutzgesetz 814.20 (art. 7); GLA Act 2007, Flood & Water management Act 2010, Dutch Water Act 2008)
MARKET GOVERNANCE			
Green roof industry (individual/partnerships)	Economic: Efficiency	Throughout the policy process	Raising of awareness for and knowledge of green roofs. Creation and securing of market demand and customer satisfaction; innovation in green roofs to bring down their costs and raise their benefits
Property owners	Economic: Efficiency	Policy implementation: financing & implementation of green roofs	Green roofs have many co-benefits, without which they would not be cost-effective; in Basel and Stuttgart cost levels are already optimal/mature market
		Maintenance	Maintenance clause as part of contract with green roof suppliers to earn additional money and for quality control; in Basel high quality standards at installation significantly reduce maintenance costs
Consultants/ecologists	Economic: Securing (biodiversity) action	Policy making: agenda setting & knowledge creation (Basel & London)	Through active lobbying and conducting research they managed to convince local authorities of the need to initiate green roof policy for biodiversity reasons
INTERACTIVE GOVERNANCE			
Schweizerische Fach-vereinigung Gebäudebegrünung	Economic: Efficiency	Policy making: agenda setting; Policy implementation: info provision; Policy evaluation: quality labelling	Creation and securing of market demand and customer satisfaction; promotion of green roofs, with specific emphasis on quality guarantees. Currently a new SIA norm (no. 312) is developed for green roofs, as a strong national guideline for architects to conform to

3.5.1.1. Hierarchical arrangements

All five cities show hierarchical arrangements in the policy making stage. Public authorities have taken on the responsibility (self-initiated) for agenda setting, knowledge creation, initiation of green roof policies, and for target setting. This means that various municipal authorities from the five cities have these tasks in common[8]. The prime motivation for this public responsibility is that local authorities want to ensure green roof installations are encouraged to secure adaptation action; without some form of government intervention, private actors will not take sufficient voluntary action. A second consideration of local authorities is fairness; the precautionary principle is taken into account in dealing with uncertainties regarding the impacts of increased precipitation rates for current and future generations. Rule of law is a third consideration, which has some bearing in three of the cities in initiating policy. National/federal Acts place duties of care for flood management on the local authorities of Basel, London and Rotterdam (so this is a case of mandated responsibility), and hence they might be held liable for flood damages and forced to provide compensation (BSG, 1991; GLA, 2007;WGW, 2008; WW, 2008; FWM, 2010).

In all cities the (self-initiated) responsibility for strategy making also rests with these public authorities: they decide upon the use of green roofs as a measure for storm-water retention, and upon the type of policy instrument(s) introduced to promote the uptake of green roofs. However, the cities do differ in the types and breadth of instruments used. Basel and Stuttgart authorities employ the broadest mix: they use coercive regulations to make green roofs mandatory on new buildings, while simultaneously rewarding green roof installations with financial incentives (storm-water fee reduction and, in the past, also with subsidies). According to respondents, this combination of instruments has helped to make the regulation acceptable. Furthermore, in Basel the subsidies and information/education campaigns preceded the regulation, which also helped to break down resistance. Both cities have very strong ulterior environmental motives for adopting the regulation: biodiversity in Basel and air quality in Stuttgart. This made the consideration of securing (adaptation, biodiversity, clean air) action even more prevalent. By contrast, Chicago and Rotterdam mainly use voluntary instruments to induce private behaviour; financial incentives are complemented by communication and education. London is the most restrained, and mainly relies on communication instruments.

Consistent with their policies, Basel and Stuttgart show a hierarchical arrangement in the evaluation stage of the policy process; the local authorities take on responsibility for monitoring and controlling green roof installations. In Basel the Stadtgärtnerei (urban green department) checks the required architectural roof plan of each new or renovated building, and performs a physical inspection upon completion, taking the quality guidelines into account. In Stuttgart a building can (but does not need to) be inspected by the Department of Building Law. The main consideration for performing this task is fairness; since green roofs are mandatory, enforcement mechanisms have been put in place to guarantee a level playing field for all developers. In the other three cities the local authorities' responsibilities in the evaluation stage are limited due to administrative and financial constraints. They put some effort into keeping records of green roof installations and subsidies provided, but there is no physical check of actual instalments.

3.5.1.2. Market arrangements

Market arrangements are witnessed throughout the policy process, but they really dominate in the implementation and maintenance stages. Private actors engaged in green roofs are numerous, and can broadly be divided into those with primary commercial interests (consultants, architects, green roof suppliers, horticulturists), and property owners (developers, real estate companies and civilians).

In all cities the most active stakeholder group with high interests at stake is the green roof industry, which has taken on many responsibilities (self-initiated). They can operate individually, as an industry association, or in private partnerships with gardeners, landscapers, roof contractors and consultants, in order to bring together the expertise of different professions. In the policy-making stage they lobby to get green roofs on the agenda of local authorities, architects and the like, and they are very active in research. In Stuttgart, for example, various private partnerships (such as the Green Roof Industry Association FBB, the German Gardener Association DDV, and the German Landscape Research, Development and Construction Society FLL) were instrumental as agenda-setters and knowledge brokers in advocating the adoption of green roofs. In the rest of the policy process the green roof industry's most prominent (self-initiated) responsibilities are in providing and distributing information regarding the beneficial properties of green roofs, and their cost-benefit ratios, in the actual installations, and finally in the maintenance of green roofs through guarantee clauses in purchase agreements. Steering happens autonomously through pricing and competition, and the instruments used are mainly communicative. In addition, some private regulation is also undertaken by the industry itself through the creation of quality standards and labels. Efficiency is the key consideration for local governments to leave these responsibilities with the green roof industry. Green roof suppliers have continuously sought for economies of scale, and have been driving down the prices for green roofs over the years, in particular in Basel and Stuttgart. They have realised substantial infrastructural efficiencies through innovations (e.g. pumps to blow substrates on the roof, development of light-weight and modular substrate systems). Furthermore, the industry has generated new products geared towards excellence in certain properties, such as special water retention roofs. In Chicago the industry is shifting attention to the revenue side of green roofs, by promoting them as urban roof top farms. As one respondent said: "green roofs can't be implemented on a broad scale unless they make financial sense" (green roof consultant in Chicago, 2011).

Property owners are another important group of private actors. Since most urban property is in private hands, their responsibility is most pronounced in the financing and actual instalments of green roofs on their properties, and in the maintenance of these roofs. However, there are major differences in the levels of private responsibility depending on whether green roofs are legally mandatory or not. Property owners in Basel and Stuttgart have a mandated responsibility since they have to comply with regulation, while in the other three cities instalments of green roofs very much depend on the extent to which property owners themselves are willing to take on this responsibility. Those that do, tend to be driven by motivations of sustainability, whether intrinsically or for strategic reasons to boost their green image. As one respondent put it "Green roofs are visible sustainability" (policy officer in Rotterdam, 2011). Barriers for taking on private responsibility are mostly financial, as stated before. Furthermore, there is the issue of 'split incentive', which deters landlords/housing corporations from investing in green roofs since they are often unable to pass on these costs to their tenants.

Another group of private actors, which has been quite actively involved in the policy-making stage in every city, are green roof experts/consultants. For example, in both Basel and London, ecologists were instrumental in getting green roofs on the local political agenda. They managed to exert a sizeable influence on the spread of awareness for, and knowledge of, green roofs in and beyond their cities, and can be regarded as 'policy entrepreneurs'. In Basel this ecologist conducted extensive research, which ultimately led to the creation of the Basel mix, and to the adoption by the Basel authorities of quality guidelines in order to guarantee lasting durability of the roofs. In London the ecologist was heavily involved in drawing up the policy in the London Plan, as well as in drawing up technical guidelines.

3.5.1.3. Interactive arrangements

The only prominent example of an interactive governance arrangement is the Swiss Green Building Association. This is a public-private partnership, which includes the Basel authorities, green roof suppliers and roof contractors. It has taken on responsibility for the promotion of green roofs in Switzerland, and for the development of quality standards. However, overall in all cities there is a lack of true joint public-private responsibility. In the early stages of the policy process the local authorities consulted the private sector, but the ultimate decisions regarding storm-water retention strategies and green roof policies remained in their hands. The extent of consultation does vary per city: in Basel and Stuttgart consultants, NGOs, economists and the industry were most actively involved. This was mainly meant to facilitate the practical implementation of the regulation and quality standards (not to co-decide). The consideration of legitimacy was the prime motivation of local authorities for seeking stakeholder input; it helped to reduce the resistance to the regulation. It is important to note that the political consideration of accountability was never mentioned as a motivation. When specifically addressed in the interviews, respondents would indicate that there was no real lack of transparency in responsibilities and decision-making processes, or a lack of access to information (although information from suppliers is not always trusted).

3.5.2. *EVALUATION OF GREEN ROOF ARRANGEMENTS*

The previous section highlighted a key difference in governance arrangements among the cities. In Basel and Stuttgart we have seen a dominance of hierarchical arrangements, since there was a greater consideration for securing adaptation action. Given the importance of this consideration, we will now address the question of which arrangement is most effective in securing sufficient levels of adaptation action, thereby reducing vulnerability to increased levels and intensities of precipitation. We could only tentatively answer this question because of a lack of data related to retention capacities of green roofs, as well as to their spread across the cities. We assumed that the available data on the amounts of square metres installed, related to the population size and the eligible roof space, would at least give some indication of implementation levels for the green roof technology and serve as a proxy for the performance of the arrangewe 3.5 shows that the arrangements in Basel and Stuttgart are by far more advanced in green roof implementation; almost one-quarter of the eligible roof space has been greened, while in the other cities this percentage is still below 1%. This supports the hypothesis that a hierarchical arrangement with coercive steering through regulations would perform better in securing adaptation action. Nevertheless, our research also suggests that the combination of regulations and financial incentives is particularly fruitful; the incentive might make the regulation more legitimate. Moreover, the findings indicate towards a need for local authorities to take responsibility throughout the whole policy process, and in particular in the evaluation stage resulting from the regulation. The hypothesis might therefore be nuanced with the addition of this specific instrument mix, and the need for explicit public responsibility in the monitoring, controlling and enforcement of green roof installations.

CHARACTERISTIC	BASEL	CHICAGO	LONDON	ROTTERDAM	STUTTGART
Policy since	1996	2003	2004	2008	1986
M2 installed by 2010	1.000.000	700.000	715.000	40.000	1.000.000
Inhabitants	170.000	3.000.000	7.800.000	600.000	600.000
M2 per capita	5,8824	0,2333	0,0917	0,0667	1,6667
% Of eligible roof space covered	25%	<1%	<1%	<1%	22%
Average price/m2 in Euros for a common green roof	25-35	40-80	60-65	50-90	10-40

Sources: The amounts of installed square metres, percentages of eligible roof space and average price levels are indicative and mainly derived from information of respondents. For Basel and Stuttgart, additional sources could be used such as Brenneisen (2010); Green roofs.com; Travellerspoint.com

Table 3.5: Implementation levels of the green roof technology

While the dominance of hierarchical arrangements provides a potential explanation, three other factors appear to have contributed to the high levels of implementation in Basel and Stuttgart. First, both cities are well known for their favourable green political climate, which stimulates the adoption of sustainable solutions by residents. Second, both cities have had policies in place substantially earlier than in the other cities. These preceding policies helped to build know-how and experience in green roof technology. Third, this long experience might explain why price levels are much lower than in the other three cities (see Table 3.5). Perceptions of respondents in Basel and Stuttgart confirm this. When asked about critical success factors, respondents mention the mandatory requirement, the green political climate, the independent jurisdictional status, and (in Basel only) the perseverance of the green roof consultant in promoting green roofs with the local authorities. According to respondents the requirement has not met with any major resistance in Basel; there was some resistance in Stuttgart but this was not severe enough to deter the local authorities from introducing the requirement. In fact, when asked about alternative arrangements in their cities to boost green roof technology, several respondents in London and Rotterdam indicated that a mandatory requirement would be the best way forward. They preferred the regulation rather than, for example, a subsidy, exactly because it creates an equal playing field and because it creates certainty over a longer period of time. Through regulation, cities can make use of urban regeneration cycles, which will foster organic growth of green roofs over time.

3.6. CONCLUSION

Green roofs represent a short-term no-regrets climate adaptation measure. In addition to raising urban sustainability more generally, they are able to buffer (excessive) rainfall in densely built urban environments without consuming space. Given the dependence of local governments on the private sector for green roof instalments on private property, and against the background of shifts in governance arrangements from government to governance, this paper has addressed the question of what type of governance arrangements between public and private actors have been put in place to stimulate the uptake of green roofs, for what reason and with what outcome.

Our research reveals that hierarchical arrangements dominate in the early stages of the policy process, with responsibilities being taken on by local authorities to secure adaptation action, as was seen in all five cities. The theoretical-economic literature on the public-private divide in adaptation supports this finding. This body of literature states that public adaptation goods need public responsibility (Berkhout, 2005; Mendelsohn, 2006; Stern, 2007; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010),

either to provide that good directly or to develop policy that motivates private actors to provide that good (also referred to as "privately provided adaptation public goods" in Tompkins and Eakin, 2012). We might conclude that green roofs essentially deliver a local public good, i.e. the provision of dry feet, clean air, biodiversity etc. Nevertheless, our findings also suggest when and in what way public responsibility is salient and effective. Based on the cases of Basel and Stuttgart, it appears that, for a wide adoption of the green roof technology, hierarchical arrangements are needed throughout the policy process: public responsibility is apparent in roles for local authorities in each stage, supported by a balanced policy mix that combines different policy instruments (in particular simultaneous use of economic and regulatory instruments) over certain periods of time (employing economic and communicative instruments prior to the introduction of regulation). The spread of the green roof technology in the other three cities is still in its infancy, suggesting that enhanced public responsibility might need to be considered. This is not to say that private responsibility does not matter. The results in all five cities clearly signal the added value of private involvement in raising efficiencies through innovation. In particular the green roof industry has been active in lowering prices and in raising the benefits of green roofs, so as to make them more accessible.

By concluding that a dominant public responsibility is both feasible and indispensable for getting green roofs off the ground, this research provides a nuanced view on the shift from government to governance. Several empirical studies on the governance of climate adaptation seem to hint in a similar direction; that the planning of adaptation is often government-led (e.g. Storbjörk, 2007; Johnson and Priest, 2008; Mees and Driessen, 2011). A recent study on network arrangements of public and private actors for climate adaptation by Juhola and Westerhoff (2011) also hints towards the need for a (prominent) role for national governments in the co-ordination of adaptation efforts across policy levels and sectors. Furthermore, our research suggests that hierarchical arrangements have several positive spin-offs. The cases of Basel and Stuttgart show that they might raise fairness because they guarantee a level playing field for all, and raise accountability in terms of clarity of responsibilities. Finally, these cases suggest that hierarchical arrangements can also be perceived as legitimate (in terms of receiving societal support) as long as the process preceding the arrangement is characterised by extensive consultation of key stakeholders (also referred to as throughput legitimacy).

This is not to say that alternative types of arrangements might not be feasible and effective for other climate adaptation issues. Issues that require adaptation to be mainstreamed with other policy sectors (Adger et al., 2005; Biesbroek et al., 2010; Berrang-Ford et al., 2011) increase the need for co-operation and hence might require interactive governance arrangements. Likewise, one could imagine market-governance to be more prevalent in sectors whose financial performance is very dependent on an adequate and timely response to climate change and whose goods can be traded, such as the insurance, infrastructure and agricultural sectors (Mendelsohn, 2006). In order to gain a more complete picture of the governance of adaptation, it will be necessary to explore the feasibility and effectiveness of governance arrangements along the continuum from government to governance. Future research could help discern the scope of governance arrangements for adaptation themes, such as water safety, heat stress and fresh water supply, on various geographical scales. This could help verify or falsify the need for a dominant public arrangement for climate adaptation. The analytical framework presented in this paper has provided a useful classification of these arrangements according to four parameters: responsible actors, steering strategy, policy instruments and key underlying considerations. We encourage other researchers to apply our framework for furthering empirical studies of governance arrangements for climate adaptation.

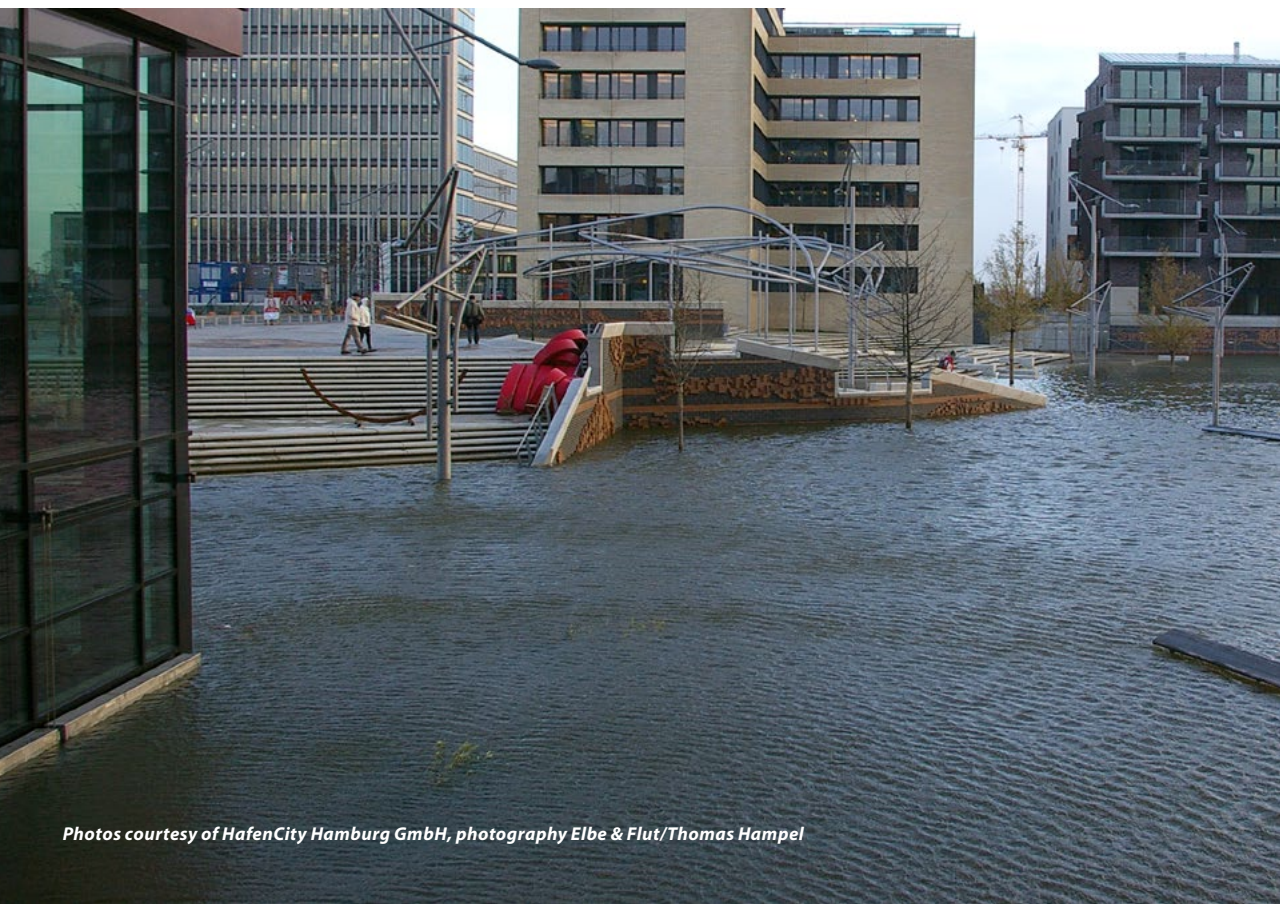
END NOTES

5] *Various studies show that rainfall retention of green roofs ranges from around 30% to nearly 90%, depending on the depth and material of the substrate, the vegetation used and the slope of the roof (see e.g. van Woert et al., 2005; Mentens et al., 2006; Villarreal, 2007).*

6] *Green roofs prolong the roof life (Wong et al., 2003; Kosareo and Ries, 2007); insulate buildings from both heat and cold, thus reducing energy bills for heating in the winter and air conditioning in the summer (Wong et al. 2003; Sailor, 2008); insulate against noise (van Renterghem and Botteldooren, 2011); have higher (perceived) aesthetic values than a regular roof (White and Gatersleben, 2011) and might therefore raise the value of a property.*

7] *In the (environmental) governance literature, deliberative network arrangements are claimed both to enhance and to reduce democratic values such as legitimacy and democracy (for a discussion see e.g. Bogason and Musso, 2006; Lemos and Agrawal, 2006; Juhola and Westerhoff, 2011).*

8] *In Chicago, primarily the Department of Zoning and Planning and the Mayor's office; in Rotterdam, primarily the departments of water management and of Rotterdam Climate Proof; in Stuttgart, primarily the department of Urban Planning. In Basel, the Canton authorities are the main public actor, in particular the 'Stadtgärtnerei' (the urban greening department); and in London the Greater London Authority, the Environment Agency and the planning departments of the 33 boroughs.*



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4 LEGITIMATE ADAPTIVE FLOOD RISK GOVERNANCE BEYOND THE DIKES:
THE CASES OF HAMBURG, HELSINKI AND ROTTERDAM

ABSTRACT It has recently been recommended that a shift from traditional flood prevention to more adaptive strategies is made, focusing on the reduction in and recovery from flood impacts as a means to improve resilience to climate impacts. This shift has had implications for the public-private divide in adaptive flood risk governance. In an urban context, it means that private actors such as developers and residents come into play, necessitating governance arrangements which cross the public-private divide. The division of responsibilities for water safety between the public and private sectors affects the way legitimacy is gained for these arrangements and raises new legitimacy issues. The paper offers an analysis of public and private responsibilities in adaptive flood risk governance arrangements, as well as of the legitimacy of the arrangements in the light of the public-private divide. A comparative case study is presented for three urban regeneration projects in un-embanked areas in Hamburg, Germany, Helsinki, Finland, and Rotterdam, the Netherlands, where adaptive strategies have been applied. The results show that network arrangements with joint public-private responsibilities use direct forms of participation and deliberation, but that these do not necessarily lead to more legitimate arrangements in the eyes of stakeholders as is often suggested in the literature. Both network and more public hierarchical arrangements can be perceived as quite legitimate under certain conditions.

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4.1. INTRODUCTION

In the governance of adaptation to climate change, an adaptive approach is favoured by scientists and policymakers (e.g. Adger et al., 2005; IPCC, 2007). This approach aims at preparing society to deal with and recover from the impacts of climate change, rather than merely trying to resist those impacts. In flood risk management, a similar adaptive approach has been gaining ground. While traditional flood management is focused on controlling and fighting water, an adaptive flood risk governance approach is meant to accommodate water through strategies such as 'space for the rivers' and 'managed retreat' to reduce the impacts of floods (e.g. Vinet, 2008; Nye et al., 2011; Schelfaut et al., 2011; Van Herk et al., 2011). Adaptive strategies are promoted in addition to flood prevention as a means to adapt to increased river discharge levels and to sea-level rise from climate change. In the urban planning context, it entails adaptive measures such as the wet- and dry-proofing of buildings, and recovery measures such as flood insurance programmes and evacuation routes and plans. The broadening of strategies has had implications for the public–private divide in the governance of flood risk (Gersonius et al., 2008; Meijerink and Dicke, 2008; Watson et al., 2009; Butler and Pidgeon, 2011). In many countries, traditional flood prevention is the responsibility of public water authorities, since most defence measures are regarded as public goods from which all people benefit. Adaptive flood risk governance (further abbreviated as AFRG) requires not only the involvement of public actors from other policy sectors (most deeply with land-use planning, e.g. Wheater and Evans, 2009; Kokx and Spit, 2012), but it also means that private actors such as developers, insurance companies, housing corporations and residents gain certain responsibilities for flood risk governance.

It is commonly recognized that the shift from government to governance raises legitimacy issues (Van Kersbergen and Waarden, 2004; Bekkers and Edwards, 2007). The legitimacy of governance arrangements beyond the state has become an important field of scientific study, given their presumed democratic deficit (e.g. Dingwerth, 2007; Biermann and Gupta, 2011). There are various interpretations of legitimacy stemming from different scientific disciplines (for an overview, see Bekkers and Edwards, 2007). For this study, we regard legitimacy as the acceptance of authority and justification of political power (Bernstein, 2005; Dingwerth, 2007; Biermann and Gupta, 2011). In the case of AFRG, the acceptance of authority is no longer (exclusively) achieved through public responsibilities ratified through a classical representative democracy (Behagel and Turnhout, 2011; Van Buuren et al., 2012). The allocation of certain responsibilities to private actors leads to other sources of legitimacy (e.g. direct representation) and raises new legitimacy issues (e.g. skewed interest representation). This paper deals with the question of how legitimacy is gained for AFRG arrangements in terms of their decision-making process and outcomes, and how differences in legitimacy can be explained in terms of differences in the divisions of responsibilities between public and private actors. However, much literature on the public–private divide in climate adaptation, as well as on the legitimacy of governance arrangements for climate adaptation, is still of a conceptual nature (e.g. Mendelsohn, 2006; Paavola and Adger, 2006; Hulme et al., 2007; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010). Our research has an empirical focus. It aims to generate knowledge on climate adaptation practice at the local level by studying the governance arrangements for three urban regeneration projects that use multiple flood risk strategies for adapting to climate change. Many cities have waterfront development projects, turning former harbour areas into high-quality residential and office areas (Priemus and Davoudi, 2012). These represent an interesting case study, since often the responsibilities for flood protection in these kinds of un-embanked development projects fall beyond the exclusive scope of public authorities. This leads to the development of new flood risk strategies and novel governance arrangements.

First, we present a framework for the analysis of legitimacy. Second, we introduce the three case studies by analysing the governance arrangements for HafenCity, Hamburg, Kalasatama, Helsinki, and Heijplaat, Rotterdam, in terms of the division of responsibilities between the involved public and private actors. The selected cases reflect differences in the public–private divide: Helsinki and Hamburg show a clear split in responsibilities between public and private actors, albeit with slightly different degrees of private responsibilities, while Rotterdam is characterised by a considerable degree of joint public–private responsibilities facilitated through a public–private partnership. Third, we analyse the legitimacy sources and issues of these governance arrangements and discuss the main differences found, before presenting our conclusions.

4.2. GOVERNANCE ARRANGEMENTS AND THEIR ASSOCIATED LEGITIMACY SOURCES AND ISSUES

It is crucial for both government and governance to gain legitimacy, but the sources of legitimacy and issues have changed due to the shift of responsibilities to private actors (Klijn and Skelcher, 2007; Behagel and Turnhout, 2011). Public hierarchical arrangements centre on the legitimacy of the state that acts for the common good. This conforms to the representative democracy model that generates legitimacy through peoples' equal rights to vote (Bekkers and Edwards, 2007). It relies on indirect representation of interests by representatives chosen by the majority of people for its legitimization (Van Buuren et al., 2012); direct involvement of stakeholders may pose a threat to the sovereignty of elected governments and give rise to a blurring of public and private interests (Sørensen, 2005).

Although many scientists agree on private involvement in environmental governance, it is acknowledged that this raises legitimacy concerns (for a literature review, see Lemos and Agrawal, 2006). The bulk of literature that discusses the legitimacy of private involvement in environmental governance focuses on network governance, due to its rising significance in policy practice (e.g. Sørensen, 2005; Bäckstrand, 2006; Bogason and Musso, 2006; Lemos and Agrawal, 2006; Dellas, 2011). Network arrangements are built upon policy networks consisting of the public and private interests at stake. In line with participatory and deliberative models of democracy, the procedural characteristics of the decision-making processes are important for the legitimacy of network arrangements (e.g. Sørensen and Torfing, 2005). Acceptance of authority is promoted through the participation of stakeholders (Paavola, 2008; Adger et al., 2009) and through an open deliberative process which leaves room for reasoned debate (e.g. Dryzek, 2000; Bäckstrand et al., 2010). Furthermore, participation and deliberation may increase societal support and facilitate implementation (e.g. Lemos and Agrawal, 2006; Juhola and Westerhoff, 2011). In the next subsection, we provide a literature review of the different legitimacy sources and issues of network governance vis-à-vis public hierarchical arrangements, from which we have derived our framework for the analysis of legitimacy.

4.2.1. *LEGITIMACY, AN ANALYTICAL FRAMEWORK*

For our research, we analyse legitimacy according to what governance scholars and political scientists often refer to as input, throughput and output legitimacy (e.g. Papadopoulos, 2011). Input legitimacy relates to inclusive interest representation and is gained through the representation of all interests at stake and through the equality of representation (e.g. Bäckstrand, 2006; Renn, 2006; Dingwerth, 2007; Bekkers and Edwards, 2007; Paavola, 2008). In network governance, this interest representation is realised directly by the inclusion of stakeholders in the decision-making process. In public hierarchical arrangements, representation of interests is indirectly achieved by elected representatives whose political decisions reflect the preferences in society, the will of the people (Scharpf, 1997; Van Tatenhove, 2011, p. 91), in our case operationalised as the ratification of the key decisions of the governance arrangement by elected representatives. Legitimacy issues regarding direct representation in environmental governance have been widely discussed (for an overview see Few et al., 2007). A key concern is that representation reflects existing power relations, such that certain elites obtain a dominant voice through their participation in the governance network, leading to procedural and distributive inequities (e.g. Sørensen, 2005; Bogason and Musso, 2006; Lemos and Agrawal, 2006). For instance, in the case of AFRG, developers and real estate companies may have more means to voice their interests and concerns than the residents who are actually exposed to flood risk (Eakin et al., 2011; Kokx and Spit, 2012). Moreover, short-term economic interests might overshadow long-term non-economic interests such as the safeguarding of flood risk from sea-level rise for present and future generations. The scientific uncertainty related to climate change might reinforce the tendency to base decisions on short-term interests (Few et al., 2007). Skewing of interests can also occur in the case of indirect interest representation in hierarchical arrangements. Public officials and elected representatives can be influenced by lobby groups. In our case for instance, officials from urban planning might be pressurized by the real estate lobby to speed up the development at the cost of taking long-term precautionary flood measures. For our research, we therefore pay particular attention to representation of the interest of water safety for present and future generations, as potentially being the weakest interest for AFRG vis-à-vis stronger short-term socio-economic interests.

Throughput legitimacy relates to the quality of the rules and procedures to reach decisions, and the fairness of the process (Bekkers and Edwards, 2007; Dingwerth, 2007). This is in line with what Paavola (2008) refers to as procedural justice for climate adaptation. In network governance, throughput legitimacy is gained through meaningful participation (e.g. Smith, 2003; Paavola and Adger, 2006; Paavola, 2008) and due deliberation (e.g. Dryzek, 2000; Adger et al., 2009; Lidskog and Elander, 2010). A key concern regarding participation lies in the true nature of stakeholders' influence on decision-making; their voices should count. Public decision-makers might use participatory processes as window dressing to legitimize predetermined outcomes (Few et al., 2007), a phenomenon famously described by Arnstein (1969, p. 218) as 'tokenism'. In the case of AFRG, the public authority responsible for flood management might have already decided to raise an existing dike and use deliberative processes to justify this. Harries and Penning-Rowsell (2011) found that public consultation reinforced a traditional engineering approach to flood management because it was biased by a dominant discourse of recent flood victims. A key issue regarding deliberation lies in the stakeholders' ability to understand complex information as well as the rationales behind decision-making, in particular with lay people such as residents (Renn, 2006; Ebi and Semenza, 2008). Certainly, this issue seems prevalent in AFRG, a field which presupposes much specialized knowledge and expertise on hydrological and climate models, flood probabilities, risk assessments, technical features of flood measures, etc. This may put residents at a disadvantage due to

their inability to deliberate in full and hence to influence decision-making. In our research, we therefore analyse throughput legitimacy by the quality of participation and deliberation, i.e. the extent of influence on the decision-making process, and the open exchange of argumentation, respectively.

In case of output legitimacy, acceptance of authority is gained by the extent to which that authority is effective in achieving goals (Scharpf, 1997), or has the capacity to solve the policy issue (Van Tatenhove, 2011, p. 91). According to Biermann and Gupta (2011, p. 1858), it is about the 'perceived effectiveness among stakeholders' rather than effectiveness as in the actual solving of the issue. Perceived effectiveness relates to acceptance of the outcomes of the governance process (Bekkers and Edwards, 2007). For our research, we have operationalised this as the stakeholders' acceptance of two major results of AFRG arrangements. The first is the division of responsibilities among public and private actors. This is based on the assumption that private actors must accept the responsibilities for AFRG assigned to them in order for the arrangement to be viewed as legitimate. The second is the actual flood risk and its allocation across stakeholders after implementation of the proposed measures. This is based on the assumption that a high flood risk as well as differences in flood risk allocation among residents might result in a loss of perceived legitimacy of the arrangement. Table 4.1 shows the framework with which we analysed the input, throughput and output legitimacy, based on indicators to measure the sources of representation, participation, deliberation and stakeholders' acceptance. With these indicators, we scored the three cases relative to each other from high to low.

LEGITIMACY FORMS	SOURCES OF LEGITIMACY	INDICATORS
Input	Interest representation (e.g. Bäckstrand, 2006; Renn, 2006; Few et al., 2007; Paavola, 2008)	Extent to which all interests at stake are included and equally represented, in particular the interest of flood safety for present and future generations (derived from acquired safety levels) High: all interests are equally represented either directly, or indirectly through formal ratification with high agreement by elected representatives Medium: all interests are represented, but representation is skewed by direct representation of certain interests over others; there is some controversy among elected representatives Low: some interests are clearly under-represented; no ratification by elected representatives
Throughput	Quality of participation (e.g. Smith, 2003; Paavola and Adger, 2006; Few et al., 2007; Paavola, 2008)	Stakeholders' extent of access to and influence on the policy process (e.g. derived from the possibility to propose alternative solutions) High: high access to and influence on major stages of the policy process Medium: limited access/influence on the policy process, or limited in terms of the stages of the policy process Low: no real influence on decision-making in the policy process
	Quality of deliberation (e.g. Dryzek, 2000; Smith, 2003; Bekkers and Edwards, 2007; Adger et al., 2009; Lidskog and Elander, 2010)	Extent to which deliberation between stakeholders is open, and encourages and facilitates mutual understanding High: open exchange of argumentation, discussion is encouraged Medium: discussions are less open and constructive in the eyes of participating stakeholders Low: deliberation is more symbolic than real according to stakeholders
Output	Stakeholders´ acceptance (e.g. Bekkers and Edwards, 2007; Peter, 2010; Mees et al., 2012)	Extent of stakeholders' acceptance, including affected citizens, of the divisions of responsibilities for AFRG, and of the allocation of flood risk High: all stakeholders accept the outcomes Medium: the outcome is accepted by most Low: the majority does not accept the outcome

Table 4.1: Analytical framework for legitimacy

4.2.2. *RESPONSIBILITIES WITHIN ARRANGEMENTS*

Since we analyse legitimacy in the light of differences in public and private responsibilities, we now turn to our notion of the concept of responsibilities within governance arrangements. Governance arrangements refer to the organisation of tasks between public and private actors. For our research, we characterise governance arrangements along the analytical dimension of the division of responsibilities among public and private actors. We analyse responsibilities instrumentally as the tasks of an actor or organisation, and for which it can be held accountable. These responsibilities can be self-initiated, delegated or mandated by law. Responsibilities can be characterised along a continuum from purely public on the one end to purely private on the other end (see e.g. Driessen et al., 2012). We delineate responsibilities in terms of both width and scope. For the width, we analyse responsibilities through the different stages of the policy process. In line with policy practice, we distinguish between the 'Plan', 'Do', 'Check' and 'Maintenance' stages (see Mees et al., 2012 for an elaboration). 'Plan' represents the planning stage in which one decides what should be achieved. 'Do' concerns strategy development (how targets are achieved) and the actual implementation and financing of adaptation measures. 'Check' is about the monitoring and evaluation of policies. 'Maintenance' is applicable to the daily management situation after policy implementation. This is particularly relevant to AFRG and entails typical roles such as flood risk communication, flood preparedness, flood damage control and recovery. For the scope of responsibilities, we distinguish between (1) exclusive responsibility, meaning that responsibilities are either 100 % public or 100 % private, (2) joint responsibilities, meaning that there is a joint public–private responsibility, and (3) split responsibilities, meaning that there is a clear separation of the same responsibility between the public and private sectors.

4.3. RESEARCH METHOD

We apply an in-depth comparative case study approach, which enables us to explore and analyse differences in the legitimacy of governance arrangements. HafenCity, Hamburg, Helsinki, Kalasatama, and Heijplaat, Rotterdam, were selected for a number of similarities. They are faced with an increased flood risk from sea-level rise (in Hamburg and Rotterdam, this flood risk is exacerbated by increased discharge levels from the rivers Elbe and Meuse, respectively, while in Helsinki the threat comes solely from the sea). They represent urban regeneration projects that turn former harbour areas into residential areas. They lie adjacent to the city centre and are not protected by structural embankments. All three employ a mix of flood risk strategies. In all three cases, private actors have gained certain responsibilities. However, a key difference of relevance to our evaluation of legitimacy lies in the scope (exclusive, joint or split responsibilities) and width (across the stages of the policy process) of these private responsibilities. In Rotterdam, private involvement is more widespread and enhanced through the creation of a public-private partnership.

We conducted four expert interviews (three scientists and one consultant) to gain insight into the main issues related to the adaptive flood risk governance of un-embanked areas and to scope interesting projects as potential case studies. For the actual case studies, we combined two sources of information. A content analysis of major policy documents and official websites was per- formed, which provided insight into the formal responsibilities for AFRG. We complemented this with 36 stakeholder interviews with key public and private actors involved in these projects (see Appendix 4 for an

overview of respondents). Respondents were recruited using websites and the snowball technique, and represented various public authorities as well as private stakeholder groups such as investors, architects, residents, NGOs, politicians and housing associations involved in these case studies. The interviews were semi-structured and conducted between April and November 2012 (34 face-to-face interviews and two telephone interviews). The interviews gave a ground-level view of stakeholders' experiences with respect to responsibilities, and they yielded insights into the perceived legitimacy of the arrangements from different stakeholders' perspectives. The perspectives of the respondents did not diverge very much except for some instances of controversy, which are mentioned in the results section. We interpreted the data from these interviews to analyse and compare the extent to which the four legitimacy sources were present in the case studies. A separate report was made of the three case studies[9], which contains detailed information about water safety planning cultures, responsibility divisions and the evaluation of legitimacy sources based on the analytical framework of Table 4.1. These reports were verified by obtaining feedback from key respondents (five respondents per city), before they were used to inform the comparison of the cases.

4.4. CHARACTERISATION OF THE CASE STUDIES

4.4.1. *FLOOD RISK STRATEGIES*

Here, we provide a short description of the case studies and their mix of flood risk strategies, before analysing the division of responsibilities resulting from these strategies (an elaborated description can be found in the separate report). Despite the wide endorsement of AFRG among scholars and policymakers, our scoping exercise of European urban regeneration projects revealed that the majority still relies on flood prevention as the sole strategy (in most cases, public authorities require a minimum elevation of building plots). The three case studies selected for this research represent frontrunners in the field of AFRG since they use various flood risk strategies (see Table 4.2). Together, these measures ensure a water safety level in line with the overall norms for the respective cities set by public authorities, with the exception of Heijplaat, Rotterdam, where the norm is co-decided among the stakeholders and partly deviates from the rest of Rotterdam. We will now briefly introduce the three projects.

	HAFENCITY - HAMBURG	KALASAMTA - HELSINKI	HEIJPLAAT - ROTTERDAM
Flood prevention measures	Elevated building height per plot	Elevated building height for the whole area	Partial levy
Measures reducing flood impacts	Adaptive building Ground floor excluded from residential functions	Adaptive building Floating houses	Adaptive building
Flood preparation and recovery measures	Elevated evacuation routes above street level Flood risk communication Flutschutzgemeinschaften	Elevated infrastructure at street level Regular public rescue services	Flood risk communication Regular public rescue services
Safety levels	Parity with the embanked areas of Hamburg	Parity or better than the flood prone areas of Helsinki	New village: parity with embanked areas Old village below this level

Table 4.2: Flood risk strategies and water safety levels

HafenCity, Hamburg in Germany is claimed to be one of Europe's largest urban regeneration projects with a development time span between 2000 and 2020/2030. The area lies in front of the main dike-line of Hamburg adjacent to the Elbe River. Rather than building a dike around HafenCity, the Hamburg authorities developed a mix of innovative strategies to manage flood risk so as to raise efficiencies. They introduced the so-called 'Warftenkonzept', by building on elevated plots with heights of +7.5 metres. This corresponds to a similar safety level to that behind the dikes and will soon be upgraded to +8.30 metres, resulting from new predictions for sea-level rise (Bürgerschaft, 2012). Thus, the area could be developed plot by plot, and development could start straight away. All infrastructures in HafenCity are elevated above street level to allow access by the fire brigade during storm surges. In addition, built-in flood resistance ('Objektschutz') was introduced, i.e. flood protection measures to individual buildings such as flood doors and walls, as well as the institutionalization of 'Flutschutzgemeinschaften' among property owners and residents of particular neighbourhoods in HafenCity (Schaerffer, 2012). These civic communities are responsible for flood preparedness, for timely alert during a flood event and for closing the mobile flood doors.

Kalasatama is one of several former harbour areas in Helsinki, Finland, which is being transformed into a new residential area between 2010 and 2020/2030. Its coastline lies directly on two bays of the Baltic Sea. In order to conform to the water safety norms prescribed by the Finnish Meteorological Institute, the minimum building height for Kalasatama is set at +3 metres as an overall flood prevention measure. A small district of 40 floating houses will be built in the northern part as a pilot project by 2016. Flood risk management for Kalasatama is thus enacted through a traditional prevention measure (land elevation) and an innovative adaptive measure (floating houses), while flood recovery is promoted through elevation of the whole project site, including streets to evacuate. Following a competition organised by the public authorities, two developers were allowed the exclusive rights to development of the floating district.

Heijplaat, Rotterdam, in the Netherlands is a 'village' created in around 1920 for the employees of a former shipyard in the middle of the harbour area adjacent to the Meuse River. The most deteriorated area of the village has been scheduled for redevelopment between 2012 and 2020, and is also referred to as the 'new village', vis-à-vis the part that is planned to remain as is, and referred to as the 'old village'. The redevelopment is used as a window of opportunity for raising the water safety level. For cost-efficiency reasons, the complete embankment of Heijplaat as well as the partial elevation of the new village was not viable. Instead, a mix of flood prevention, mitigation and recovery measures has been decided upon. These entail first, the partial elevation of a main boulevard to create a levy of 3.60 metres. This levy will reduce the probability of flooding by a factor 50 for both the new and the old village. Second, the application of adaptive designs to the building plots and buildings should bring the flood probability level of the new village up to parity with the rest of Rotterdam. Risk communication to residents is being introduced as flood preparation and recovery measures.

4.4.2. *RESPONSIBILITY DIVISIONS*

A summary of responsibility divisions for each project is given in Table 4.3. This summary is based on detailed overviews per project, which were derived from the analysis of policy documents and from the feedback of respondents during the interviews. These detailed overviews can be found in Appendix 5. The analysis shows that in Hamburg and Helsinki, public responsibility is more pronounced than in Rotterdam, both in scope and in width. As can be seen in Table 4.3, many responsibilities are exclusively public, in particular in the Plan and Check stages (see rows 1 and 3).

Public responsibilities for these two cases stretch across all stages of the policy process. Instances of private responsibilities in Hamburg and Helsinki manifest themselves in the Do and Maintenance stages, and always alongside public responsibilities. Here, responsibilities are clearly delineated between public and private actors (in Hamburg according to public space versus private property; in Helsinki according to the mainland of Kalasatama versus the floating district). Nevertheless, even in these two publicly dominated arrangements, the private sector carries responsibilities for the implementation and financing of measures delegated to them by the public authorities (see Table 4.3, row 2), which shifts costs to those directly benefiting from the measures and from living close to the water. This deviates from the traditional collective manner in which flood measures are implemented and financed through taxes.

Width of responsibilities across stages	HafenCity, Hamburg Scope of responsibilities	Kalasatama, Helsinki Scope of responsibilities	Heijplaat, Rotterdam Scope of responsibilities
1 Plan	Exclusive ***public*** responsibility	Split responsibility: - ***public***: Kalasatama re-development; -partly ***private***: floating district	Joint ***public-private*** responsibility
2 Do	Split responsibility: - ***public:*** strategy making, implementation and financing of climate-proofing public space - ***private:*** implementation and financing of climate-proofing private property including elevation of plots	Split responsibility: - ***public:*** strategy making, implementation and financing of the elevation of Kalasatama mainland - ***private:*** implementation and financing of floating district	Joint ***public-private*** responsibility
3 Check	Exclusive ***public*** responsibility	Exclusive ***public*** responsibility	Split responsibility: -***public:*** monitoring adaptive building measures as part of planning permission - ***private:*** monitoring adaptive measures over time (in cases of transfer of property ownership)
4 Maintenance	Split responsibility: -***public:*** flood risk communication and flood preparedness -***private:*** flood preparedness, flood damage control; recovery of flood damage of private property	Split responsibility: - ***public:*** flood preparedness - ***private:*** flood damage control and recovery of flood damage of private property	Split responsibility: - ***public:*** maintenance of levy; flood preparedness; in the near future: flood risk communication - ***private:*** flood damage control and recovery of flood damage of private property

Table 4.3: Responsibilities for the 3 case studies

By contrast, in Rotterdam, private involvement is much more pronounced and manifests itself through joint public–private responsibilities across most stages of the policy process. The Rotterdam case is more complex due to a multitude of private interests; most land and real estate is owned by a housing association/developer and individual house owners (in Hamburg and Helsinki, land has been acquired by the public authorities prior to development), and the project area has existing residents in the old village (Hamburg and Helsinki had no prior residential functions). A public–private partnership has been formed with all key public and private stakeholders, and this partnership is ratified with a contractual agreement stipulating the responsibilities of each stakeholder.

A striking similarity across the three arrangements is the common private responsibilities for flood damage control and flood recovery in the maintenance stage (see Table 4.3, row 4). In HafenCity, Hamburg, this private responsibility also extends to flood preparation. The public authorities developed a special local law to formalize these responsibilities with the owners/residents of buildings through 'Flutschutzgemeinschaften' (HmbGVBl, 2002). In Hamburg, the public authorities have taken on the responsibility for extensive and continuous communication to create and maintain awareness among the residents of HafenCity of their own responsibilities in flood risk governance.

4.5. LEGITIMACY OF THE GOVERNANCE ARRANGEMENTS

A summary of our analysis of the sources used for gaining input, throughput and output legitimacy, as derived from the interviews, is presented in Table 4.4 (for an elaborated evaluation, see the separate report mentioned in endnote 9).

Regarding input legitimacy, based on the literature review in the 'Legitimacy, an analytical framework' section, we expected a higher level for Rotterdam than for the other two cases due to the direct and inclusive representation of all key stakeholders in the public–private partnership and its decision-making forums. Our analysis, however, indicates similar levels for the three cases based on three findings (see Table 4.4, row 1). First, in each case, the non-economic interest of water safety for present and future generations has been seriously taken into account. Securing sufficient levels of water safety appears to be a particularly important consideration of the public actors involved and appears to be most dominant in Hamburg, which suggests a link with higher flood risks (material damage and loss of life). Of the three projects, HafenCity, Hamburg, is most vulnerable to sea and river flooding due to the absence of a storm surge barrier. Second, in each case, key decisions were endorsed and ratified by elected representatives. The classical way of indirect interest representation by elected representatives remains very dominant regardless of differences in the governance arrangements. In Hamburg and Helsinki, key project decisions were ratified by members of parliament and council, respectively. Even in Rotterdam, the major decisions were prepared by the partnership but ratified by the Mayor and Aldermen who have the ultimate GO/NO GO decision-making power. Third, regardless of direct or indirect representation, in each arrangement, there is some indication of skewed representation: in Hamburg due to direct representation of developers during implementation; in Helsinki due to controversies among elected representatives and public officials regarding the sense of urgency; in Rotterdam due to lower levels of water safety for the old village as opposed to the new village and the rest of Rotterdam.

In line with the literature in the 'Legitimacy, an analytical framework' section, Rotterdam has gained a higher level of throughput legitimacy than the other two arrangements due to the high quality of participation and deliberation among the public and private stakeholders of the partnership (see Table 4.4, rows 2 and 3). The various stakeholders had ample opportunity to participate and deliberate on a structural basis through the deliberation forums created by the partnership. Regarding participation, the interviews revealed that the public water managers experienced some

constraints in the influence they had on decisions regarding the ultimately chosen adaptation measures, in part because they were involved relatively late in the project. Despite their agreement with the chosen adaptation measures, they shared some concerns regarding the awareness and capacity of the residents in actually fulfilling the responsibilities for flood recovery assigned to them. The public-private partnership managed to deal with the limited deliberation competencies of residents by hiring an external consultant to represent the residents of Heijplaat, Rotterdam, in the major decision-making forum (while the residents themselves directly participate in the operational forum that discusses more practical matters). The residents rely on the expertise of this consultant in these deliberations. Compared to Rotterdam, Hamburg and Helsinki show low levels of throughput legitimacy. This corresponds with the dominance of public responsibilities and a hierarchical steering, where responsibility divisions are decided upon by public authorities and responsibilities are delegated to the private sector. In these two cases, consultation happens more on an ad hoc basis (conforming to legal obligations regarding public participation) and with professional stakeholders, rather than the wider public. Nevertheless, in Helsinki, the two developers involved in the floating district are relatively influential in the decision-making, but primarily on matters of implementation due to their specific expertise in building floating constructions.

Regarding output legitimacy, based on the identified perspectives of the different respondents, we conclude that only minor differences are observed among the cases. The higher level of throughput legitimacy for the Rotterdam case did not lead to higher levels of output legitimacy. Contrary to what is often suggested in literature (e.g. Edelenbos and Klijn, 2005), satisfaction with the policy process did not increase acceptance of its outcomes in Rotterdam. In all three cases, there is considerable acceptance by public and private stakeholders regarding the division of responsibilities, and the extent and allocation of flood risks after implementation of measures (see Table 4.4, row 4). Nevertheless, in Rotterdam, some controversy is witnessed through a conflict of interests around divisions of responsibilities and adaptation solutions. The interviews revealed a clash between the interests of efficiency and speed on the one hand (housing association, residents, city development department) and the interest of water safety (public water management) on the other hand. In all three cases, we find it somewhat remarkable that residents and investors simply seem to accept the responsibilities for flood damage control and flood recovery assigned to them. In particular, HafenCity, Hamburg, respondents explain that this stems from the upfront clarity of responsibilities and of the extent of flood risk, and from the repeated communication on these responsibilities and risks. Investors and future residents know this in advance and can make a conscious choice whether or not to accept these if they want to live/invest in HafenCity. In the Rotterdam and Helsinki cases, this acceptance of responsibilities rather seems to reflect the limited awareness and sense of urgency of residents regarding flood risks. In Rotterdam, for instance, many residents are hardly aware that they live in an un-embanked area (De Boer et al. 2012). Even if they are aware, the residents of Heijplaat, Rotterdam, are more concerned with some pressing socio-economic issues (such as maintaining the local public school and supermarket) than with water safety. This means that there is a chance that a (near) flood event can easily change their perceptions on legitimacy, in particular if these result in different damage levels due to different water safety levels as is the case in Rotterdam (and also in Hamburg in the future). Furthermore, this means that public responsibility is necessary for an open and permanent communication of their responsibilities to the private sector, of the flood risks that private actors might face, and of the actions residents themselves can take to alleviate the flood damage.

Legitimacy source	HafenCity, Hamburg	Kalasatama, Helsinki	Heijplaat, Rotterdam
1 Interest representation (Input)	***Medium:*** The water safety of present and future residents is seriously taken into account by public officials, leading to parity safety levels versus the embanked areas of Hamburg. Major decisions on the HafenCity development are ratified by a committee for urban development in Parliament and by the Senate. In the Do stage there appears to be a more pronounced direct representation of developers vis-à-vis residents	***Medium:*** The water safety is seriously taken into account, leading to a slightly higher safety level for Kalasatama than nationally required. Major decisions on the Kalasatama development are ratified by various Council Committees, the City Board and the Council itself. Nevertheless the urgency of sea flooding remains rather controversial among different public departments and among politicians	***Medium:*** The interactive process sufficiently ensures equal representation of all interests, but the interest of water safety was integrated relatively late in the project. The contractual agreement and the policy document on Adaptive Building were ratified by the Major and Aldermen. Despite considerable improvement, the old village will attain a lower water safety level than the rest of Rotterdam
2 Quality of participation (Throughput)	***Low:*** In the Plan stage the decision-making is entirely in the hands of officials from various public authorities. Project developers only get some influence in the Do stage. Residents are occasionally consulted on very practical matters, but the decisions are taken by public officials	***Low:*** Decision-making is in the hands of public officials. The two developers of the floating district have some influence in the Do stage, since the officials lack the expertise in this field. Residents have the ability to formally share their views (as required by law), but officials determine how they use this input	***Medium:*** The interactive arrangement ensures sufficient access to and influence on decision-making by all public and private stakeholders. However, the water managers experienced a constrained influence on discussions regarding the costs, benefits and risks of different options for adaptive building
3 Quality of deliberation (Throughput)	***Low:*** Deliberation among public and private actors hardly occurs, and not on matters that lead to decisions	***Low:*** Deliberation among public and private actors does not occur	***High:*** Opportunities to have open debates are ample and facilitated through deliberative forums. Debates are viewed as very constructive
4 Stakeholders' acceptance (Output)	***High:*** All respondents are very satisfied with the division of responsibilities. The responsibilities of the private sector are clear, well communicated and well-known. Respondents are also satisfied with the residual flood risks for HafenCity, since the safety level is viewed as being very high	***Medium-high:*** Respondents are quite satisfied with the arrangement, in terms of responsibility divisions and residual flood risks. Some respondents pointed out that flood safety levels and various flood risk management options should be more widely discussed	***Medium-high:*** The contractual agreement of the partnership was signed by all stakeholders involved. Most respondents are satisfied with the division of responsibilities and the levels of flood risk. The water managers are slightly concerned with residents' responsibilities for flood damage control, since these do not regard water safety an urgent issue, and are hardly aware of differences in flood risks

Table 4.4: Legitimacy sources for the three case studies

4.6. CONCLUSION

Adaptive flood risk governance in the urban context entails the involvement of multiple public and private actors. We argue that an increase in private responsibilities for adaptive flood risk governance alters the way legitimacy is gained and raises new legitimacy issues. Based on our results, we come to several conclusions. First, in these frontrunner cases, we observe a shift from government to governance in a policy sector which is normally dominated by public authorities, even though this shift is less wide and deep in two of the three cases, i.e. Hamburg and Helsinki. For all cases, we find that these private responsibilities are more explicit and pronounced than in traditional flood management.

Second, we have demonstrated that such a shift indeed alters the sources with which legitimacy is gained, but only when private responsibilities become quite dominant. Joint public-private responsibilities throughout most of the policy process, as witnessed in the case of Rotterdam, have led to more participation and deliberation, resulting in a substantially higher level of throughput legitimacy. In the cases of Hamburg and Helsinki, where private responsibilities are relatively small (alongside public responsibilities) and narrow (mainly manifested in the maintenance stage), throughput legitimacy is low. Nevertheless, output legitimacy for these cases is still high, due to a high level of acceptance by stakeholders.

Third, the findings in Rotterdam also demonstrate that network governance does not make obsolete the indirect forms of gaining legitimacy by ratification by elected representatives. This is in line with the sparse empirical literature on the issue of legitimacy in flood risk governance, which describes the coexistence of direct and indirect forms of legitimisation, where network governance complements rather than replaces the traditional representative democracy (Klijn and Skelcher, 2007; Hahn, 2011; Van Buuren et al., 2012). It even appears that the traditional form still dominates, which resonates with other studies in the Dutch context (Behagel and Turnhout, 2011; Van Buuren et al., 2012). General literature on public policy suggests a similar position. Sørensen (2005, p. 355) suggests that governance networks should be combined with representative democracy to ensure the 'democratic anchorage' of networks.

Fourth, although literature in climate adaptation governance (e.g. Bäckstrand, 2006; Paavola, 2008; Adger et al., 2009; Juhola and Westerhoff, 2011) and adaptive governance (e.g. Folke et al., 2005; Lebel et al., 2006) often stresses the importance of participatory and deliberative processes, our results suggest that participatory and deliberative models of democracy do not automatically lead to higher levels of output legitimacy. The Hamburg case shows that legitimacy is gained for hierarchical arrangements under the following conditions: (1) high input legitimacy guaranteed through an extensive process of ratification via elected representatives, (2) clarity of public and private responsibilities, and (3) transparency and continuity in communicating these responsibilities, leading to accountability of both public and private actors (Dingwerth, 2007).

Fifth, in addition to the issue of skewed interest representation which has been thoroughly described in environmental governance literature, our research has revealed another relevant legitimacy issue. Private responsibilities for flood damage control and flood recovery raise the issue of whether citizens (1) have sufficient sense of urgency of what is at stake and (2) have the capacity to take action on flood remediation and flood recovery, and to what extent this might result in differences in flood risk allocation and actual flood damage. Regardless of the type of arrangement, for these private responsibilities to be perceived as legitimate, public authorities need to take on responsibility for flood risk communication on a continuous basis. Public authorities could also play a role in increasing the capacity of more vulnerable citizens/neighbourhoods through, for instance, subsidy programmes for adaptive building measures, and/or ensure equal access to insurance programmes (in some countries, flood insurance does not currently exist).

As the use of multiple flood risk strategies gradually gains ground and private stakeholder involvement consequently becomes more complex, the issue of legitimacy will gain relevance. In addition to legitimacy, this research has shown the relevance of the issues of accountability regarding private responsibilities for adaptive flood risk governance. This is because we expect that the legitimacy of private responsibilities also depends on whether these responsibilities can be lived up to in practice, and whether and how private actors can be held accountable. Focusing on accountability issues related to the private governance of climate adaptation would provide an interesting future research agenda alongside a further empirical exploration of the legitimacy issue.

END NOTE

9] *This report is available at http://promise.klimaatvoorruimte.nl/pro1/publications/show_publication.asp?documentid=7859&GUID=c8c2aff8-89d6-4d0c-9846-75395a545e3f*

5 'COOL' GOVERNANCE OF A 'HOT' CLIMATE ISSUE: PUBLIC AND PRIVATE RESPONSIBILITIES FOR THE PROTECTION OF VULNERABLE CITIZENS AGAINST EXTREME HEAT

ABSTRACT In cities in temperate climate zones the elderly, disabled and socially deprived are most vulnerable to extreme heat, as witnessed by increased mortality rates during heat waves in Europe and North America. Many cities, however, lag behind in the protection of vulnerable citizens against heat stress, an issue gaining importance in the face of climate change, ongoing urbanisation and an ageing population. This raises questions as to who bears responsibility for the protection of these vulnerable citizens. Should they protect themselves, or is this a collective responsibility? Which public and private organisations could take on this collective responsibility? This study explores potential governance arrangements between public and private actors by analysing the perceived responsibilities and their underlying considerations of public and private actors through two multi-stakeholder workshops and one focus group held in two Dutch cities. Furthermore, the study looks into what can be learned from 10 foreign cities where a heat stress policy has been implemented, with respect to the concrete shaping of responsibilities and how trade-offs in considerations are dealt with. The research reveals that because of conflicting considerations there is disagreement as to who bears responsibility for the implementation of health care measures, and it shows how this might be resolved through differentiated approaches for an active outreach to vulnerable citizens. We conclude that 'cool' governance suggests extensive public responsibilities throughout the policy process, but that policy implementation needs public-private networks tailored to these differentiated approaches.

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5.1. INTRODUCTION

The rise in global mean temperature is expected to enhance the frequency, intensity and duration of hot days and heat waves (Coumou et al., 2013; IPCC, 2013a). Of all natural disasters, heat waves are claimed to have most impact on human health in Europe; they are estimated to have caused between 22,000 and 70,000 excess deaths in 2003 in West and Eastern Europe (IFRC, 2004; Kovats and Ebi, 2006; Robine et al., 2008; EEA, 2012), and another 55,000 in 2010 in Eastern Europe (Barriopedro et al., 2011). It is claimed that urban populations are more vulnerable to the health effects of climate change than their rural counterparts because of the Urban Heat Island effect, but there are also considerable differences in vulnerability among urban citizens to climate impacts (Costello et al., 2009; Friel et al., 2011). "Vulnerability is the propensity or predisposition to be adversely affected." (IPCC, 2012, p. 3). In line with scholars, who describe vulnerability as a function of sensitivity, exposure and adaptive capacity (e.g. Adger, 2006; Wilhelmi and Hayden, 2010), citizens who are vulnerable to heat stress are i) less able to regulate and adapt their body temperature (high sensitivity, in particular the elderly cf. Verbeke et al., 2001); ii) living in older, poorly insulated houses in densely built neighbourhoods lacking green space (high exposure; Friel et al., 2011); and iii) less mobile and often live in social isolation (low adaptive capacity; Luber and McGeehin 2008; Sampson et al., 2013). In temperate climate zones it is the elderly, chronically ill and socially deprived citizens who are shown to be most vulnerable to extreme heat (Ebi et al., 2004; Kovats and Ebi, 2006). The heat waves of Philadelphia (1993), Chicago (1995), Paris (2003) and Moscow (2010) are cases in point, which have led to increased rates of morbidity and mortality in particular among the elderly (Schär and Jendritzky, 2004; Fouillet et al., 2006, Luber and McGeehin, 2008; Robine et al., 2008). With an ageing population and an ongoing urbanisation these rates might significantly increase in the coming decades.

Heat stress may be preventable through early warning systems and response plans, meant to trigger the short-term adaptive behaviour of citizens, such as shading windows, drinking water, and seeking cooler places (WHO, 2007; Luber and McGeehin 2008; Friel et al., 2011; Lowe et al., 2011). For many cities, however, such plans are lacking for this poorly recognised climate adaptation issue (e.g. Bernard and McGeehin, 2004; Runhaar et al., 2012). Moreover, these plans pay insufficient attention to vulnerable citizens, and often fail to address them effectively (Kovats and Ebi, 2006; Sheridan, 2007; Allex et al., 2013; Poutiainen et al., 2013; Sampson et al., 2013). This raises the issue of who could bear responsibility for taking measures to protect vulnerable citizens who have trouble in protecting themselves. Is this primarily a personal, individual responsibility, or is this a collective, social responsibility? The issue of personal versus social responsibility, which has gained importance with the emergence of the neo-liberal agenda and the decline of the welfare state, is heavily debated in the healthcare literature (e.g. Minkler, 1999; Galvin, 2002; Wikler, 2002; Cappelen and Norheim, 2005; Buyx, 2008; Tinghög et al., 2010). And even if society views it as a collective responsibility to care for the weakest, the issue arises as to which actors or organisations carry this responsibility. Is it primarily a public responsibility of city governments or their public health officers; or is it a private responsibility of health practitioners, caretakers, community workers or family and friends?

To address the issue of who, or which organisations, bear responsibility for the protection of vulnerable citizens against extreme heat, we need to understand the underlying rationales for allocating responsibilities to certain public or private actors (Mees et al., 2012). For instance, a primary consideration for individual responsibility is the empowerment of citizens so that they can control their own health and avoid patronage; or efficiency aimed at the reduction of costs of the healthcare system (Galvin, 2002). An important consideration for public responsibility is fairness, since local authorities can redistribute the benefits of adaptation measures that combat extreme heat to those most in need (e.g. Eakin and

Lemos, 2006; Paavola, 2008; Osberghaus et al., 2010). An important consideration for allocating private responsibility to, for instance, home care workers is efficiency, since they can relatively simply integrate heat stress treatment in their routine visits to the elderly and chronically ill. The above examples show that different rationales can compete with each other for the same responsibility division issue. Tensions exist between the different considerations underlying responsibility divisions, and this might lead to inevitable trade-offs (Mees et al., 2012).

Research on the issue of responsibility divisions for the emerging policy field of climate adaptation is still sparse and dominated by conceptual explorations (e.g. Mendelsohn, 2006; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010; Mees et al., 2012), even though a lack of clarity of responsibilities is considered a key barrier to the governance of adaptation (e.g. Biesbroek et al., 2010; Dovers and Hezri, 2010). This research aims to contribute to the literature by exploring the range of governance arrangements between public and private actors/organisations that enable adaptation. We focus on an adaptation issue that so far has received little attention, i.e. heat stress and its governance in terms of 'cooling' cities, despite the declared high morbidity and mortality rates of vulnerable citizens. A recent study showed that heat related mortality is both the most certain and the most relevant health effect for Dutch adaptation policy according to experts (Wardekker et al., 2012). In The Netherlands the governance of adaptation to heat stress has been limited to the development of a national heat response plan, while governance at the local level is virtually absent (Runhaar et al., 2012). The Netherlands has a universal health care system based on solidarity and available to everyone. Recently, more and more health care tasks are being devolved from the Dutch national government to the municipalities. Although Dutch municipalities have a broadly defined duty of care for the health of their citizens as described by law (WPG, 2008), this law is purposefully vague in terms of responsibilities to allow flexibility, and it therefore remains unclear how responsibilities are arranged at the local level to protect vulnerable citizens during a heat wave. We therefore also hope to inform (Dutch) policy makers about potential local governance arrangements.

We address the following research questions: 1) What are public and private responsibilities and their underlying considerations for the protection of vulnerable citizens from extreme heat, as perceived by Dutch local stakeholders?; and 2) What can be learned from cities where a heat stress policy has been implemented, with respect to the concrete shaping of responsibilities and to how potential trade-offs are resolved? We provide answers to these questions through two research projects. The first project consisted of two multi-stakeholder workshops, and one focus group discussion of elderly people as the largest affected citizen group, held in the cities of Arnhem and Rotterdam, the Netherlands. During the workshops and focus group representatives of various public and private organisations that have a stake in this issue discussed and deliberated on the considerations supporting certain allocations of responsibilities to specific public and private stakeholders. The second project consisted of a desk research that analysed the actual responsibilities and measures taken in 10 foreign cities in with temperate climates that are frontrunners in the implementation of adaptation to extreme heat. Of these cities, seven are located in countries with some form of a universal public health care system, and three in a country (USA) with individual health care. By comparing the results of the workshops with the results found in other cities, we provide an analysis of potential local governance arrangements for the protection of vulnerable citizens against extreme heat. First, we present the analytical framework used for the exploration of responsibilities and considerations, as derived from a literature review. Next, we describe the research method. Consequently, the results are discussed of the Dutch workshops and focus group, and of the 10 foreign cities contained in the desk research. We end with conclusions and reflections.

5.2. ANALYTICAL FRAMEWORK

5.2.1. *RESPONSIBILITIES*

In order to make sense of the concept of responsibility, we distinguish four stages in the policy process relevant for the protection of vulnerable citizens. The first is problem analysis in terms of the assessment and mapping of vulnerable citizen(group)s in light of the diversity in vulnerabilities depending on their living environment, physical and mental health, and socio-economic well-being. Identifying vulnerable citizens has proven to be difficult (Bulkeley et al., 2013). This identification is often limited to a geographic analysis that identifies hotspots, but fails to identify differential vulnerabilities among population groups within these hotspots (Luber and McGeehin, 2009; Wilhelmi and Hayden, 2010). There is insufficient data at household level, and more specifically, data is missing on households' adaptive capacity, such as access to air conditioning and extent of social isolation (Wilhelmi and Hayden, 2010). The second stage concerns policymaking: the development of a (heat response) plan for the protection of vulnerable citizens. The third stage entails policy implementation: the realisation of adaptation measures. These measures are divided into two categories: healthcare measures and adaptive measures to the built environment. The first is meant to reduce heat stress during a heat wave through adjustment of behaviour, such as drinking extra water, shutting windows, heat information lines etc. The latter is meant to prevent heat stress by moderating temperatures indoors and outdoors through adaptive measures to buildings and the urban fabric, such as installations of green roofs, air conditioning, insulation of buildings, tree planting etc. The fourth stage is about policy maintenance after implementation. For heat prevention it concerns (ongoing) risk communication: to have a media campaign ready for the issue of a heat alert and for the provision of heat prevention tips to the public. Each of these stages can be the responsibility of public actors (public responsibility), of private actors (private responsibility), of the vulnerable citizen him/herself (individual responsibility), or a joint responsibility between public and private actors as witnessed in policy networks and partnerships (public-private responsibility).

5.2.2. *CONSIDERATIONS*

We contend that each allocation of a certain responsibility to a public or private actor is driven, either implicitly or explicitly, by one or more considerations. Based on the work of Mees et al. (2012) we distinguish six considerations which might play a role in responsibility divisions for the protection of vulnerable citizens against extreme heat.

Rule of law concerns conforming to the regulations to which the adaptation issue is subject (Driessen and Van Rijswick, 2011). National regulations and constitutions often assign certain duties of care to local public authorities. For instance, municipalities may have a duty of care for the health of their citizens, or for the liveability of their city, which includes the creation of a comfortable climate.

Fairness is about a reasonable distribution of costs, benefits, risks and responsibilities (Aakre and Rübbelke, 2010b). Fairness is a subjective concept, and several principles serve to structure the debate on fairness. Those principles can be applied to achieve a fair distribution of burdens and benefits in society. Fairness often leads to public responsibilities, to safeguard an equitable distribution of burdens and benefits (e.g. Eakin and Lemos, 2006; Paavola, 2008; Osberghaus et al., 2010). Local governments can, for instance, re-distribute benefits, i.e. scarce municipal resources to reduce the heat load of senior citizens' houses through better insulation, by applying Rawl's maximin principle of "putting the most vulnerable first" (e.g. Paavola and Adger, 2006; Grasso, 2007; Paavola, 2008). On the other hand a fair distribution can also be guided, for instance, by the "beneficiary pays principle", in which case the burdens fall on those who benefit from taking adaptation action (e.g. Atkinson et al., 2000; Driessen and Van Rijswick, 2011).

Securing adaptation action concerns the attainment of pre-defined adaptation goals to secure the supply of sufficient levels of an adaptation good, in our case the effective protection of vulnerable citizens against extreme heat. In case of market failure, governments can step in by providing the adaptation good themselves, or by stimulating private adaptation action, for instance by offering subsidies for better insulation of houses (e.g. Berkhout, 2005; Mendelsohn, 2006; Aakre and Rübbelke, 2010a).

Efficiency relates to the optimum allocation of scarce resources by supplying an adaptation good at the lowest cost. Economists claim that markets are generally more efficient in allocating scarce resources and in spurring innovations (e.g. Agrawala and Fankhauser, 2008; Baarsma et al., 2010), and therefore the consideration of efficiency is often linked to private responsibilities.

Legitimacy relates to the acceptance by stakeholders and society of certain adaptation goals and measures, and of the way in which decisions about these goals and measures are made. Acceptance is generally enhanced through the involvement of all relevant public and private stakeholders (Edelenbos and Klijn, 2005). It often requires public-private arrangements through deliberative processes in which a wide range of stakeholders can participate, and particularly those most affected by extreme heat (e.g. Hulme et al., 2007; Adger et al., 2009).

Accountability refers to clarity of responsibilities and transparency of information on the content and process of policymaking, so that public and private actors can be held accountable. It requires transparency in decision-making processes, and open access to and sharing of information among actors. Literature suggests that networks in which responsibilities are shared are able to foster communication, information and knowledge dissemination (e.g. Bogason and Musso, 2006; Bodin and Crona, 2009).

The above shows that each consideration could place responsibilities on different actors. The question then is: which consideration(s) is/are considered to be more important than others, and which important but contradicting considerations might pose trade-offs in the division of responsibilities among the various public and private actors involved?

5.3. METHODS

Three research steps were conducted. Since there are currently no local arrangements for heat stress prevention in The Netherlands, the first step explored the perceptions of public and private responsibilities for the care of vulnerable citizens among representatives of key public and private organisations with a potential stake in adaptation to extreme heat, as well as the underlying considerations for assuming these responsibilities. It consisted of two interactive multi-stakeholder workshops organised in 2013 in Arnhem and Rotterdam, the Netherlands; and one focus group of elderly people in Rotterdam. The workshops were co-organised with the local authorities of these cities: they were interested in hearing the views of relevant public and private stakeholders, as input for the development of a local heat adaptation policy and of a local governance arrangement. Workshop participants were representatives of key public and private stakeholders in social and health care, special interest groups such as for the elderly and chronically ill, and various stakeholders involved in the built environment, such as housing corporations, urban planners, architects, construction companies and certifying bodies for sustainable building. Appendix 6 contains a list of the organisations represented in the two workshops. 63 Participants were divided into subgroups involved either in health care or in the built environment. Each subgroup consisted of 10-14 people who deliberated on the division of responsibilities for adaptation to extreme heat and the breadth of tasks of the local authorities, and the rationales for assuming such divisions. These discussions were recorded, transcribed and summarised in reports. To complement the results of the workshops, we organised a discussion of around one hour with 14 senior citizens active as peers in community work for the elderly, as the largest affected citizen group. During this discussion we particularly explored the issue of individual versus collective responsibility. This discussion was also recorded and transcribed.

The second step answered the question of what can be learned from cities where a heat stress policy has been implemented, with respect to how responsibilities are shaped and to how trade-offs are resolved in practice. The existing governance arrangements of these cities were analysed by a content analysis of relevant literature, reports (mostly from the World Health Organisation and European research projects such as CIRCLE-2 and GRABS), local policy documents and internet sites. 10 Foreign cities were selected for their experience with the four policy stages in adaptation to extreme heat so that actual responsibilities can be mapped: Chicago, Kassel, London, New York, Paris, Philadelphia, Rome, Stuttgart, Tatabanya and Toronto. Moreover, they represent cities in temperate climates that may show a range of arrangements under a range of different more publicly or more privately oriented health care systems. The cities in Europe and Canada, like The Netherlands, have some form of a universal public health care system based on the principle of solidarity. By contrast, the three cities in the USA provide examples of arrangements that have emerged under an individual health care system based on the beneficiary pays principle. Finally, the selection was constrained by practical reasons: information had to be easily traceable, transparent and available in the English, Dutch or German language (as restricted by the language skills of the first author). Appendix 7 contains an overview of the main adaptation activities and measures of these cities. The desk research resulted in an overview of existing public and private responsibilities for adaptation to heat stress and an analysis of how these cities deal with vulnerable citizen groups.

In a final analytical step the results of perceived responsibilities (from the workshops/focus group) and of the actual responsibilities (from the desk research of 10 cities) were combined and compared. In doing so the 10 cities provided on the ground experience against which the perceived responsibilities could be checked. Furthermore, these cities provided valuable examples of how the trade-offs in terms of considerations found in the workshops could be dealt with in practice, in particular with respect to the different ways in which active outreach to vulnerable citizens is organised to balance the trade-off between personal empowerment and legitimacy on the one hand, and securing sufficient adaptation action to protect vulnerable citizens on the other hand.

5.4. PERCEIVED RESPONSIBILITIES AND CONSIDERATIONS

The first project gained insight into the perceived responsibilities and their underlying considerations, an overview of which is provided in Table 5.1. This section summarises the key points raised in the discussions held during the multi-stakeholder workshops and the elderly focus group. The results are structured in line with the four policy stages. As stated in the introduction, two questions are pertinent in the debate on responsibilities for the protection of vulnerable citizens against extreme heat: individual versus collective responsibility, and in case of collective responsibility, public versus private responsibility. Stages one, two and four concern a debate between public versus private or public-private responsibilities; the third stage contains the additional dimension of individual versus collective responsibility; a contentious issue, as is further discussed below.

5.4.1. PROBLEM ANALYSIS

Participants perceive the assessment of vulnerabilities to be quite critical, since this type of knowledge underpins an efficient and effective policy targeted at different vulnerable citizen groups. The discussions focussed on the socially isolated elderly who live independently, since they are judged as most vulnerable, but also the most difficult group to identify. They literally slip through the safety net because they do not fall into some kind of healthcare system (such as home care or elderly care homes), but they are perceived to be unfit to bear individual responsibility for their heat health.

In all subgroups the local authorities are perceived to be the appropriate actor to acquire and assemble knowledge regarding vulnerabilities. The considerations for allocating this responsibility with the local authorities are two-fold. First, they are regarded as the most efficient actor to oversee the whole city; to collect the necessary information from different sources/actors, such as health practitioners, social workers and community groups; and to ensure that the mapping of vulnerable groups happens in a uniform way. Second, it was assumed that they take on this responsibility because of the consideration of rule of law: from their duty of care for the general health of the population as prescribed by law in the Dutch Public Health Act (WPG, 2008). In the health care subgroups it was suggested that the public health service agency should develop "a social neighbourhood map" (translated from Dutch "sociale wijkkaart") based on the collective knowledge of different organisations. As expressed by a representative of a private home care organisation: "My employees are an important source of information, since they are able to observe people behind the front door" (Arnhem, 2013). This neighbourhood map should not be limited to the prevention of heat stress, but can be used to address all kinds of social issues.

There was no difference of opinion between public or private representatives: all believe the public authority to be primarily responsible. Some difference was observed between the healthcare and built environment subgroups. Discussions in the first group were more people-oriented and focussed on the personal characteristics of vulnerable people. In the latter group discussions were more place-oriented: the geographic identification of "hot spots", of places with more heat-load due to the density of buildings and lack of green space. The challenge is how to bring these social-human and physical-environment assessments together, a challenge which was more directly addressed in the healthcare subgroups where the need for cooperation between health care and the built environment was explicitly mentioned as an important step forward.

Role	Consensus or dissensus	Responsibility	Considerations	Explanation
Problem analysis: assessment of vulnerabilities of different citizen(group)s	Consensus	Public responsibility of the local authority	Efficiency	Local authority (public health service) oversees the city as a whole, and can gather data from relevant public and private organisations
			Rule of Law	Local authority has a duty of care for the health of its citizens as prescribed by Dutch law (but it is sufficiently broad and vague to allow flexibility)
Policymaking: development of a plan for vulnerable citizens	Consensus	Public responsibility of the local authority	Rule of Law	Local authority has a duty of care for the health of its citizens as prescribed by Dutch law
			Fairness	Only public authorities can fairly weigh different interests and guard the interests of the weakest
Policy implementation: realisation of health care measures	Dissensus	Individual responsibility of the vulnerable person him/herself	Legitimacy	Interventions by third parties, in particular active interventions, are regarded as paternalism and invasion of one's privacy
			Personal empowerment	Everybody has the right to decide for themselves in matters of their health
			Accountability	Many measures, such as drinking more water, are simply hard to control and non-enforceable
		Collective: joint responsibility of all public and private stakeholders	Securing adaptation action	Use the collective resources in society in an effort to safeguard the protection of vulnerable citizens that are unable to bear that responsibility themselves
Policy implementation: realisation of adaptive measures to individual buildings	Consensus	Individual responsibility of the inhabitant or owner of the building	Fairness	Beneficiary Pays Principle: it is fair that the person benefiting from the measure, pays for that measure
			Efficiency	The inhabitant/owner can adjust according to his/her own needs and budget
Policy implementation: realisation of adaptive measures in neighbourhoods	Consensus	Collective: joint responsibility of all public and private stakeholders	Efficiency	Implementation of measures that serve multiple purposes, such as green no-regrets measures, thus accessing multiple budgets to finance these measures
Policy implementation: realisation of adaptive measures at city-wide scale	Consensus	Public responsibility of the local authority	Rule of Law	Local authority has a duty to care for the maintenance of the public space and the liveability of the city in general
Policy maintenance: risk communication	Consensus	Public responsibility of the local authority	Rule of Law	Local authority has a duty of care for the health of its citizens as prescribed by Dutch law

Table 5.1: Summarised overview of perceived responsibilities and considerations

5.4.2. *POLICYMAKING*

The discussions illustrate a pragmatic approach to policymaking: the protection of vulnerable citizens should not be treated separately, but should be integrated as an attention point within existing healthcare and sustainable urban planning policies. For instance, the heat health of vulnerable citizens can be addressed by incorporating heat prevention in social neighbourhood teams ("sociale wijkteams"); or by incorporating insulation standards in the procurement of buildings for elderly care homes, hospitals and other places with large concentrations of vulnerable citizens.

There was broad agreement among the participants that policymaking should be undertaken by the local authorities. They are responsible for the initiation and coordination of policymaking, and in doing so they should seek cooperation with other organisations. Duty of care for the health of citizens is an important consideration for this public responsibility. Furthermore, the consideration of fairness is also important, since public authorities are able to fairly weigh societal interests and guard the interests of those most vulnerable. The latter is a representation of the fairness principle of "putting the most vulnerable first".

The debate regarding policymaking did not centre so much on who should be responsible, but rather on how public authorities should exercise their responsibility, in particular with respect to policies to ensure that buildings become "heatproof" over time through the introduction of norms in building codes or the requirement for certain adaptation measures such as green roofs. This was a viable option among most representatives in the healthcare groups, given the duty of care of the government for the liveability of the built environment. There was, however, some debate in the built environment groups regarding the usefulness and necessity of such a regulation. Arguments against regulation ranged from lack of urgency, lack of knowledge regarding which type of norms would be feasible, lack of political support for any new regulation, to lack of verifiability and enforceability. On the other hand some participants, from public ánd from private organisations, think it is the only option for the effective protection of vulnerable citizens, after a preparatory period of awareness-raising and stimulation via, for instance, subsidies for insulation or green roofs. One participant commented: "In the long run you cannot avoid addressing healthy living issues such as heat stress prevention in the building code" (Rotterdam, 2013a).

5.4.3. *POLICY IMPLEMENTATION*

It is this policy stage that was fiercely debated, and over which certain dilemmas emerged regarding the allocation of responsibilities. We first address the debates on healthcare measures, where the dilemma of individual versus collective responsibility was most dominant. Secondly, we address the debates on measures in the built environment. Thirdly, we address another dilemma that came to the surface, i.e. that of the divisions of responsibility between healthcare and the built environment.

5.4.3.1. Healthcare measures

All participants agree that the responsibility for the protection of vulnerable citizens, who are hospitalized or living in healthcare institutions, is borne by that particular healthcare institution. The debate focused on the isolated elderly/disabled people living alone as the most difficult vulnerable group to reach out to. Interestingly, views diverged randomly and not necessarily between public and private representatives, suggesting that there is a general societal dilemma regarding individual versus collective responsibility for one's health.

Participants in favour of individual responsibility use three different considerations. The first is the right to decide over one's own health ("Why can't I decide for myself how and when I want to die?", Arnhem, 2013). Another consideration is accountability; there is no way of actually controlling or forcing someone to change their behaviour ("Old people are very stubborn", Rotterdam, 2013b). By far the most important consideration is legitimacy: interventions that directly approach vulnerable individuals are viewed as patronizing and as invasion of one's privacy. This corresponds with the work of Wolf et al. (2010) who found in a UK study that such interventions are perceived as impingement on one's independence. The word "patronising" was mentioned very often during the workshops and in the elderly focus group. In the elderly focus group some nuances were sensed regarding the limits of patronage from different forms of active interventions. A house visit ("getting behind the front door", Rotterdam, 2013b) was not acceptable, in any case by strangers, but an SMS alert or phone call was still considered legitimate.

Other participants inclined towards collective responsibility, basing this on the consideration that it is the only effective way to protect vulnerable people. These participants assume a collective responsibility, in the sense that all public and private actors who can potentially play a role should bear a joint responsibility. Effectiveness is a key consideration for this joint responsibility, since a collective effort provides the best guarantee that vulnerable citizens are actually reached. It is suggested that public health authorities should seek cooperation with existing private healthcare networks and community networks such as neighbourhood watch groups, volunteer networks such as the Red Cross, and interest groups for the elderly. The specific role of the public health authorities would then be to initiate, facilitate and coordinate these networks. Furthermore, it is suggested to piggyback by integrating heat prevention into existing public-private networks such as the earlier mentioned social neighbourhood teams.

5.4.3.2. Measures in the built environment

All agreed that measures to individual buildings are an individual responsibility of the inhabitant(s) of that building or the building owner. There are two considerations for this responsibility. First and foremost, it is regarded as fair that the person(s) who benefit from taking the measure should also bear the responsibility for realising and financing that measure, an expression of the fairness principle of "the beneficiary pays". However, concerns were expressed as how to use this principle in practice, since the building owner and the building inhabitant are often not the same person. This would require smart financial constructions. The second consideration for individual responsibility is that it is seen as most efficient that the inhabitant him/herself selects the most appropriate solution for his/her own purposes. With particular regard to vulnerable individuals, it is suggested to adopt new technologies such as home automation, so that these individuals and their living environment (e.g. indoor temperature) can be monitored from a distance. With respect to measures at the neighbourhood level, participants are quite reluctant to implement measures purely for the sake of heat stress prevention. Even for the areas more vulnerable to heat stress such as specific hotspots and deprived neighbourhoods, it is suggested not to address heat prevention as an isolated issue, but to link up with other interests and benefits so that various public and private stakeholders can bear responsibility for improving those neighbourhoods. The most important argument used for this joint responsibility is efficiency: it is cheaper to implement measures that serve multiple purposes and their fringe benefits help disclose different public and private budgets. Another consideration is legitimacy; in the eyes of the participants there is no societal support for tackling heat prevention separately. City-wide measures are regarded as the sole responsibility of the public authority, being the manager of the public space. Not much emphasis was placed on these measures, because it was agreed that it would be much more efficient to target specific vulnerable hotspots/neighbourhoods.

5.4.3.3. Healthcare versus the built environment

From the comparison of the discussions in the healthcare and built environment groups a slight tendency to shift responsibilities from one side to the other surfaced. Healthcare representatives contend that a gradual, proactive adaptation of the built environment of vulnerable citizens over the next 30 years will make a reactive quick fix of the health effects of extreme heat superfluous in the long term. On the other hand, representatives of the built environment argue that it is far more efficient to react to extreme heat events as and when they come ("How often do heat events occur?" and "They affect only a limited number of vulnerable citizens", Rotterdam, 2013a), than to take expensive adaptive measures. Furthermore, they argue that any attempt at adapting a building is worthless, if the vulnerable individual fails to ventilate properly or drink sufficiently. This dilemma indicates that there is a need for the two types of stakeholder groups to cooperate with each other.

5.4.4. POLICY MAINTENANCE

There was general agreement that the role of risk communication is a public responsibility. According to participants the absolute minimum that can be done is a passive intervention, i.e. ensure that vulnerable people and their social network are aware of the risks and well-informed about the things one can do oneself to adapt to extreme heat. According to the participants the national government and local authorities bear the responsibility for issuing a media campaign when a heat wave is anticipated. Again, rule of law is the key consideration: the duty of care of the municipality/ government for the health of its citizens.

5.5. ACTUAL RESPONSIBILITIES

The second project entailed an analysis of actual responsibilities as observed in the governance arrangements of 10 foreign cities, the insights of which enable a reflection on the perceived responsibilities discussed in the previous section. In this section the responsibilities for the four policy stages and the extent to which attention is paid to the protection of vulnerable citizens are discussed (a detailed overview of activities can be found in Appendix 7). The desk research revealed an increased focus on adaptation to extreme heat in Europe, where the heat waves of 2003 and 2010 triggered planning activities at various governance levels (Matthies and Menne, 2009; Lowe et al., 2011). Table 5.2 summarises the observed responsibilities. Many cities spend considerable efforts on the protection of vulnerable citizens, but these are mainly confined to healthcare measures.

Policy stage	Responsibility	Explanation
Policy preparation: assessment of vulnerabilities of different citizen(group)s	Public responsibility of the local authority	Most cities extend their assessment beyond purely geographic indicators, to include socio-economic factors that may lead to increased sensitivity, exposure or reduced adaptive capacity
Policymaking: development of a plan for vulnerable citizens	Public responsibility of the local authority	All cities have an early warning system and response plan, but relatively few plans focus to a large extent on vulnerable citizens. Two cities were found to have a dedicated plan for the protection of vulnerable citizens
Policy implementation: realisation of healthcare measures	Individual responsibility of the vulnerable person	
	Public responsibility of the local authority	Active intervention of the public health or social service towards vulnerable citizens (witnessed in one city)
	Collective: joint responsibility of all public and private stakeholders	In many cities public authorities collaborate with health practitioners and civil society groups to actively engage with vulnerable citizens (see Appendix 7)
Policy implementation: realisation of adaptive measures to individual buildings	Individual responsibility of the inhabitant or owner	
	Public responsibility of the local authority	Public authorities install or subsidise air conditioners for low income vulnerable elderly people (witnessed in one city)
Policy implementation: realisation of adaptive measures at district or city-wide level	Public responsibility of the local authority	Several cities turn public buildings into cooling centres during a heat wave in districts with high concentrations of vulnerable citizens
Policy maintenance: Risk communication	Public responsibility of the local authority/government	All cities (or their national governments) activate a media campaign for the general public during a heat wave

Table 5.2: Summarised overview of actual responsibilities in the foreign cities

5.5.1. *PROBLEM ANALYSIS*

Most cities have data available (aided by satellite imagery) to identify hotspots within the city and these are often combined with data on concentrations of elderly citizens. This identification is typically a public responsibility of the local authorities, which corresponds with the perceptions of the Dutch stakeholders. Several cities have a refined method for detecting specific vulnerable groups or individuals, based on socio-economic indicators of vulnerability. In Paris, France, a so-called CHALEX database exists of vulnerable citizens who have registered themselves voluntarily following an invitation letter from the Mayor (Cadot et al., 2007). Voluntary registration also happens in Kassel, Germany (Müller et al., nd). A registration system of vulnerable citizens in Rome was informed by records of hospital admissions and by general practitioners (WHO, 2007). One of the most advanced assessments is witnessed in Toronto, Canada. The Toronto public health authority uses an advanced modelling tool, which assesses vulnerable population groups based on an extensive list of indicators for exposure, sensitivity and adaptive capacity (TPH, 2011a). It contains both general and target group-specific indicators (e.g. 12 specific indicators for sensitivity in the elderly), which enables a very refined mapping of vulnerable citizen groups (see Figure 5.1 for an example).

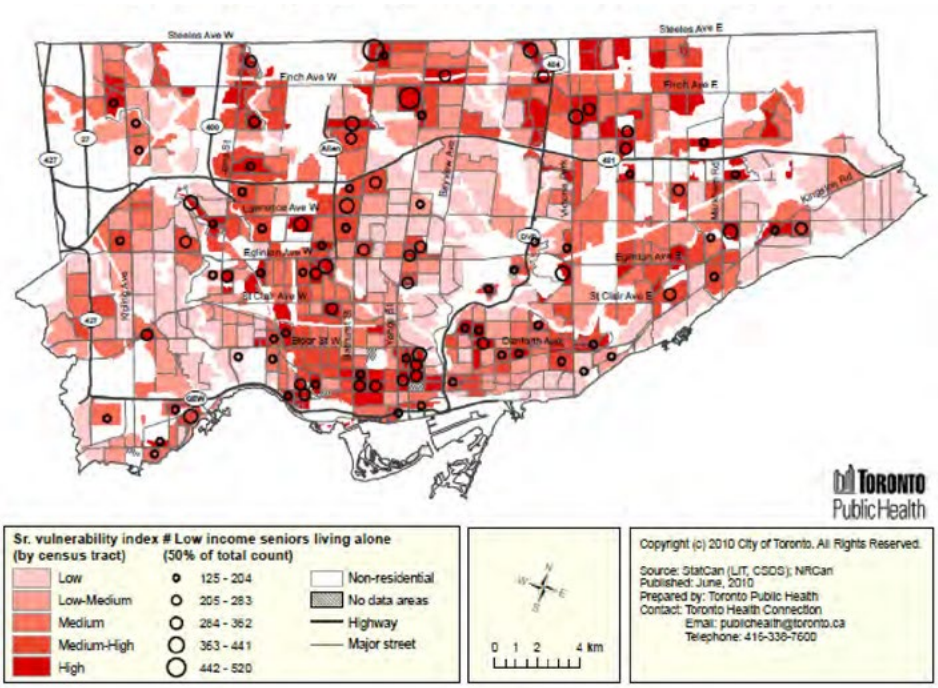

Figure 5.1: Coverage of low income seniors living alone and seniors' heat vulnerability index in Toronto (Reprinted with the permission of Toronto Public Health; TPH, 2011A)

5.5.2. POLICYMAKING

In the 10 cities heat health early warning systems and response plans are in place and their development is a public responsibility borne by the local authorities, which again corresponds with the perceptions of the stakeholders of the workshops. In a recent large empirical study on adaptation in cities Bulkeley et al. (2013) found that only in four out of 76 cases there was an explicit focus on the protection of vulnerable citizens in the formal adaptation planning processes of the city. As far as documents of the cities were retrievable, we found that most make mention of vulnerable citizens in formal planning documents. Only three cities, however, have elaborate descriptions about activities for the protection of vulnerable citizens. The Heat Emergency Plan of Philadelphia pays extensive attention to the allocation of responsibilities for the protection of vulnerable citizens (POEM, 2010); Toronto and Paris have separate policy documents for the protection of vulnerable people.

5.5.3. POLICY IMPLEMENTATION

5.5.3.1. *Healthcare measures*

Most cities have different arrangements in place resulting from different approaches to reaching out to vulnerable individuals (see Table 5.3 for an overview of different approaches). In Paris a public arrangement exists; the local authorities are in charge of the earlier mentioned CHALEX database, and during a heat wave, the registered citizens in this database are called every other day by the public social services. The analysis also revealed several interactive arrangements, where public (health) authorities collaborate with health practitioners and social/community workers. The most prominent example appears in Philadelphia, USA. The public authorities cooperate with the Philadelphia Corporation for Aging by implementing a heat-line during heat waves. A nursing team is available to pay home visits following the calls from the heat-line. Furthermore, the city works with a buddy system, consisting of community volunteers who actively keep an eye on and pay visits to vulnerable citizens (Ebi et al., 2004; EPA, 2008; Kalkstein et al., 2009). In Kassel, Germany a network ("Netzwerk Hitzeprävention") has been created of public health officials, health practitioners and community workers who actively approach vulnerable citizens through home visits and telephone assistance (WHO, 2007). In Toronto, in addition to setting up a heat-line, active outreach is organised via public agencies and community groups (TPH, 2011b). In Rome registered citizens are actively contacted during a heat wave, using existing networks of social services, general practitioners and volunteers (WHO, 2004; Matthies and Menne, 2009).

Approaches to vulnerable citizens living independently	Examples from the 10 foreign cities
How vulnerable citizens are identified	Assessment and geographic mapping (most cities)
	Voluntary self-registration (Paris, Kassel)
	Records of hospitals and general practitioners (Rome)
How vulnerable citizens are addressed	Passive heat line (most cities)
	Active phone calls (Paris, Kassel, London, Toronto)
	Home visits (Philadelphia, Rome)
	Cooling centres for vulnerable citizens (most cities)
Who approaches vulnerable citizens	Social service (Paris)
	Public-private networks (Kassel, Philadelphia, Rome)

Table 5.3: Approaches of active outreach to vulnerable citizens

5.5.3.2. *Measures in the built environment*

Measures at the level of buildings, such as for instance the installation of air conditioning, are the individual responsibility of the building owners. In some cities public authorities promote more sustainable adaptive measures such as green roofs. These cities have hierarchical arrangements where the public authorities take on responsibility for initiating some kind of policy to change the behaviour of building owners, either through a building code that requires building owners to install an albedo or green roof, or through economic incentives (e.g. subsidies for green roofs). Measures on a larger spatial scale that apply to parts or the whole of a city are generally the responsibility of public authorities, such as the designing of ventilation corridors, the planting of street trees, the installation of permeable paving and the provision of drinking fountains. Many city governments, for instance, have tree planting programmes in place, some of which direct planting efforts to specific hotspot areas (e.g. Toronto). Based on the desk research we could find only one common measure directly targeted at vulnerable citizens: in several cities (New York, Chicago, Philadelphia, Toronto and Paris) the local authorities assign certain public places (such as swimming pools, libraries, senior centres, hotels etc.) as cooling centres in specific neighbourhoods.

5.5.4. POLICY MAINTENANCE

In the foreign cities, the public authorities are responsible for informing and advising the general public about an upcoming heat wave. This passive public intervention relies on the self-governance of citizens; citizens bear an individual responsibility for adapting their behaviour to extreme heat. This public responsibility is in line with the perceptions of the Dutch stakeholders.

5.5.5. PERCEIVED VERSUS ACTUAL RESPONSIBILITIES

The perceptions of the 63 stakeholders and 14 elderly in the two Dutch cities regarding responsibilities for the protection of vulnerable citizens are broadly in line with the actual responsibilities in the 10 foreign cities. The duty of care of Dutch municipalities for the citizens' health drives the expectation in Rotterdam and Arnhem that the local authorities are responsible for the collection of information regarding physical, geographic and socio-economic determinants of vulnerabilities of different citizen groups, and this is mirrored in the actual responsibilities for problem analysis as observed in the foreign cities. Likewise, there is a perceived public responsibility for policy making (initiating and developing a policy plan for the protection of vulnerable citizens), for the implementation of city-wide measures in the built environment, and for policy maintenance (risk communication), which again is consistent with the public responsibilities observed in the foreign cities. The observed public responsibilities are omnipresent in the 10 foreign cities; they also apply to the three US cities subject to individual health care. The expected private responsibilities for adaptation to private buildings also coincide with the observed private responsibilities in the foreign cities.

The workshops brought an important dilemma to the fore regarding individual versus collective responsibility for the protection of vulnerable citizens. The different customised approaches that were observed in the foreign cities (see Table 5.3) suggest this is a common dilemma: each city has found a way to actively reach out to vulnerable citizens in an effort to strike a balance between the consideration of legitimacy (avoidance of paternalism) and securing sufficient action to protect the most vulnerable. In some cases vulnerable individuals are spontaneously contacted; in other cases vulnerable people

register themselves on a voluntary basis. In several cases house visits are conducted; in other cases telephone calls are made, as this is less intrusive. In one city (Paris) public officials approach the vulnerable; in most other cities this activity is done by private actors such as community workers, elderly peers or health practitioners. In the majority of the studied foreign cities this has led to a collective, public-private responsibility for the implementation of health care measures through the employment of networks that contain public health officials, community workers, health practitioners and/or elderly peers.

5.6. CONCLUSION AND REFLECTION

While most of us can readily adapt to heat, vulnerable citizens such as the elderly, disabled and socially deprived are faced with high risks of morbidity and mortality if they are not properly supported. Research has so far paid limited attention to the governance of the protection of vulnerable citizens against extreme heat. In the governance practice of cities the protection of vulnerable citizens is not (yet) extensively addressed either, even if heat events are described as the most deadly natural disasters in temperate climates. This research aimed to explore potential local governance arrangements for adaptation to heat stress. It analysed stakeholder perceptions of public and private responsibilities for the protection of vulnerable citizens, as well as their underlying considerations and the trade-offs among these considerations in two Dutch cities. These results were compared against the actual responsibilities as observed in 10 foreign cities. These foreign cities also provided valuable input as to how the trade-offs could be resolved by showing a variety of approaches as to how vulnerable citizens can be actively approached. From the results of this twin-research method we derive the following conclusions.

First, the common patterns of perceived and actual responsibilities show that, although the need for both public and private responsibilities is apparent, an extensive public responsibility borne by local authorities is regarded as pivotal to safeguarding the protection of vulnerable citizens. The fulfilment of three out of four policy stages is viewed and fulfilled as a public responsibility. This is not to say that the contribution of private actors, such as health practitioners, community volunteers, families and friends is not viewed as necessary, but they mainly play a role in the policy implementation stage by actively reaching out to the different vulnerable citizen groups in the implementation of healthcare measures, often in network arrangements with the local authorities.

Second, this research highlights that the issue of individual versus collective responsibility generates debate and embodies a serious trade-off in terms of considerations. The workshop results show that (at least for the Netherlands), individual responsibility for one's own (heat) health and consequently for taking adequate health measures is a sensitive topic. Interventions by others, meant to safeguard the protection of those citizens who have difficulty bearing this individual responsibility, are easily viewed as interference or even paternalism. Hence the considerations of securing sufficient adaptation action and fairness, in terms of protection of the weakest in society, face competition from considerations such as legitimacy (avoidance of paternalism) and personal empowerment. This trade-off appears to have played in the 10 foreign cities too, as can be deduced from the different approaches they have taken to deal with this sensitivity issue. At least for this climate adaptation issue, this trade-off provides a challenge. How does one put into practice the dominant stance in the adaptation literature of 'putting the most vulnerable first' to achieve a fair adaptation to climate change (e.g. Paavola and Adger, 2006; Grasso, 2007; Paavola, 2008)? Building on the works of Sampson et al. (2013) and Wolf et al. (2010) we argue that this extra dimension needs careful attention in governance arrangements that aim to protect vulnerable citizens against extreme heat.

Third, the results indicate that a customised and differentiated approach is needed for the implementation of health care measures in light of the trade-off mentioned above. This differentiated and context-dependent approach becomes apparent in the different ways in which the 10 foreign cities implement healthcare measures for the protection of vulnerable citizens. It suggests that the implementation of healthcare measures should be targeted at different types of vulnerable groups, taking into account sensitivities as to which type of active interventions (e.g. SMS alert, telephone call, house visit) by which type of actors (e.g. family, friends, peers, health care professionals, community volunteers) are still perceived as legitimate.

Fourth, joint public-private responsibilities are viewed to be important for employing this customised and diversified approach in the implementation of health care measures. Here forces are joined, since it is rather difficult to reach vulnerable citizens and activate them to change their behaviour (e.g. Sheridan, 2007; Allex et al., 2013; Sampson et al., 2013). Several arrangements have been created in the cities of Kassel, Rome, Philadelphia and Toronto by using networks of local public, private and civil society groups. These networks and the types of active interventions can vary per city, depending on the availability of these public and private groups and the resources they have at their disposal, leading to localised network arrangements.

Finally, Dutch stakeholders think that heat prevention should be integrated into existing policies, health and community networks, and urban design measures. This so-called 'mainstreaming of climate adaptation' (cf. e.g. Adger et al., 2005; Berrang-Ford et al., 2011; Uittenbroek et al., 2012) delivers efficiency gains by utilising existing societal resources rather than requiring new resources to be spent on a climate issue of incidental character such as a heat wave. Mainstreaming applies to both healthcare and built environment responses; for the latter it also entails the implementation of no-regrets measures, in which heat prevention of the built environment is combined with other interests such as, for instance, the energy efficiency of buildings or the improvement of the liveability of a city district.

In sum, this research suggests that there is likely to be a co-existence of several governance arrangements in correspondence with the different policy stages and the different contexts of a city. The stages of problem analysis, policymaking and policy maintenance are likely to be fulfilled through more public arrangements, while policy implementation is likely to be fulfilled by one or more network arrangements tuned to different vulnerable groups and to different deployable public and community networks. These network arrangements can be dormant, and activated only when a heat wave occurs.

We end with some reflections regarding our research. Our starting point was that a certain sense of urgency is present for dealing with heat stress. For many cities the reality is that this urgency is still absent or weakly developed (e.g. Luber and McGeehin 2008; Runhaar et al., 2012). In such cases the creation of awareness and sense of urgency require attention first before discussions can start regarding who does what to protect vulnerable citizens during a heat wave. Another reflection is that, even if we selected Western democratic cities as comparative cases for the two Dutch cities, this does not imply that the governance arrangements of these cities can be blindly transplanted, since this would also depend on the resemblance of institutional contexts of these cities (e.g. De Jong, 2004). Furthermore, it became apparent that for this adaptation issue the dichotomy of public versus private should be nuanced, because of 1) the additional dimension of individual versus collective responsibility, 2) the apparent necessity of joint public-private responsibilities for health care measures, and 3) the thin line between what is actually public and what is private, as demonstrated by for instance private voluntary organisations such as the Red Cross that serve public interests.

While our research focussed on the local level, an avenue for further research would be to study multi-level dimensions of governance arrangements, and the (supportive) roles of national governments and supranational organisations such as the WHO. Another future avenue for research would be to evaluate emerging governance arrangements in terms of how effective they are in reducing the health effects of heat waves with vulnerable citizens, as and when heat wave occurrences increase and urban governance arrangements in this area become mainstream. As cities become hotter and the number of vulnerable citizens increases, the awareness and need for instigating local heat policy for the protection of vulnerable citizens will likely increase. Local governments are the most likely actors to take on the responsibility for the initiation and facilitation of 'cool' governance networks in which the diverse public and private stakeholders are employed for a targeted outreach to vulnerable citizens.

6 AD NIEUWS vrijdag 2 augustus 2013

Water, water en nog meer water

HET LICHAAM ZET ALLE ZEILEN BIJ OP BLOEDHETE DAG

De tropische temperaturen van vandaag - tot boven de 35 graden Celsius - betekent voor het menselijk lichaam hard werken. En dat geldt niet alleen voor ouderen en sporters. 'Je lichaam zet alle zeilen bij om op 37 graden te blijven.'

RENSKE BAARS en IRIS VAN DEN BOOM

ROTTERDAM • Hein Daanen, warmteonderzoeker bij TNO en bijzonder hoogleraar thermofysiologie aan de Vrije Universiteit in Amsterdam komt net uit een experiment met [illegible] waarden tot 45 graden. „Geen probleem, hoor. Ik ben eraan gewend," lacht de wetenschapper. En dat is meteen de kern van zijn betoog: hoe goed de mens tegen de hitte kan is per persoon verschillend.

„Eigenlijk is het heel simpel. Het menselijk lichaam streeft naar een lichaamstemperatuur van 37 graden. Sommige mensen moeten alle zeilen bijzetten om koel te blijven. De lichaamstemperatuur van getrainde marathonlopers kan wel oplopen tot 41 graden zonder dat ze daar last van hebben, maar voor ouderen is dat al bijna dodelijk."

Het Centraal Bureau voor de Statistiek (CBS) becijferde dat er bij elke graad boven een buitentemperatuur van 23,3 graden wekelijks 33,5 Nederlanders extra sterven. Vooral ouderen en chronisch zieken bezwijken als het kwik stijgt.

Bij temperaturen boven de 27 graden dienen verzorgingshuizen verplicht hun hitteprotocol uit de la te halen. [illegible] Liane den Haan, directeur van seniorenbond ANBO: „Lang niet alle tehuizen gebruiken hun protocol. Zeker als een groot deel van het personeel niet op zijn plek is."

Erger nog, nog steeds moet de bond constateren dat senioren op het heetst van de dag in te warme kleding op hun stoel zitten. „Ze krijgen [illegible] hun vestjes en panty's aan [illegible]."

In de schaduw zitten, een petje opdoen, met je voeten in een teiltje water en een

Warmste dag van het jaar

Het wordt vandaag de heetste dag van het jaar. In delen van Oost-Brabant en Noord-Limburg stijgt de temperatuur zelfs tot boven de 35 graden. [illegible] De warmste plek van Nederland wordt waarschijnlijk Eil [illegible] de thermometer kan pieken tot 37 graden. Indien het kwik er stijgt tot boven de 37,1 graden dan is het zelfs de warmste dag in de afgelopen 10 jaar. Voor de meteorologen in De Bilt wordt het vandaag ook spannend, want daar dreigt het dagrecord van 37,0 graden te sneuvelen. „De warmste dag ooit wordt het waarschijnlijk niet," zegt AD-weerman Ben Lankamp. „Want het record was 38,6 graden in Warnsveld op 23 augustus 1944."

De hitte komt snel op en vertrekt ook snel weer, voorspelt Lankamp. „Voor de avond en de nacht zullen onweersbuien ontstaan." Maar overdag zal het in het hele land tropisch warm zijn. „Alleen aan de westkust komt een wind uit zee die verkoeling biedt."

Voor mensen met luchtwegproblemen wordt het een zware dag door de smog. Het is volgens het Rijksinstituut voor Volksgezondheid en Milieu beter om vandaag zware lichamelijke inspanning te vermijden, zeker in de middag en avond. Werknemers kunnen zich door de warmte moe [illegible] hebben last van een jeukende huid of kramp, zo blijkt uit de Meldlijn Zomerproblemen van FNV Bondgenoten. Daaruit blijkt [illegible] dat de meeste werkgevers niets blijken te doen om overlast door de hitte te beperken.

AD Amerfoortse Courant 02-08-2013

AD NIEUWS 9

zaterdag 7 mei 2011

Voorjaar met uitzonderlijk weinig regen veroorzaakt schade

Extreem droog weer zorgt voor problemen

ROTTERDAM • Prachtig, dat mooie weer – maar niet voor iedereen. De droogte van de afgelopen weken speelt steeds meer Nederlanders parten. Niet alleen boeren wachten met smart op een flinke regenbui.

Zelden was het in mei zó droog. En in maart en april was het al niet anders. Volgens het KNMI is de situatie, een langdurige combinatie van amper neerslag en veel zon, vergelijkbaar met het recordjaar 1976: toen was het van het voorjaar tot het eind van de zomer extreem droog. Het tekort aan neerslag is net zo groot als normaal in juli of augustus. En naar verwachting houdt de droogte nog wel even aan.

Voor velen goed nieuws, zeker in vakantietijd, maar heel wat mensen hebben er last van. Zo heeft de Rijn in een halve eeuw niet zo laag gestaan in deze tijd van het jaar. En dus liggen tientallen woonboten in diverse plaatsen, onder meer in Arnhem, ineens op het droge. Op andere plaatsen zijn veerponten uit de vaart genomen, onder meer in Druten en Varik, of kunnen zelfbouwen niet uitvaren en liggen vakantievierders dus vast. Door het ge- geldt ook al weken pen om hun land te besproeien, omdat het waterpeil anders te ver zakt. Vermoedelijk krijgen boeren in meer regio's daar komende week mee te maken.

Maar de boeren kampen nu al met minder snel groeiende gewassen, bijvoorbeeld in Zeeland, waar nog amper zoet water voorradig is. „De schade is nu nog te overzien, maar de problemen worden met de dag groter," zegt Jaap Haanstra van LTO Nederland. „Hier en daar is dat nu al te zien aan de afgeremde groei van bijvoorbeeld granen. Het uitzonderlijk droge voorjaar leidt tot schade en extra kosten, al kunnen we nu nog niet inschatten om hoeveel geld dat gaat. Als het de komende weken droog blijft, raken we echt in de problemen."

En wie daar allemaal geen last van heeft? Die moet vooral genieten van het mooie weer. Sommige waterschappen vragen de burger al wel zuinig te zijn met sproeiwater in de tuin. Rond het avonduur

Door de aanhoudende droogte staat het wat brug in Nijmegen zichtbaar laag. Daardoor l op het droge (foto onder). FOTO'S ANP/KOEN S

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Wetenschap 13

Daktuinen verkoelen de stad

Het natuuronderzoek verplaatst zich naar het dak. Want daken met bodems en planten erop kunnen de stad verkoelen en water bergen.

Door MARIANNE HESELMANS

WAGENINGEN. Asfalt, plaveisel, muren, daken, door al dat steen kan het in een stad wel zes graden warmer zijn dan op de Veluwe. En gaat het plotseling plenzen, dan kan het riool het plotselinge wateroverschot niet verwerken, waardoor riolen overstromen.

Daktuinen zijn de oplossing, liet ecologisch onderzoek in Michigan, Sheffield en Malmö al zien. Daar is al gemeten aan daken met bodems waarop sedum, grassen, kruiden of zelfs struiken of bomen groeiden. Daktuinen kunnen 40 tot 80 procent van het regenwater in een stad opvangen of vertraagd afgeven. En waar de temperatuur van kale daken kan schommelen tussen 100°C in de zomer en -20°C in de winter, blijft de temperatuur van begroeide daken gematigder – in één Duits onderzoek (van een daktuinleverancier) tussen de -5 en plus +25 °C.

Hoeveel waterberging en verkoeling leveren Nederlandse daktuinen op? Dat gaat het ecologisch instituut NIOO-KNAW na op zijn eigen platte dak in Wageningen, samen met daktuinleveranciers, de gemeente Rotterdam, de Vlinderstichting, waterbeheerders en de Stichting Toegepast Wateronderzoek (STOWA).

Het NIOO heeft 45 tuintjes op zijn dak aangelegd, ieder acht vierkante meter. Daar liggen nu vijf typen bodems, waaronder goedkope lava uit de Eifel gemengd met compost. Onderzoeksleider Klaas Metselaar, bodemkundige op de Universiteit Wageningen, ginstermiddag in de miezerregen op het zij bijna donkere dak: „Hier bijvoorbeeld groeit gras op een vijf centimeter diepe bodem van zand, gemengd met gruis van bouwafval. Daaronder ligt een waterdichte mat met temperatuursensoren en een systeem om het water te meten." De tuin die bij aanwijst heeft gras als dominante soort. Gras heeft het voordeel dat het snel water laat verdampen, waardoor ze'n grandak extra water kan bergen. In andere proeftuintjes zien we vooral sedum – in de tinten bruin, groen en rood. Deze vetplant, met zo'n 500 soorten en duizenden variëteiten, is wereldwijd een echte dakplant. Sedum heeft genoeg aan vier centimeter bodem, heeft weinig voedingsstoffen nodig, kan goed tegen droogte en slaat flink water op in zijn vette bladeren.

Het NIOO heeft ook tuintjes waarin naast sedum en gras ook inheemse kruiden zoals steenanjer, verschillende klaveren, tijm en zilene groeien. Als die soorten aanslaan, zouden daktuinen ook nog kunnen bijdragen aan natuurherstel.

Proeftuinen met struiken en bomen zijn er bij het NIOO niet, want die hebben tot tachtig centimeter dikke bodems nodig. „Onze dunnere bodems zijn ook geschikt voor bestaande gebouwen, zoals de daken van flats uit de jaren zestig", verklaart Petra van den Berg, directeur bedrijfsvoering bij het NIOO. De onderzoekers geven geen kunstmest en bestrijdingsmiddelen. Jonge boompjes trekken ze zo nodig uit.

De Columbia universiteit in New York mat in 2010 aan vijf daktuinen met tien centimeter bodem een wateropslagcapaciteit van 422 liter per vierkante meter. „Het potentieel in steden loopt in de miljarden liters", aldus tuinbouwhoogleraar Stuart Gaffin toen in *Scientific American* (2 februari 2010). Hij schrijft dat daktuinen de temperatuur rond het dak met gemiddeld 16 graden kunnen verlagen. Ook zou het oppervlakte dakgroen in New York nu al – met nog maar een klein percentage begroeid dak – 22 keer het oppervlak van Central Park beslaan.

„Zulke getallen zijn belangrijk", zegt NIOO-directeur Van den Berg. „Ze onderbouwen investeringen en subsidies voor daktuinen. En ze moeten kunnen ze gebruiken bij beslissingen over de capaciteit van nieuwe rioleringen."

Experimentele daktuinen op het dak van ecologisch onderzoeksinstituut NIOO-KNAW. Foto NIOO-KNAW

1] AD Amerfoortse Courant 07-05-2011

2] NRC Handelsblad 31-10&01-11-2012

6 A METHOD FOR THE DELIBERATE AND DELIBERATIVE SELECTION OF POLICY INSTRUMENT MIXES FOR CLIMATE CHANGE ADAPTATION

ABSTRACT Policy instruments can help put climate adaptation plans into action. Here, we propose a method for the systematic assessment and selection of policy instruments for stimulating adaptation action. The multi-disciplinary set of six assessment criteria is derived from economics, policy and legal studies. These criteria are specified for the purpose of climate adaptation by taking into account four challenges to the governance of climate adaptation: uncertainty, spatial diversity, controversy, and social complexity. The six criteria and four challenges are integrated into a step-wise method that enables the selection of instruments starting from a generic assessment and ending with a specific assessment of policy instrument mixes for the stimulation of a specific adaptation measure. We then apply the method to three examples of adaptation measures. The method's merits lie in enabling deliberate choices through a holistic and comprehensive set of adaptation specific criteria, as well as deliberative choices by offering a stepwise method that structures an informed dialogue on instrument selection. Although the method was created and applied by scientific experts, policy-makers can also use the method.

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6.1. INTRODUCTION

Although, in the past decade, efforts to plan for climate adaptation have increased, in particular, in developed countries (Biesbroek et al., 2010; Preston et al., 2011), their translation into actual adaptation practice is still scarce and constrained by multiple barriers (Biesbroek et al., 2010; Archie et al., 2012; Bierbaum et al., 2013). Although the climate adaptation debate nowadays includes the "how to adapt" question (Wilby and Vaughan, 2011, p. 271), so far, the literature offers little insight into how adaptation plans are put into practice, and by whom (Dovers and Hezri, 2010; Berrang-Ford et al., 2011). Given their collective nature, adaptation plans often appear to be initiated and developed by governments, at various levels (Johnson and Priest, 2008; Berrang-Ford et al., 2011; Mees and Driessen, 2011; Runhaar et al., 2012). Governments can make a conscious choice about allocations of responsibilities for adaptation; they can decide to transfer certain responsibilities for adaptation action to private actors such as citizens, civil organisations, and businesses (Mees et al., 2012). They can also incentivize private adaptation action through policy instruments (Berkhout, 2005; Fankhauser et al., 2008; Wilby and Vaughan, 2011). However, which instruments are suitable for climate adaptation purposes, and which criteria are important for the selection of those instruments? The how and by whom questions are interrelated and address the topic of governance modes and available instruments for climate adaptation.

The selection of policy instruments is a classic dilemma for policy-makers and a recurrent research topic in policy studies (e.g. Howlett, 1991; Glasbergen, 1992; Bemelmans-Videc et al., 1998; Gunningham and Grabosky, 1998). So far, there is limited insight into which policy instruments are available for promoting adaptation to climate change and how they perform against criteria such as effectiveness and legitimacy. Insights from other policy domains are not easily transferable; the literature suggests that the performance of policy instruments is heavily influenced by the specific problem characteristics (Hellegers and Van Ierland, 2003).

We argue that certain specific characteristics of climate adaptation offer challenges to its governance, and these should be taken into account when selecting policy instruments for climate adaptation. These challenges are uncertainty, spatial diversity, controversy and social complexity (Termeer et al., 2011; Mees et al., 2012; Van Buuren et al., 2014). Uncertainty relates to the climate system itself, its effects on society, and the costs, benefits, and effectiveness of adaptation measures (e.g. Füssel, 2007; Adger et al., 2009; Van Vuuren et al., 2011). The long-term character of climate change, and consequently, the long-term planning horizon it requires clashes with short term policy and political cycles and hence exacerbates this uncertainty (e.g. Fankhauser et al., 1999; Dovers and Hezri, 2010). Spatial diversity of climate impacts occurs between and within regions, city districts, and socio-economic groups in society, leading to differential vulnerabilities and inequalities (Lindley et al., 2007; Aaheim et al., 2010). Controversy refers to contradictory perceptions of adaptation problems, goals, and measures (Adger et al., 2009; Hinkel et al., 2010). Social complexity refers to the multi-level, multi-sector, and multi-actor character of adaptation action, leading to unclear and fragmented responsibilities and institutional voids (e.g. Urwin and Jordan, 2008; Termeer et al., 2011, Mees et al., 2012). We argue that these challenges give direction to the objectives that policy instruments should fulfil, and they should therefore influence criteria for the selection of policy instruments. For example, the uptake of green roofs by private actors for the retention of heavy rainfall is hampered by the uncertainties regarding the costs and benefits of green roofs. Effectiveness, i.e. achieving sufficient levels of adaptation action to achieve a critical mass of green roofs for rainfall retention, will be an important criterion for governments to stimulate the uptake of green roofs by private actors. Hence, governments might decide to employ a technical requirement for green roofs through a building code as the key policy instrument to secure sufficient adaptation action (Mees et al., 2013).

Here, a team of experts from legal, policy and economic studies develops and applies an ex-ante method for the systematic selection of policy instruments for climate adaptation action, taking into account the particular governance challenges of climate adaptation. This work fills a gap in climate adaptation governance literature by contributing to the question of how adaptation can be put into practice. The method may also support public policy-makers in systematically assessing and selecting policy instruments for climate adaptation and justifying their choices. Furthermore, the method allows for the design of policy instrument mixes, a topic that has not yet been elaborated upon in much detail in policy studies. Various authors have claimed that in environmental policy, the employment of a mix of policy instruments is often preferable for reaching multiple policy objectives and target groups because policy instruments may complement each other and compensate each other's weaknesses (see Taylor et al., 2012). Conceptualisations and empirical evidence, however, are limited (Glasbergen, 1992; Oikonomou and Jepma, 2008; Weber et al., 2014). In part, this is explained by the inherent nature of the identification of appropriate policy instrument mixes: It strongly depends on what criteria are considered most important in a particular adaptation context, what weights are put on those criteria (e.g., in the case of uneven distribution of vulnerabilities, fairness may be the most important criterion), and the extent to which compensation between criteria is considered feasible or desirable.

Specifically, we address the following two questions: How can criteria for the selection of policy instruments for climate adaptation be specified according to the challenges to the governance of climate adaptation? How can policy instrument mixes be selected systematically based on these criteria? By means of an expert judgment applied to three examples of urban adaptation measures, we demonstrate the usefulness of the method. We first present a framework for the assessment of policy instruments, followed by an explanation of the method. We then describe three examples of urban adaptation measures (green roofs, flood-resilient building, and behavioural measures to extreme heat), illustrate the method through its application to these examples, and discuss the results of our exercise. We end with conclusions and some reflections.

6.2. ANALYTICAL FRAMEWORK

6.2.1. *POLICY INSTRUMENTS: A TYPOLOGY*

Policy instruments are "effecting tools", which are meant to have an effect on behaviour (Hood, 2007, p. 139). They are often referred to as the "tools of government" (Hood, 1983). We use the following definition of a policy instrument: "a deliberate structured effort by governors to solve a policy problem by modifying actions of the governed" (Brukas and Sallnäs, 2012, p. 605). We take the perspective of local urban policy-makers as the governors who can employ policy instruments to stimulate adaptation action, or alternatively, use the market by stimulating private actors to employ policy instruments to regulate the market (Fankhauser et al., 2008), or use the governance network (Vabo and Røiseland, 2012). This government-led perspective is distinct from more autonomously-led adaptation by organisations, which have their own drivers for taking action (e.g. Berkhout et al., 2006; Wilby and Vaughan, 2011; Berkhout, 2012), or by individuals (e.g. Tompkins and Eakin, 2012; Wamsler and Brink, 2014). To identify systematically the variety of policy instruments for adaptation, we use a two-dimensional classification scheme that includes the following.

- *The type of governance arrangement:* We distinguish between hierarchical public arrangements with governments as the main governing actors; interactive arrangements in which governments and private actors jointly govern; and market governance in which the initiative to implement adaptation measures is left to private actors (e.g., companies or homeowners) and civil society. These three arrangements are generally identified in the governance literature, albeit sometimes under different headings (Thompson et al., 1991; Gunningham and Sinclair, 2002; Kjær, 2004; Driessen et al., 2012).
- *The associated policy instruments and their underlying rationales:* In the literature, three types of policy instruments are usually distinguished: legal (or regulatory) instruments, economic instruments, and communicative (or informational) instruments (Hood, 1983; Glasbergen, 1992; Vedung, 1998; Gunningham and Sinclair, 2002; Brukas and Sallnäs, 2012). Each type is based on a different rationale regarding the way actors are steered; by restricting or allowing behavioural options (legal instruments), by changing the cost-to-benefit ratios of these options (economic instruments), or by informing about options (communication instruments).

Type of policy instrument	Hierarchical (public) governance	Interactive governance	Market (private) governance
Legal instruments	Technical requirements (including quota, zoning, relocation and prescription of Best Available Technology or best practices) (TR) Performance standards (PS) Mandatory labelling (ML)	Contractual agreements/ Covenants (CA)	Private labelling (including investor requirements) (PL)
Economic instruments	Subsidies (including reduction of fees) (SU) Taxes (TAX)	Smart subsidies/ Auctions (SSU) Tradable permits (TP)	Insurances (fee differentiation) (INS)
Communicative instruments	Public information campaigns (PI)		Product information (PI)

Between brackets are the abbreviations used for these instruments in other tables

Table 6.1: Promising policy instruments for promoting adaptation to climate change

We classify policy instruments for adaptation according to these two dimensions (Table 6.1). Most instruments can potentially be employed in any type of governance arrangement, although regulatory instruments tend to dominate with hierarchical arrangements, and economic instruments with market arrangements. In the category of legal instruments, for instance, one could introduce a building requirement for houses in flood-prone areas (Aerts and Botzen, 2011) or mandatory labels that specify the vulnerability of a house to floods. Economic instruments for adaptation could, for instance, comprise insurance fee discounts if property owners invest in measures that reduce flood risks, such as green roofs (see Kleindorfer and Kunreuther, 1999; Kunreuther and Pauly, 2006). A typical communication instrument is the public information campaign, for example, advice from municipal health services on how to avoid heat stress, a phenomenon that is expected to increase in frequency as a consequence of climate change (Runhaar et al., 2012). Our list of instruments is not exhaustive and is necessarily incomplete (Table 6.1). We only include those instruments that are typically used to address environmental problems (see Glasbergen, 1992; Vedung, 1998; Hellegers and Van Ierland, 2003; Wurzel et al., 2003; Lockie, 2013; Taylor et al., 2012), which are therefore potential candidates for

climate adaptation policies. That does not mean that all listed instruments are equally suitable in the context of specific adaptation measures, as we show in the adaptation examples.

6.2.2. *CRITERIA FOR POLICY INSTRUMENT SELECTION*

A variety of performance criteria might apply for climate adaptation. We use a multi-disciplinary set of most commonly applied assessment criteria for policy analysis as derived from economics, policy and legal studies: effectiveness, efficiency, legitimacy, accountability, legal certainty, and fairness (e.g. Nelissen, 2002, Crabbé and Leroy, 2008). This set is also inspired by the "thick analysis framework", as employed by Adger et al., (2003), which is meant to foster interdisciplinarity and pluralism to overcome a narrow approach in environmental research. We next define the six criteria and explicitly link them to the four challenges of uncertainty, spatial diversity, controversy, and social complexity.

From economics, we derived the criteria of effectiveness and efficiency. Effectiveness is commonly understood as the extent to which policy goals are achieved by means of the selected policy instruments and the available resources; in the case of climate adaptation, it is about securing sufficient adaptation action. Effectiveness is influenced by uncertainty, in the sense that high uncertainties regarding the spatial and temporal impacts of climate change could deter people from taking adaptation action, resulting in non- or under-adaptation (Adger et al., 2009; Gifford, 2011). In such circumstances, policy instruments are called for that steer or even force people to adapt, to reach sufficient levels of adaptation action.

Efficiency is about the optimum allocation of scarce resources, ensuring that an adaptation good is provided at the lowest cost. Efficiency is also affected by uncertainty, but in the opposite direction: governments might take too much action too soon out of precaution, resulting in costly over-adaptation (Driessen and Van Rijswick, 2011). In such cases, policy instruments are needed that promote experimentation and flexible adaptation action that can be adjusted easily over time and in light of the long-term planning horizon needed for adaptation (Fankhauser et al., 1999; Huitema et al., 2009; Gupta et al., 2010; Keessen and Van Rijswick, 2012). Furthermore, efficiency is influenced by spatial diversity in the sense that each specific location or region might be impacted in different ways. In such situations, policy instruments are needed that promote adaptation action that is tailored to each specific location to minimize costs.

From policy studies, we derived the criteria of legitimacy and accountability. Legitimacy, from a policy and legal-scientific point of view, is about the acceptance of authority and justification of power (Bernstein, 2005; Bekkers and Edwards, 2007; Dingwerth, 2007). Controversies around the problems, goals and measures of adaptation affect the criterion of output legitimacy, i.e. the perceived effectiveness among stakeholders (Biermann and Gupta, 2011), often operationalised as the acceptance of the outcomes of a governance process (Bekkers and Edwards, 2007). This is because the different value systems and interests of actors might make a high acceptance level of adaptation measures among stakeholders problematic. If this is the case, policy instruments must be selected based on their ability to stimulate acceptance of their impacts by all relevant stakeholder groups that are faced with the adaptation problem at stake. Furthermore, social complexities affect the criterion of input legitimacy, i.e. inclusion of all interests at stake (Bekkers and Edwards, 2007; Few et al., 2007; Paavola, 2008). In cases of high social complexity, policy instruments must be selected based on their ability to serve all relevant interests without excluding affected parties (Paavola, 2008).

Accountability is about stakeholders and society being able to scrutinize the actions of policy-makers. This can be achieved through, for instance, clarity of responsibilities (Botchway, 2001), and transparency of information on the content and process of policy-making (Gupta, 2010). Again, a large extent of social complexity leads to fragmented and ambiguous responsibilities for adaptation (Urwin and Jordan, 2008). Hence, policy instruments are needed that support a clear allocation and transparency of responsibilities for adaptation action.

From legal studies, we derived the criteria of legal certainty and fairness. Legal certainty means that the law must provide those subject to it with the ability to regulate their conduct. Legal certainty is internationally recognized as a central requirement for the rule of law and as a grounding value for the legality of legislative and administrative measures taken by public authorities (Fuller, 1969; Radbruch, 1970; Popelier, 2000). In case of high uncertainty regarding the spatial and temporal effects of climate impacts, people need to know where they stand in terms of regulation so that they can align their adaptation action in accordance with these regulations. Therefore, policy instruments must be selected for their ability to offer legal certainty through stable and understandable rules.

Fairness is interpreted here as distributive fairness, i.e. the fair allocation of burdens and benefits for climate adaptation action. Adaptation is claimed to particularly raise the issue of fair benefit sharing, i.e. the distribution of scarce adaptation resources among recipients of benefits. This is because adaptation action generates local goods for specific targets rather than global common goods, as is the case with mitigation (e.g. Paavola and Adger, 2006; Grasso, 2007; Jagers and Duus-Otterström, 2008; Driessen and Van Rijswick, 2011). Fairness is influenced by two governance challenges. Uncertainty regarding the spatial and temporal effects of climate change activates the precautionary principle so that inter- and intra-generational equity is considered. In such a situation, policy instruments are needed that steer towards supplying sufficient levels of adaptation goods for everybody in society. The second challenge, the spatial diversity of climate impacts, means that some groups and regions are more vulnerable than others. In such cases, policy instruments must help to prioritize the supply of sufficient levels of adaptation action to specific vulnerable hotspots by putting the most vulnerable first (Paavola and Adger, 2006; Grasso, 2007). In doing so, policy instruments can also try to recover the cost of adaptation action from those who profit from that action (Atkinson et al., 2000; Driessen and Van Rijswick, 2011).

From these criteria and challenges, we derived nine specific adaptation criteria (Table 6.2). We use these nine criteria to assess the performance of the identified policy instruments (Table 6.1).

Table 6.2: Adaptation-specific performance criteria for the selection of policy instruments

Governance challenge	Criteria at risk	Explanation	Performance criteria for the selection of policy instruments for climate adaptation
Uncertainty	***Effectiveness*** Securing (adaptation) goals	Uncertainties regarding climate impacts as well as the costs, benefits and effectiveness of adaptation measures deter people from taking action, resulting in non- or under-adaptation	Steers towards supplying sufficient levels of adaptation goods/services (the more coercive, the more steering power)
	Fairness Reasonable distribution of burdens intra- and inter-generationally	Uncertainties regarding the spatial and temporal effects of climate change mean that the precautionary principle should be applied to ensure that sufficient action is taken to guarantee a minimum safety level for everybody in society, spatially and temporally	Steers towards supplying sufficient levels of adaptation goods/services for everyone now and in the future
	Legal certainty The law must provide those subject to it with the ability to regulate their conduct	Because of uncertainties regarding spatial and temporal effects of climate change and its impacts on society, people need to know where they stand in terms of regulations for a considerable period of time so that they can fine-tune their adaptation actions in accordance with these regulations	Offers legal certainty through clear, understandable and stable rules to which people can conform
	Efficiency Supply of flexible adaptation goods to achieve lowest cost	Uncertainties regarding climate impacts could entice (governments to take) actions that are overdone and costly, resulting in over-adaptation	Promotes flexible adaptation solutions and measures that can be easily adjusted over time in order to minimise costs
Spatial diversity	***Fairness*** Reasonable distribution of burdens according to carrying capacity	The spatial diversity of climate impacts leads to differential vulnerabilities owing to diversities in exposure to climate impacts, in sensitivity to those impacts and in capacity to adapt among people, districts, regions etc.	Steers towards supplying sufficient levels of adaptation goods to hotspots most vulnerable to climate impacts while recovering a fair share of the costs of adaptation action from those who benefit
	Efficiency Supply of spatially tailored adaptation goods to achieve lowest cost	The spatial diversity of climate impacts means that each specific location, region, building etc. is affected differently and might need different responses	Promotes diverse adaptation action that is tailored to a specific location in order to minimise costs
Controversy	***Output legitimacy*** Support of stakeholders for an adaptation goal, solution and the decision process	Controversies around adaptation goals and solutions reflect different interests, principles and value systems among actors, resulting in problematic support for adaptation policies	Stimulates acceptance of its impacts on all relevant stakeholders
Social Complexity	***Input legitimacy*** Inclusion of all relevant interests	Social complexities mean that various target groups, sectors and levels are affected by climate impacts, so these should be consciously considered in the policy	Serves all relevant interests that are influenced by the policy without excluding actors or groups that have something at stake
	Accountability Reciprocal clarity and transparency of governors and the governed	Social complexities lead to the fragmentation and ambiguity of responsibilities, hampering clear accountability structures	Supports the allocation and transparency of responsibilities for adaptation action for both the governors and the governed

6.3. METHOD

6.3.1. *STEP-WISE APPROACH*

As a team of scientific experts, we created a method comprising a step-wise approach for the purpose of policy instruments selection. The method starts from the point that a suitable adaptation measure has been selected based on the adaptation issue and goal at hand, for instance, through a multi-criteria analysis applied to various adaptation options (e.g. de Bruin et al., 2009). Clearly, the selection of adaptation measures would equally benefit from a deliberate rather than a routine approach based on past experience (Tennekes et al., 2014), but that is beyond the scope of this paper. Our method is designed to select policy instruments for predefined adaptation measures and comprises four steps:

I *General assessment of policy instruments:* The purpose of this step is to identify an appropriate set of policy instruments for climate adaptation in general. This can be done by assessing the promising policy instruments we identified previously (Table 6.1) using the nine performance criteria (Table 6.2). For the sake of simplicity, we propose using a three-point ordinal scale whereby each instrument receives a high, medium, or low score on each criterion.

II *Specific assessment of policy instruments for a certain adaptation measure:* To calibrate the results, a sensitivity check is performed on the suitability and scores of policy instruments from Step I for a specific adaptation measure.

III *Assessment of the four governance challenges for a certain adaptation measure:* The purpose of this step is to identify the relative importance of the performance criteria for a specific adaptation measure. This can be done by scoring the extent to which the four challenges manifest themselves for that specific adaptation measure, using the same three-point scale of high, medium, and low.

IV *Specific selection of appropriate policy instruments for a certain adaptation measure:* The purpose of this final step is to identify appropriate combinations of instruments per adaptation measure. This can be done by checking which instruments perform best on the most relevant performance criteria (combining steps I and III). Next, one can look for combinations of instruments that score well on different relevant criteria, thus complementing each other and/or compensating for each other's weaknesses, and/or by combining instruments that cover different target groups, and/or by sequentially introducing different instruments.

The four adaptation challenges play an important role in the method. First, they shape the formulation of criteria for the selection of instruments for adaptation in general (Step I). Second, they determine the weight of the criteria for each specific adaptation measure (Step III).

6.3.2. *EXPLICATING THE METHOD*

The method is designed to accommodate an interactive and deliberative process. The idea is that the steps are completed as a joint exercise by a multi-disciplinary team of different experts and/or policy-makers. The underlying assumption of the method is that potential biases can be minimized by using a holistic set of six assessment criteria comprising different rationales for policy making and by using the collective knowledge, perspectives, values and interests of a multi-disciplinary team. For an illustration, we performed this exercise as a multi-disciplinary team of six experts from the

economics, policy, and legal studies. Initially, the assessments in steps I and III were done individually by each expert. During two intense, interactive workshops, we exchanged argumentations for these individual assessments, occasionally had discussions, reached agreement on certain scores, and validated the ultimate scores by combining and/or contrasting these argumentations. Hence, the scores are based on a common judgment and interpretation of the team and represent indications of the suitability of an instrument relative to the other instruments rather than absolute scores. We found a three-point scale to be sufficiently differentiating without giving a false sense of accuracy; more refined scales increase the complexity of the method without making it necessarily more robust. We argue that the robustness of the method lies in the use of multiple criteria by experts of multiple disciplinary backgrounds as well as the deliberation on the argumentation of scores.

6.4. ADAPTATION MEASURES USED FOR THE ILLUSTRATION

We opted for three adaptation measures that are employed by the public authorities of Rotterdam, a frontrunner in adaptation planning (Mees and Driessen, 2011): (1) green roofs for storm water retention, (2) flood resilient building for water safety, and (3) behavioural adaptation to extreme heat. All three examples represent urban adaptation measures. While the examples were selected primarily for practical reasons (the team has relevant know-how and experience with these examples from previous empirical work), they have the fringe benefit that they represent privately provided goods that serve public adaptation goals (see Tompkins and Eakin, 2012) as well as private goals. This makes them particularly relevant for our research since local governors need the private sector (citizens and organisations) to attain the aspired public adaptation good; therefore, governors have a motive to incentivize the private sector to implement these measures through policy instruments.

The three examples purposely differ in the type of adaptation issue they address, assuming that this will lead to differences in the extent to which the four adaptation challenges manifest themselves across the examples. The examples are illustrative of the application of our method for the selection of instrument mixes and are not meant to be representative of the performance of policy instruments for climate adaptation. This would be impossible anyway because climate adaptation encompasses a wide variety of risks from climate change, as well as a wide variety of possible measures (Runhaar et al., 2012). We briefly describe the three adaptation measures before sharing the results obtained through the application of the method by the expert group.

Green roofs are roofs with vegetation. They help to store excessive rainfall and also reduce excessive heat build-up in houses. Green roofs are often promoted as 'no-regrets' adaptation measures: even if their effects on climate adaptation are uncertain or unknown, they have co-benefits for property owners and society at large. Nevertheless, autonomous installations by private actors have not yet occurred widely. Green roofs are generally not considered by private actors because of an imbalance between high short-term installation costs and the slow reaping of benefits over time, amongst other reasons. If installation is left to private actors, adaptation action is likely to be insufficient and fragmented (Mees et al., 2013). Moreover, adaptation action will probably not occur in those parts of the city most prone to surface water flooding or heat stress. Consequently, policy-makers have started to employ a wide range of policy instruments to promote the uptake of green roofs (Carter and Fowler, 2008), of which economic instruments are most commonly applied (Mees et al., 2013).

Flood-resilient building measures are measures applied to new and existing houses and other buildings that reduce the impact of a flood, i.e. prevent flood damage from occurring. These measures are an alternative to flood walls and elevated buildings and are often applied in un-embanked areas. They are also referred to as the wet-proofing or dry-proofing of buildings. In the former case, water is allowed to enter the building, and the finishing of floors and walls is adapted to withstand water. In the latter case, the building itself provides watertight protection for itself and its surroundings. The application of flood-resilient building measures depends very much on the specifics of the location and its vulnerability to flooding. A common way to ensure the implementation of these types of measures is via legal instruments of spatial planning such as master plans and building codes, or to specify them as technical requirements through contractual agreements (Mees et al., 2014).

Behavioural measures to adapt to extreme heat range from drinking more water and refraining from heavy exercise to ventilating rooms, seeking cooler places and closing window shutters. These types of measures are meant to keep the body temperature under a certain level to prevent heat stress, morbidity, and even mortality, particularly among vulnerable population groups such as the elderly and chronically ill (Schär and Jendritzky, 2004). Behavioural measures to combat extreme heat are generally advised through heat health early warning systems and response plans (Lowe et al., 2011). A key governance issue lies in the fragmentation of responsibilities among the multiple public and private actors involved (WHO, 2007), ranging from officers of public health and social services to health practitioners, caretakers in residential homes, and citizens or their family and neighbours. A commonly applied instrument is the public health information campaign (WHO, 2007).

6.5. APPLYING THE METHOD: AN ILLUSTRATION

6.5.1. STEP I: GENERAL ASSESSMENT OF POLICY INSTRUMENTS

We assessed all policy instruments (Table 6.1) on the nine criteria (Table 6.2), resulting in scores for all policy instruments (Table 6.3). Here, we give an example of the argumentation behind these scores. A technical requirement, for instance one that prescribes green roofs for new developments with flat roofs, scores high on effectiveness (Table 6.3). The argumentation for this score is that a technical requirement offers a high certainty that the adaptation goal is reached through its coercive nature, as long as its application can be monitored and enforced. By contrast, a smart subsidy scores low on effectiveness. Consider, for instance, a subsidy for green roofs that is allocated through an auction mechanism that ensures that only the low-cost actors are selected to adapt (see Ferraro, 2008). A smart subsidy is a voluntary instrument: actors can decide not to participate, and, in the case that an auction is used, only the low-cost adapters will receive a subsidy. Hence, a smart subsidy is expected to offer too little of that adaptation measure. On the other hand, a technical requirement scores low on the two efficiency criteria, whereas a smart subsidy scores high on these efficiency criteria. A technical requirement is a one-size-fits-all instrument which does not select the least-cost suppliers and does not offer any flexibility for adjustment over time or for tailor-made adaptation action (unless it is formulated by way of describing several allowed best practices). By contrast, a smart subsidy instrument allows for the selection of the least-cost actors to implement the adaptation measure. Furthermore, it offers flexibility over time because a smart subsidy is only introduced as and when adaptation action is needed and can be applied for a certain specific vulnerable region only. An example of the scores and argumentations for one instrument, the technical requirement, is provided in Appendix 8.

			POLICY INSTRUMENT										
Challenge	Criterion	Indicator to assess a policy instrument	TR	PS	ML	SU	TAX	PI	CA	SSU	TP	PLB	INS
Uncertainty	Effectiveness	Steers towards supplying sufficient levels of adaptation goods/services (the more coercive, the more steering power)	H	M	L	L	M	L	M	L	H	L	M
	Fairness	Steers towards supplying sufficient levels of adaptation goods/services for everyone now and in the future	M	M	L	L	M	L	L	L	M	L	L
	Legal certainty	Offers legal certainty through clear, understandable and stable rules to which people can conform	H	H	M	M	H	L	M	M	H	M	M
	Efficiency	Promotes flexible adaptation solutions and measures that can be easily adjusted over time in order to minimise costs	L	H	M	M	M	H	M	H	H	H	H
Spatial diversity	Fairness	Steers towards supplying sufficient levels of adaptation goods to hotspots most vulnerable to climate impacts while recovering a fair share of the costs of adaptation action from those who benefit	H	M	M	M	H	M	H	H	H	L	L
	Efficiency	Promotes diverse adaptation action that is tailored to a specific location in order to minimise costs	L	M	L	L	L	H	H	H	H	L	M
Controversy	Legitimacy	Stimulates acceptance of its impacts by all relevant stakeholders	M	M	M	M	L	H	M	M	M	M	M
Social complexity	Legitimacy	Serves all relevant interests that are influenced by the policy without excluding actor(groups) that have something at stake	L	L	L	L	L	M	M	L	L	L	L
	Accountability	Supports the allocation and transparency of responsibilities for adaptation action for both the governors and the governed	H	M	L	H	H	L	H	H	H	L	H

Table 6.3: General assessment of 11 policy instruments

Abbreviations: TR=technical requirement; PS=performance standard; ML=mandatory labelling; SU=subsidy; PI=product information; CA=contractual agreement; SSU=smart subsidy; TP=trading permit; PLB=private labelling; INS=insurance.
Performance criteria were assessed using a qualitative score: H = high, M = medium, L = low.

6.5.2. *STEP II: SPECIFIC ASSESSMENT OF POLICY INSTRUMENTS FOR A CERTAIN ADAPTATION MEASURE*

By conducting a sensitivity check, we discovered that certain instruments were less suitable for the three adaptation measures than others. Taxes were disregarded because they are intended to discourage harmful behaviour rather than to encourage good behaviour such as the implementation of adaptation measures. It is, for instance, difficult to imagine taxing an individual for not wanting to install a green roof. Similarly, tradable permits seem less appropriate for these adaptation measures because they are also meant to discourage harmful behaviour by putting a price on carbon emissions or on the use of scarce resources. These two instruments were therefore disregarded in steps III and IV for the three adaptation measures in our study, but they may be useful for other adaptation policies that, for instance, intend to limit the use of fresh water in case of scarcity. Furthermore, we fine-tuned the scores of the policy instruments for the criterion of accountability based on the characteristics of one of the adaptation measures (Table 6.3). Measures for behavioural adaptation to extreme heat are rather difficult to trace and monitor in practice compared to the other two types of measures, resulting in a lower accountability. For instance, how would one monitor whether people drink sufficient water? For behavioural adaptation to extreme heat, we therefore lowered the scores for the criterion of accountability by one grade, i.e. from high to medium for policy instruments with a high score, and from medium to low for instruments with a medium score.

6.5.3. *STEP III: ASSESSMENT OF THE FOUR GOVERNANCE CHALLENGES FOR A CERTAIN ADAPTATION MEASURE*

In this step, we assessed the extent to which the four adaptation challenges manifest themselves in the three adaptation measures (Table 6.4). It shows that the challenge of uncertainty has the highest presence in the example of green roofs. This is because there is uncertainty in many aspects: in terms of the frequency and intensity of rainfall and the effects this rainfall may have on the built environment. Furthermore, there is uncertainty about the amount of rainfall that can be retained by a green roof, as well as what its private benefits are, some of which are difficult to convert to monetary values. This causes high uncertainty with respect to the return on investment of a green roof installation. Uncertainty for the other two adaptation measures is somewhat lower due to a higher predictability of sea level rise, river discharge levels, and hot days, and because of the more advanced knowledge of costs and benefits of these adaptation measures. The challenge of social complexity is most prevalent in behavioural adaptation to extreme heat. This is because there are potentially many different actors and organisations involved, both in the public and in the private sector, some of which are difficult to steer and monitor (such as vulnerable people themselves, and their social networks). Although different public and private organisations are involved in green roofs and flood-resilient building measures, there is more clarity and traceability.

Next, based on the assessment of which challenges were most dominant for each adaptation measure, we identified the most relevant criteria from the full set of criteria in Table 6.2. For the sake of simplicity, we limited the relevant criteria to those related to challenges with a high score only. Flood-resilient building measures, for instance, are characterised by high spatial diversity. This means that two criteria are most important for the selection of instruments for this type of measure: "steers towards supplying sufficient levels of adaptation goods to hotspots most vulnerable to flooding", and "promotes diverse adaptation action that is tailored to a specific location in order to minimize costs". This way, we discerned a distinct set of relevant criteria for each adaptation measure (Table 6.5).

Challenge	Score	Argumentation
Green roofs for rainfall retention		
Uncertainty about climate impacts on society, and the effect, cost and benefits of adaptation measures	**H**	There is a considerable unpredictability in the frequency and intensity of rainfall events and the timing and severity of its impacts in different parts of the built environment; the effectiveness of green roofs for rainfall retention in specific locations is highly uncertain, as is their return on investment given their uncertain and often non-monetisable benefits.
Spatial diversity in terms of differential climate impacts on society	**H**	The amount of rainfall can vary spatially; more significantly the extent of nuisance from heavy rainfall and the effectiveness of green roofs heavily depends on the specific location, amount of existing green space, type of building, slope of roof, etc.
Controversy about the adaptation goals and measures	**L**	No-regret measure with many public and private benefits, and no negative externalities for others.
Social complexity in terms of the multi-sector and -actor character of adaptation	**M**	Number of actors involved is traceable and manageable; there is some complexity given the split incentive issue between tenant interests and landlord/real estate investor interests.
Flood-resilient building measures		
Uncertainty about climate impacts on society, and the effect, cost and benefits of adaptation measures	**M**	There is some knowledge/expectation about sea-level rise and increased river discharge, but some degree of uncertainty remains; there is a medium level of knowledge regarding the effectiveness of different adaptation measures.
Spatial diversity in terms of differential climate impacts on society	**H**	The amounts of damage and risk differ considerably per location, house, type of measure taken, etc.
Controversy about the adaptation goals and measures	**L**	There is much agreement on the need for and specifications of building codes to make buildings flood resilient, in particular, in case of new developments.
Social complexity in terms of the multi-sector and -actor character of adaptation	**M**	Number of actors involved is traceable and manageable; however, there could be diverging views on acceptable risk and damage levels.
Behavioural adaptation to extreme heat		
Uncertainty about climate impacts on society, and the effect, cost and benefits of adaptation measures	**M**	Hot days and heat waves can be predicted well in advance; the effectiveness of simple behavioural measures to avoid or reduce heat stress is well known; such measures generally involve low cost (little uncertainty regarding return on investment); however, one cannot be certain of the extent of behavioural adaptation of vulnerable groups.
Spatial diversity in terms of differential climate impacts on society	**H**	Build-up of heat indoors and outdoors depends very much on the location, amount of green space, living environment, quality of housing etc.; vulnerability to heat stress among population groups is diverse.
Controversy about the adaptation goals and measures	**L**	No-regret measures; little effort is needed to adapt behaviour; no negative externalities for others.
Social complexity in terms of the multi-sector and -actor character of adaptation	**H**	The whole health and social network is/could be involved, in particular, in addressing the problem of vulnerable people; some actors in the social network (family, neighbours) are difficult to steer and to monitor.

Performance criteria were assessed using a qualitative score: H = high, M = medium, L = low.

Table 6.4: Assessment of the four challenges for each of the three adaptation measures

Challenge	Extent to which this challenge is present	Criteria at risk	Performance criteria for the selection of policy instruments (see Table 6.2)
Green roofs for rainfall retention			
Uncertainty	High	Effectiveness	Steers towards supplying sufficient levels of adaptation goods/services
		Fairness	Steers towards supplying sufficient levels of adaptation goods/services for everyone now and in the future
		Legal certainty	Offers legal certainty through understandable rules
		Efficiency	Promotes flexible solutions that can be adjusted over time
Spatial diversity	High	Fairness	Steers towards supplying sufficient levels of adaptation goods to vulnerable hotspots
		Efficiency	Promotes diverse adaptation action tailored to a specific location
Flood resilient building measures			
Spatial diversity	High	Fairness	Steers towards supplying sufficient levels of adaptation goods to vulnerable hotspots
		Efficiency	Promotes diverse adaptation action tailored to a specific location
Behavioural adaptation to extreme heat			
Spatial diversity	High	Fairness	Steers towards supplying sufficient levels of adaptation goods to vulnerable hotspots
		Efficiency	promotes diverse adaptation action tailored to a specific location
Social complexity	High	Input legitimacy	Serves all relevant interests that are influenced by the policy without excluding actors that have something at stake
		Accountability	Supports the allocation and transparency of responsibilities for adaptation action for both the governors and the governed

Table 6.5: Measure-specific relevant criteria for the selection of policy instruments

Dominant Challenge	Relevant indicators to assess a policy instrument	Policy instruments which score high on these relevant criteria	Policy instruments which score high on all relevant criteria	Weakness(es) of these instruments: indicators for which these instruments have low scores
Green roofs for rainfall retention				
Uncertainty	Steers towards supplying sufficient levels of adaptation goods/services	Technical requirements & Performance standards	Performance standards	Risk of not serving all relevant interests that are influenced by the policy without excluding actor(group)s that have something at stake
	Steers towards supplying sufficient levels of adaptation goods/services for everyone now and in the future			
	Offers legal certainty through understandable rules			
	Promotes flexible solutions that can be adjusted over time			
Spatial diversity	Steers towards supplying sufficient levels of adaptation goods to vulnerable hotspots	Contractual agreements & Smart subsidies		Risk of not steering towards supplying sufficient levels of adaptation goods (for everyone now and in the future)
	Promotes diverse adaptation action tailored to a specific location			
Flood resilient building measures				
Spatial diversity	Steers towards supplying sufficient levels of adaptation goods to vulnerable hotspots	Contractual agreements & Smart subsidies	Contractual agreements & Smart subsidies	Risk of not steering towards supplying sufficient levels of adaptation goods (for everyone now and in the future)
	Promotes diverse adaptation action tailored to a specific location			
Behavioural adaptation to extreme heat				
Spatial diversity	Steers towards supplying sufficient levels of adaptation goods to vulnerable hotspots	Contractual agreements & Smart subsidies	Contractual agreements	Risk of not steering towards supplying sufficient levels of adaptation goods (for everyone now and in the future)
	Promotes diverse adaptation action tailored to a specific location			
Social complexity	Serves all relevant interests that are influenced by the policy without excluding actors that have something at stake	Contractual agreements		
	Supports the allocation and transparency of responsibilities for adaptation action for both the governors and the governed			

Table 6.6: Measure-specific assessment of policy instruments

6.5.4. *STEP IV: SPECIFIC SELECTION OF INSTRUMENTS FOR AN ADAPTATION MEASURE*

Based on the general assessment of policy instruments (Step I; Table 6.3), we were able to identify policy instruments that scored high on the sets of relevant criteria for each adaptation measure (Step III; Table 6.5). The results achieved by combining these steps are given in Table 6.6. In the next subsections, we briefly discuss each adaptation measure in terms of appropriate instrument mixes.

6.5.4.1. Green roofs

This measure is characterised by relatively high levels of uncertainty and spatial diversity. We discerned the six criteria that are most relevant for the assessment of policy instruments for green roofs (Table 6.5) and then searched for policy instruments that received good scores for these six criteria based on the results in Table 6.3. The policy instrument that performs best, (having medium to high scores on all six criteria, is the performance standard, implying a public governance arrangement with the local authority as the principal governor. The most important weakness of this instrument is that it scores low on input legitimacy, i.e. the criterion of serving all interests that are influenced by the policy, because it is a universal instrument that is not designed to cover all relevant interests (Table 6.6). However, no other instrument really scores well on that specific criterion. The most appropriate alternative to the performance standard would be the contractual agreement, which scores quite well on the six relevant criteria and also has a medium score for input legitimacy. One could combine these two instruments by introducing contractual agreements based on a performance standard. This would allow those public and private actors that enter into the contract to adjust the adaptation measure to their location-specific needs, suggesting an interactive governance arrangement. A potential weakness of the combination of these instruments is that they score relatively low on the indicator of "steers towards supplying sufficient levels of adaptation action" (Table 6.6). Finally, a sequential introduction can be designed by starting with the introduction of contractual agreements based on performance standards. As and when the green roof technology becomes well-known and accepted, and its costs drop (potentially due to economies of scale), a technical requirement for all new developments can be introduced, which scores well on the effectiveness criterion of sufficient levels of adaptation action. Note that this would imply a shift from interactive to public governance over time.

6.5.4.2. Flood resilient building

This type of measure is relatively less complex than green roofs or behavioural adaptation to extreme heat in the sense that it is primarily characterised by a high level of spatial diversity. Based on the two relevant criteria for dealing with spatial diversity, contractual agreements would seem to be most appropriate, so that areas specifically prone to flooding are addressed. Another appropriate instrument would be the use of smart subsidies directed towards these hotspots. Both instruments are in line with interactive governance. The downside of these instruments is that they do not guarantee a sufficient level of adaptation to flooding for everybody. This could leave some households less protected than others, which would perhaps be unfair, particularly if these households cannot afford the costs of adaptation measures. If experts and policy-makers find that safety for all is critical, the alternative would be to introduce a technical requirement for a specific set of flood-resilient measures through building codes in specific flood-prone areas. This would entail a public instead of an interactive arrangement.

6.5.4.3. Behavioural adaptation to extreme heat

In addition to high spatial diversity, which it has in common with the other two measures, this type of measure is characterised by a high level of social complexity. Hence, two additional criteria are of importance here: "serves all relevant interests that are influenced by the policy" and "supports the allocation and transparency of responsibilities" (Table 6.5). No single instrument scores high on all four criteria (Table 6.3). Contractual agreements score best on all these criteria. An example of a contractual agreement is a covenant between local health authorities and civil society such as advocacy groups for the elderly and community workers, which stipulates responsibilities for active advice to elderly people. Contractual agreements, however, score medium on the criterion of serving all relevant interests. This would imply that several instruments are needed to cover the diversity of stakes involved in this socially complex issue. It is, for instance, obvious that population groups vulnerable to heat stress should be steered differently than the health practitioners who could keep an eye on them. Clearly, a requirement that forces a vulnerable individual to drink an extra glass of water is probably ineffective and would certainly not be considered legitimate. However, a requirement for health practitioners and social workers to track and monitor vulnerable individuals seems less inappropriate. In particular, for this adaptation measure, a mix of instruments is preferable. General heat health campaigns can be directed at the whole population and further targeted with specific information to vulnerable groups. Contractual agreements can be made between public health officials, health care institutions, and social/community workers that make special arrangements for stimulating active engagement with particular vulnerable groups. The mix of instruments also implies a mix of governance arrangements.

Overall, the results indicate that contractual agreements are an appropriate policy instrument for the three adaptation measures in our study (Table 6.6). This is because the three measures score high on the governance challenge of spatial diversity. Contractual agreements permit governors to differentiate between vulnerable areas, regions, and population groups, and hence, to direct adaptation actions toward these hotspots. The varieties of appropriate instrument mixes among these three adaptation measures, therefore, stem from the differences in the extent of uncertainty and social complexity.

6.6. CONCLUSION AND REFLECTION

We presented a method for the selection of a mix of public and private policy instruments for promoting climate adaptation action. So far, the 'how to adapt' question has tended to be dominated by debates on the adaptive capacities required (e.g. Eakin and Lemos, 2006; Gupta et al., 2010; Juhola and Kruse, 2013) and on overcoming the barriers that constrain action (e.g. Moser and Ekstrom, 2010; Biesbroek, 2014). We pose the employment of policy instruments as an alternative interface between adaptation planning and practice; the proposed method for their selection takes into account some of the key barriers and challenges as discussed in the literature.

Through the application of the method to three examples of climate adaptation measures, we arrive at the following four conclusions. First, the method fosters the assessment of various types of policy instruments with a comprehensive set of normative criteria commonly applied in policy practice. The bulk of the literature on the assessment of environmental policy instruments focuses on issues of effectiveness and efficiency only (e.g. Bemelmans-Videc et al., 1998; Bennear and Stavins,

2007; Taylor et al., 2012) or deals with the assessment of one type of instrument only (e.g. Bennear and Stavins, 2007). The few studies on the evaluation of policy instruments for climate adaptation tend to emphasise economic instruments and economic criteria (Hellegers and Van Ierland, 2003; Fankhauser et al., 2008; Filatova, 2014). Furthermore, these normative criteria are specified for climate adaptation by taking into account four particular challenges to the governance of adaptation, namely uncertainty, spatial diversity, controversy, and social complexity. This adaptation specific set of criteria allows for a deliberate rather than a routine or intuitive choice of instruments for climate adaptation.

Second, the stepwise approach of the method enables a structured and interactive process that fosters dialogue and consensus building among experts, resulting in a deliberative choice of policy instruments. This resonates with adaptation scholars, who agree that deliberation and dialogue between policy-makers, scientists and stakeholders is needed to deal with the inherent uncertainty and social complexity of climate adaptation (e.g. Paavola, 2008; Adger et al., 2009; Juhola and Westerhoff, 2011).

Third, there is no question of a one-size-fits-all policy instrument mix for climate adaptation. The examples of adaptation measures we used show variety in the extent to which the four governance challenges manifest themselves, resulting in different levels of appropriateness for different policy instrument mixes. Again, this seems to fit with the bulk of adaptive capacity/governance literature, which stresses the need for variety, flexibility, and tailor-made solutions (e.g. Adger et al., 2009; Saavreda and Budd, 2009; Gupta et al., 2010).

Finally, the examples of adaptation measures also show that the method opens up avenues for launching new policy instrument mixes. This, in turn, has implications for the division of responsibilities between public and private actors. A shift in policy instruments may therefore trigger a shift in governance arrangements for a certain adaptation issue or measure.

We end by reflecting on some limitations to our study and, based on those, suggesting some ideas for future work. The process for the selection of policy instruments was completed by a group of six experts representing three scientific disciplines of relevance to the broad field of policy studies. Repeating our study with more or other experts, including experts in policy-making and policy practice, would eliminate potential biases we are unaware of and increase the robustness of our judgments. Policy-makers may place different weight on certain performance criteria, in resonance with the political or social culture to which they are bound. Instrument choices can also be influenced by considerations and constraints in the political and societal context (Hood, 1983) or by the attributes of the policy network (Bressers and O'Toole, 1998), phenomena which we did not consider. Another limitation is the choice of adaptation examples, which focused on urban adaptation measures. This could bias the set of criteria employed. Future work could evaluate the comprehensiveness of the set of criteria by testing it with other adaptation measures, which may also entail additional policy instruments. Finally, based on our experience with presenting the method to a group of policy-makers involved in adaptation planning for fresh water supply in the Netherlands, we found that the method was perceived to be quite challenging but also complex. Therefore, we argue that scientific experts may be needed to facilitate the process and give structure to the debates. These experts should have knowledge of the adaptation theme at hand, and should be able to promote the understanding of the performance criteria and to foster exchange of argumentation among policy-makers. Ultimately, they can check the validity of these argumentations to avoid negotiated nonsense (Van de Riet, 2003).

2 AD NIEUWS zaterdag 26 januari 2013
NL

STAD MOET LEREN LEVEN MET MOGELIJKE DIJKDOORBRAAK

Dordrecht in de ban van horrorscenario's

DORDRECHT • In Dordrecht juichen ze het plan van verzekeraars om volgend jaar een overstromingspolis verplicht te stellen van harte toe. Daar weten ze als geen ander wat het is om met het water te leven. „Als mensen moeten meebetalen, worden ze zich bewuster dat ze in een risicovol overstromingsgebied wonen."

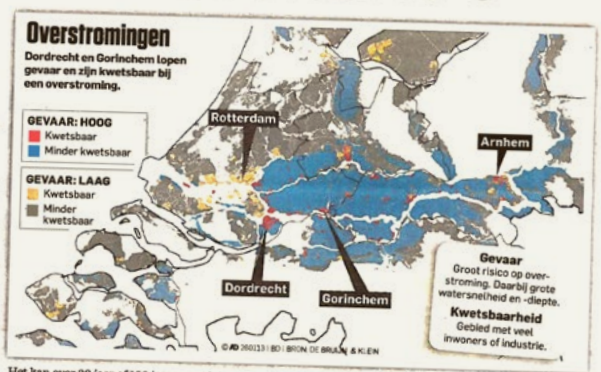
NATASJA DE GROOT

Dagen zonder stroom, geen warm water, huizen die verwoest zijn, gesloten winkels, gezinnen dakloos, overal modder in de straten. In deze ellendige staat liet orkaan Sandy vorig jaar New York achter.

Maar dit had ook zomaar in Dordrecht kunnen gebeuren, zo realiseert gemeentelijk projectleider Ellen Kelder zich. Namens de gemeente houdt zij zich al jaren bezig met het waterbeleid.

Het was in 2005, toen de orkaan Katrina New Orleans onder water zette, dat bij het stadsbestuur doordrong hoe kwetsbaar Dordrecht is. De stad bleek te behoren tot een van de meest risicovolle overstromingsgebieden van ons land. Na 3 jaar onderzoek werd het duidelijk hoe groot het gevaar eigenlijk is: als het écht misgaat, dan loopt de hele binnenstad onder en zullen de economische schade en het aantal slachtoffers niet te overzien zijn.

„In een extreme situatie komt het water van twee kanten: zowel uit zee als uit de rivieren. Dan zal de dijkring het aan de noordoostkant niet houden en doorbreken.



Het kan over 20 jaar of 100 jaar gebeuren, maar ook morgen. Één ding is zeker: dan zit Dordrecht echt in de problemen," vertelt projectleider Ellen Kelder, die zich namens de gemeente al jaren bezighoudt met het waterbeleid.

Zelf woont Kelder in Hoek van Holland, maar niet vanwege de dreiging. „Het water kan ook uit zee komen." Wat haar wel zorgen baart, is dat het voor Dordtenaren moeilijk zal zijn weg te komen als het moment daar is. „De snelweg A15 zal snel vastlopen en het is de vraag of de Moerdijkbrug nog begaanbaar is. Bewoners zitten dan mogelijk dagenlang opgesloten."

Het zijn dit soort horrorscenario's die voor het stadsbestuur aanleiding zijn om bij de rijksoverheid aan te dringen te investeren in de aanleg van een zogeheten Deltadijk, een dijk die niet kan doorbreken. „Dit is een stuk versteviging dat op een kwetsbaar deel van de dijk geplaatst kan worden. Hierdoor hoeft niet meteen de hele dijk te worden vervangen. Maar of zo'n Deltadijk er komt, hangt af van de Deltacommissie. Die zal daar de komende jaren over beslissen."

Maar niet alleen in Dordrecht zijn ze zich bewust van het wassende water. Want uit een onderzoek uit 2011 van de rijksoverheid blijkt dat ook in gebieden als de Alblasserwaard en de Krimpenerwaard de risico's groot zijn. Sterker nog: een op de drie dijken en een op de vijf kunstwerken, zoals gemalen en sluizen, verspreid over heel Nederland blijkt zelfs niet aan de veiligheidseisen te voldoen.

Juist daarom ziet Dordrecht het als taak burgers bewust te maken van de risico's en te helpen bij het nemen van maatregelen. „We hoeven mensen niet angstig te maken. Maar het is goed als burgers beseffen dat ze in een overstromingsgevoelig gebied wonen en weten wat ze zelf kunnen doen om eventuele schade te beperken. Zoals hun cv-ketel op de eerste etage van de woning hangen of door zandzakken neer te leggen als het water stijgt."

Dat verzekeraars met een verzekeringspolis willen komen, juicht de gemeentelijk watercoördinator toe. Bijna overal ter wereld kunnen mensen zich verzekeren tegen dit risico, maar in Nederland is het niet meer mogelijk geweest na de Watersnoodramp in 1953. De financiële schade leidde bijna tot het bankroet van verzekeraars.

Kelder: „Als mensen extra premie moeten betalen, worden ze zich bewuster van de omgeving waarin ze leven."

Dordrecht wil dat de burgers zich bewust zijn van het gevaar. Bij wassend water zouden zij zandzakken kunnen aandragen. FOTO CDR DE KOCK

AD Amersfoortse Courant 26-01-2013

7 SYNTHESIS OF RESEARCH FINDINGS

7.1. INTRODUCTION

The preceding empirical chapters offered an analysis and evaluation of different governance arrangements for each of the three cases of adaptation measures in a selection of cities. This chapter covers a synthesis of the main findings from theses analyses contained in the separate chapters, as well as from a cross-issue comparative analysis across the three cases of adaptation measures (see Figure 1.1). The latter is an additional analytical step that results in a synthesised overview and identification of common patterns of the public, private and public-private responsibilities in the different stages of the policy process for the three cases of adaptation measures, as well as their underlying considerations. Furthermore, each case is evaluated against the most relevant criterion for that case, and alternative arrangements are discussed for each case in view of the projected key challenges that climate change poses in the near future. The synthesis of findings of the three research projects (cross-city comparison) and the overall PhD research (cross-issue comparison) is structured along the six research questions posed in the introduction chapter, each representing a section of this chapter.

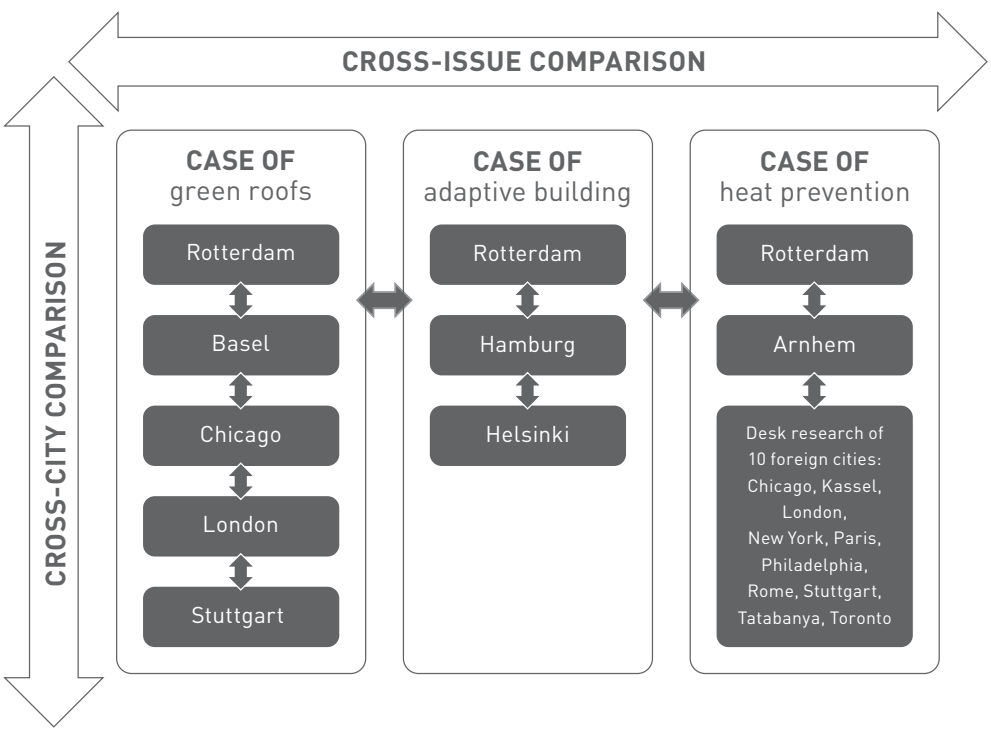


Figure 1.1: Illustration of the multiple, comparative case study design

7.2. CONSIDERATIONS IN THEORY

RQ1. *Which considerations might underlie the divisions of responsibility among public, private or public-private actor constellations, and what explains why and when particular considerations become relevant to the division of responsibilities?*

This theoretical question is addressed in Chapter 2. The scientific debate on responsibilities for adaptation to climate change is fuelled by different rationales underlying public policy, stemming from different scientific disciplines. In Chapter 2 a literature review was conducted to document and analyse these rationales, from which the considerations were derived. This literature review also yielded several challenges that are specific to the governance of adaptation to climate change, and that may influence the relevance of the considerations. The overall conclusion and the considerations and challenges are discussed below.

Overall conclusion: Six considerations are identified that may underlie public, private or shared public-private responsibilities in the different stages of the policy process. The extent to which these considerations come into play is determined by specific challenges to the governance of adaptation to climate change as well as by the economic, cultural and political context.

In a first step, the considerations were extracted from three different rationales, referred to in this dissertation as the economic, juridical and political perspective. For each perspective two key considerations were deduced, leading to a total set of six considerations that might underlie a certain public, private or public-private responsibility for adaptation to climate change. The responsibility for adaptation is operationalised as several specific roles in four different stages of the policy process (see Table 2.1 in Chapter 2). The six considerations are: *securing adaptation action* (as specification of effectiveness), *efficiency, rule of law, fairness, legitimacy and accountability* (see Figure 2.1 in Chapter 2). While they represent common criteria for policy evaluation, in this research they are also applied as considerations that public and private actors, consciously or unconsciously, take into account when assuming responsibility or delegating responsibility to others. If efficiency is the main consideration for the allocation of responsibilities for a certain adaptation issue, for instance, it is expected that many responsibilities will be borne by private actors. If fairness in terms of inter- or intra-generational equity is the dominant consideration for another adaptation issue, one could expect that several responsibilities will be borne by public actors. If legitimacy is a key consideration, it is expected that several shared public-private responsibilities will exist (for an elaboration see Chapter 2 and Table 2.2).

In a second step, from the literature review four specific challenges to the governance of adaptation were derived. These are *uncertainty, spatial diversity, controversy and social complexity.* In Chapter 2 it is hypothesised that these challenges may influence the extent to which these considerations come into play, and therefore influence the division of responsibilities for adaptation. This led to the conceptual framework of responsibilities as depicted in Figure 2.2, as well as a list of nine hypotheses for the mutual relations between the governance challenges, the six considerations, and the division of responsibilities across the four stages of the policy process (those hypotheses can be found in Table 2.2 in Chapter 2). One of these hypotheses, for instance, concerns the effect of the adaptation challenge of uncertainty on the consideration of securing adaptation action. It is expected that the higher the uncertainty about future benefits/avoided costs of adaptation measures, the more it acts as a barrier to private action and the higher the risk of not reaching adaptation targets; hence the need for governments to initiate (and

implement) adaptation policies on behalf of society. This hypothesis has proven to be valid for the cases of green roofs and adaptive building, as the findings in section 7.4 (RQ3) show.

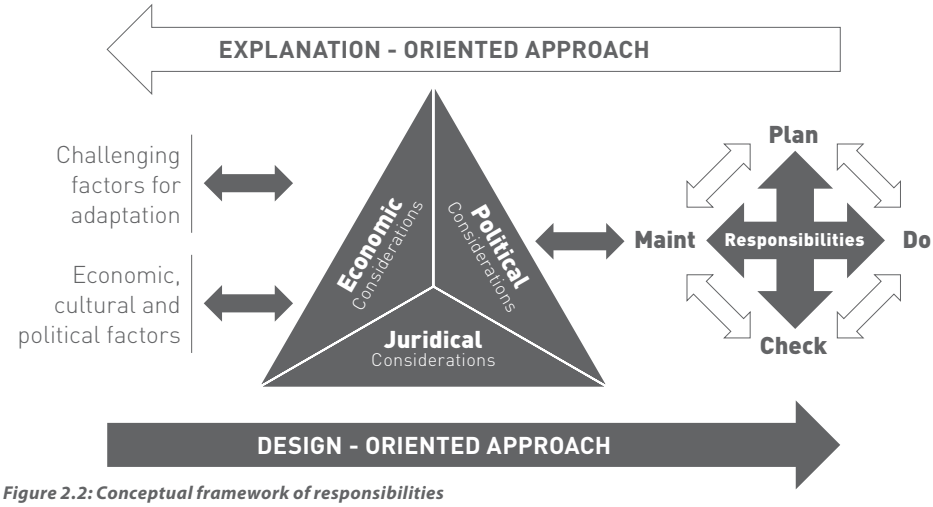


Figure 2.2: Conceptual framework of responsibilities

The conceptual framework was applied as a device for the analysis and explanation of existing divisions of responsibility (explanation-oriented approach), and for the design of alternative divisions of responsibility (design-oriented approach). The explanation-oriented approach was applied in the three chapters covering the three cases of adaptation measures, the findings of which are discussed in the sections 7.3 and 7.4. This explanation-oriented approach allowed the testing of some of the hypotheses. The design-oriented approach of the conceptual framework was used to address the research question of what could be promising alternative arrangements (RQ6). It can be used as a tool to enable a deliberate and deliberative process of decision-making for divisions of responsibilities, similar to the method for the selection of policy instruments in Chapter 5. This approach is further discussed and illustrated in section 7.7.

7.3. RESPONSIBILITIES IN PRACTICE

RQ2. *Which divisions of responsibilities between public and/or private actors exist or are envisaged for the three key urban adaptation issues of storm-water retention, water safety, and heat prevention?*

The answer to this empirical question is derived from an analysis of the three empirical chapters covering the three case studies of green roofs, adaptive building, and heat prevention measures. It has resulted in a synthesised overview of the various public, private and public-private responsibilities in the different stages of the policy process for the three cases of adaptation measures. This overview can be found in Table 7.1. For each of the 20 governance arrangements in early adopting cities analysed in this research, the responsibilities were quite clearly allocated between the relevant public and private actors. Although in itself this is hardly surprising given the establishment of these arrangements, it does pose a nuanced view on the adaptation literature that claims that responsibilities are still rather vague and ambiguous. While this may be generally true, the research results suggest that this claim does not hold for cases where adaptation planning and action is actually happening. The overall conclusion and main findings regarding patterns of responsibility divisions are discussed below. Relevant explanations for these findings are provided in the next section.

Stages	Roles	Green roofs *Storm-water retention* (Chapter 3, Table 3.4)	Adaptive building *Water safety* (Chapter 4, Table 4.3)	Health care/built environment measures *Heat prevention* (Chapter 5, Tables 5.1 and 5.2)
Plan	Agenda setting	Public (all cities)	Public (Ha&He)	Data not available
		Private (consultants, ecologists) (L&B)	Private (He only for floating houses)	
		Public-private (industry association) (B only)	Public-private (R only)	
	Risk/vulnerability assessments	Public (all cities)	Public (all cities)	Public (all cities)
		Private (consultants, ecologists) (L&B)		
	Initiation of policy	Public (all cities)	Public (Ha&He)	Public (all cities)
			Public-private (R only)	
Do	Strategy making	Public (all cities)	Public (Ha&He)	Data not available
			Public-private (R only)	
	Planning & coordination	Public (all cities)	Public (Ha&He)	Data not available
			Public-private (R only)	
	Financing & implementation	Public (financial incentives) (all cities except L)	Public (public infrastructure) (all cities)	Public (city-wide BE measures) (all cities)
		Private (property owners) (all cities)	Private (adaptive measures) (all cities)	Private (individual HC&BE measures) (all cities)
				Public-private (HC measures) (all cities)
Check	Monitoring	Public (tracking of installations) (all cities)	Public (during planning permission) (all cities)	Public (early warning system) (all cities)
		Public (quality control) (B only)		
		Private (product norms/quality label) (B&S)	Private (housing corporation) (R only)	
	Enforcement	Public (B&S)	Not applicable	Not applicable
Maintenance	Maintenance of measure	Public (for public buildings only) (all cities)	Public (for public infrastructure only) (all cities)	Not applicable
		Private (property owners) (all cities)	Private (property owners) (all cities)	
	Risk communication	Not applicable	Public (Ha&R, no risk communication in He)	Public (all cities)
	Flood damage control	Not applicable	Public (flood evacuation planning) (all cities)	Not applicable
			Private (residents, Flutschutzgemeinschaften) (all cities)	
	Recovery of damage	Not applicable	Private (residents) (all cities)	Not applicable

Table 7.1: Synthesis of responsibilities across the three adaptation measures for all cities

B=Basel, Ha=Hamburg, He=Helsinki, L=London, R=Rotterdam, S=Stuttgart

BE=Built environment, HC=Healthcare

Overall conclusion: Existing governance arrangements for local urban climate adaptation are characterised by a large extent of public responsibility; private responsibility manifests itself mainly in the implementation of measures; and joint public-private responsibilities are quite rare.

The first finding is that the results indicate a clear role for local governments, certainly in the initiation of adaptation policy. Public responsibilities are visible at every policy stage and for almost every role in urban adaptation to climate change. As Table 7.1 shows, the Plan (roles in policymaking) and Check (roles in policy evaluation) stages in particular, are dominated by public responsibilities, with public authorities taking on the roles of agenda setting, policy initiation, risk/vulnerability assessment, strategy making, policy coordination, and policy monitoring.

Second, wherever there are instances of private responsibilities, they predominantly occur in the Do (financing and implementation of measures) and Maintenance stages of the policy process. A wide uptake of these urban adaptation measures for the built environment necessitates a high deployment of the resources of citizens and businesses. The research shows that public authorities use mainly economic and legal policy instruments to effectuate this.

Third, contrary to the debate in the environmental governance literature on the rise of new governance modes such as policy networks, in which responsibilities are shared among relevant public and private stakeholders (e.g. Sørensen, 2005; Bogason and Musso, 2006; Lemos and Agrawal, 2006; Rhodes, 2007; Lange et al., 2013), shared public-private responsibilities have not yet been widely adopted in the urban adaptation practice contained in this research. This finding is supported by a recent empirical study on network governance for climate adaptation, which found that these networks are more regional than local in scale and focus more on knowledge building than on the implementation of adaptation action (Juhola and Westerhoff, 2011). It also appears that policy networks at the local urban level are better developed for mitigation than for adaptation (Granberg and Elander, 2007; Bulkeley and Schroeder, 2012). Both this research and the limited number of other empirical studies indicate that interactive arrangements such as policy networks are not yet widely established for climate adaptation. This is somewhat remarkable, since I would have expected that a new and emerging policy field would be relatively less influenced by path dependencies from existing policy routines. Therefore, I expected there would be opportunities for new governance modes such as policy networks that are claimed to be better able to cope with wicked environmental issues and their inherent uncertainties and complexities through their participatory and deliberative approaches (e.g. Börzel, 1998; Dryzek, 2000; Meadowcroft, 2007; Paavola, 2008; Burton, 2009). Given the case studies in this research, I would have also expected more interactive arrangements with shared public-private responsibilities because the cases were strategically selected for their attempts to bring public and private interests together, and for their innovative character. In this research only one governance arrangement in one city (adaptive building in Rotterdam) was found to be characterised as a predominantly interactive arrangement across several stages of the policy process. Other than that, in the two other cases of adaptation measures, public-private responsibilities are only occasionally observed for specific roles within a policy stage.

Fourth, it appears that various governance arrangements accumulate: for each case a diversity of co-existing public and private responsibilities is visible across and within the four policy stages, and even for one and the same role and for the same city. This finding, that various governance arrangements co-exist and build upon each other, is also found in other fields of environmental research (Lowndes and Skelcher, 1998; Arts et al., 2006; Nilsson et al., 2009; Driessen et al., 2012). Table 7.1 shows patterns of combinations for each adaptation measure. A common combination for green roofs is a public arrangement in the early stages and a private arrangement in the later stages of the policy process; public authorities initiate and develop policy, and they delegate the implementation of measures to private actors such as citizens and project developers or housing associations. This is also the case for adaptive building measures in Hamburg and Helsinki, although in Rotterdam a combination of public and interactive arrangements is witnessed for adaptive building. In the case of heat prevention measures it is very common to combine a public arrangement for some of the roles (mainly initiation and development of policy, and risk communication) with an interactive arrangement in the implementation of healthcare measures. This co-existence of different responsibilities for different roles/policy stages does not easily fit into commonly used ideal-typical classifications of governance modes such as hierarchical governance, market governance and interactive governance (Thompson et al., 1991; Gunningham and Sinclair, 2002; Kjær, 2004; Driessen et al., 2012). The above suggests that classifications of governance modes may need to distinguish between the different stages of the policy process (cf. Lowndes and Skelcher, 1998).

The above findings remain valid, when limiting the comparison to the three arrangements for the three adaptation measures for the city of Rotterdam within a similar institutional, political, economic and cultural context for the three cases (see Appendix 9). The only key difference between Rotterdam and the other cities has been observed in the case of adaptive building, which is of a more interactive character. The next section discusses the explanations for these findings.

7.4. CONSIDERATIONS IN PRACTICE

RQ3. *What explains why certain responsibilities are taken on by, or assigned to certain public and/or private actors?*

The divisions of responsibilities, as empirically found in the previous section, are explained by unravelling the different considerations that may underlie these responsibilities, using the conceptual framework developed in Chapter 2, and contained in Figure 2.2. This section covers a synthesis of the main findings from the three empirical chapters covering the three cases separately, as well as from a comparative analysis across the three cases (the cross-issue comparison as displayed in Figure 1.1). The cross-issue comparison, a synthesis of which can be found in Table 7.2, is performed for the arrangements in Rotterdam, since for this city the considerations were most consistently analysed for the three cases of adaptation measures. Furthermore, it facilitates the comparison within a similar institutional, political, economic and cultural context. Although the analysis is focused on Rotterdam, most findings largely hold for the foreign studied cities too. Where there is a difference between Rotterdam and the foreign cities (for the case of green roofs only), this is discussed separately. The overall conclusion and main findings are as follows.

Overall conclusion: The two considerations that are pertinent to the dominance of public responsibility are: i) effectiveness in terms of securing sufficient adaptation action, and ii) rule of law in terms of the duty of care of local authorities for the health and living environment of citizens. The dominant consideration for assigning and taking on private responsibility is efficiency. Decisions on divisions of responsibility appear to be taken rather automatically and routinely; there is little evidence that decisions on responsibility divisions are explicitly and deliberately informed by the whole set of considerations and the four challenges to the governance of adaptation.

Table 7.2 shows that the most prevalent considerations for *public responsibility* are 'securing adaptation action' and 'rule of law'. In the case of the former consideration, the local authority takes on certain responsibilities because it assumes that leaving adaptation up to citizens and businesses will lead to insufficient adaptation or to maladaptation. In this case, market failure is an important factor for activating this consideration, as well as a sense of urgency related to extreme events such as floods, which are expected to be aggravated by climate change. In the second case, the local authorities take up certain responsibilities simply because they presume it is their duty of care as prescribed by Dutch law, whether for the living environment (green roofs) or for the health of their citizens (heat prevention measures). The potential threat of liability for damage is an important factor for activating the consideration of the rule of law. Together, the prevalence of these two considerations provides a key explanation for the fact that public responsibilities are so widespread across the stages of the policy cycle and across the three adaptation measures.

A second major finding is that 'efficiency' is the dominant consideration for *private responsibility*. This applies to public actors that delegate responsibilities to private actors (e.g. through policy instruments), as well as to private actors that take on responsibilities themselves. It is generally assumed by both public and private actors that private responsibility drives costs down and stimulates innovation. This is actually empirically observed in the green roof case; market actors in the cities of Basel and Stuttgart have been instrumental in driving innovations and in finding ways to decrease the overall costs, including logistical costs, of green roof installations. Overall, efficiency is the most cited consideration, not only for the allocation of responsibilities with private actors but also with public actors. The apparent dominance of the efficiency consideration appears to reflect the emphasis on an economic rationale for policy decisions (with efficiency as a key criterion for public policymaking) which has gained resonance since the rise of neo-liberalism and of new modes of governance in which the private sector plays a role (Peters and Pierre, 1998), and which has also entered the domain of environmental governance (Lemos and Agrawal, 2006).

Responsibility	Stages/roles	Green roofs Storm-water retention (Chapter 2; Table 2.3) (Chapter 3; Table 3.4) **Considerations and their rationales**	Adaptive building Water safety (Chapter 4, section 4.5) (Online report sections 1.2, 2.2 & 3.2) **Considerations and their rationales**	Health measures Heat prevention (Chapter 5, section 5.4, Table 5.1) **Considerations and their rationales**	Built Environment measures Heat prevention (Chapter 5, section 5.4, Table 5.1) **Considerations and their rationales**
Public	Plan: knowledge creation incl. risk/ vulnerability assessments	***Securing adaptation action:*** uncertainty of costs & benefits of GRs leads to inaction of private actors	***Securing adaptation action:*** private actors do not have the means to perform flood risk assessments	***Efficiency & Rule of Law:*** the local authority is considered most efficient at gathering information from public and private organisations; Duty of care of local authority for the health of its citizens (Dutch Health Act 2008)	***Efficiency:*** local authority is most efficient at gathering information from public and private organisations regarding the assessment of vulnerable groups
Public	Plan: agenda setting/initiation of policy	***Rule of law:*** duty of care of the local authority for the prevention of surface water flooding on public grounds (Dutch Water Act 2008)	Not applicable (see public-private responsibility)	***Fairness & Rule of law:*** only the local authority can guard the interest of the weakest; Duty of care of the local authority for the health of its citizens (Dutch Health Act 2008)	***Rule of law:*** duty of care of the local authority for the health of its citizens
Public	Do: strategy making	***Efficiency:*** choice of GRs as water retention measure because they are less costly than infrastructural measures and costs can be shared with the private sector	Not applicable (see public-private responsibility)	Data not available	Data not available
Public	Do: financing & implementation	***Securing adaptation action:*** high upfront installation costs discourage private actors; local authority offers a subsidy for installation of GRs	***Securing adaptation action:*** local authority increases the protection level of the neighbourhood to a minimum security level through a partial levy	Not applicable (see public-private responsibility)	***Rule of law:*** responsibility for city-wide measures due to a duty of care for the maintenance of the public space and the liveability of the city (Article 21, Dutch constitution)
Public	Check: monitoring	***Fairness & accountability:*** local authority monitors GR installations in line with granted subsidies		Not applicable	Not applicable
Public	Maintenance: risk communication	Not applicable	***Securing adaptation action:*** local authority provides advice due to a lack of awareness for and sense of urgency of citizens	***Rule of law:*** duty of care of the local authority for the health of its citizens (Dutch Health Act 2008)	Not applicable
Private	Do: financing & implementation	***Efficiency:*** GRs have many co-benefits that make them attractive for private property owners, thus providing economies of scope		***Legitimacy & personal empowerment:*** interventions by others are impingement on one's independence and easily viewed as paternalism	***Fairness & efficiency:*** It is fair that the person benefiting from the measure, pays for that measure; the inhabitant/ owner can adjust the building to his/her needs and budget

Table 7.2: Synthesis of considerations across the adaptation measures for the city of Rotterdam

GR=Green roof. Not applicable: the role does not exist or the role is taken on by/allocated with other actors

Table 7.2 continued

Not applicable: the role does not exist or the role is taken on by/allocated with other actors

Responsibility	Stages/roles	Green roofs **Storm-water retention** (Chapter 2; Table 2.3) (Chapter 3; Table 3.4) **Considerations and their rationales**	Adaptive building **Water safety** (Chapter 4, section 4.5) (Online report sections 1.2, 2.2 & 3.2) **Considerations and their rationales**	Health measures **Heat prevention** (Chapter 5, section 5.4, Table 5.1) **Considerations and their rationales**	Built Environment measures **Heat prevention** (Chapter 5, section 5.4, Table 5.1) **Considerations and their rationales**
Private	Plan: knowledge creation incl. risk/ vulnerability assessments	***Efficiency*** GR industry develops knowledge about the benefits of GRs to make them more efficient for property owners		Not applicable	Not applicable
Private	Check: monitoring	***Efficiency*** GR industry creates voluntary quality norms for product attributes to create market demand		Not applicable	Not applicable
Private	Maintenance: of measure	***Efficiency*** adequate maintenance reduces costs; GR industry often integrates maintenance in their contracts		Not applicable	Not applicable
Public-private	Plan: agenda setting/initiation of policy	Not applicable	***Legitimacy:*** All parties that are taking on responsibility for flood risk governance should be able to influence the decision-making process (throughput legitimacy); involvement of all parties encourages a wide endorsement of the arrangement (output legitimacy)	Not applicable	Not applicable
Public-private	Do: strategy making	Not applicable	***Legitimacy:*** All parties that are taking on responsibility for flood risk governance should be able to influence the decision-making process (throughput legitimacy); involvement of all parties encourages a wide endorsement of the arrangement (output legitimacy)	Not applicable	Not applicable
Public-private	Do: financing & implementation	Not applicable		***Securing adaptation action & efficiency:*** neighbourhood teams of public and private actors can pull their collective resources together; ideally heat health concerns are integrated into existing teams to be cost effective	***Efficiency***: partnership between the local authority and citizens/housing associations with joint responsibility for neigbourhood-scale measures that serve multiple purposes, thus accessing multiple budgets to finance these measures

Third, the scope of considerations that are taken into account in decisions on responsibility divisions is somewhat narrow. All considerations play a role in responsibility divisions, but only three considerations, i.e. securing adaptation action and rule of law for public responsibility, and efficiency for private responsibility, appear to have had a substantial influence. Contrary to our expectations based on the hypotheses formulated in Chapter 2, the political considerations of 'legitimacy' and in particular 'accountability' are less influential: they were only rather influential in the case of adaptive building. I argue that the adaptation governance challenges of uncertainty, controversy and social complexity have not widely triggered the considerations of legitimacy and accountability in practice, and have therefore only been implicitly taken into account in decisions on responsibility divisions for urban adaptation to climate change. In turn, this provides an explanation for the limited scope of public-private responsibilities in adaptation practice.

Fourth, the four challenges to the governance of adaptation as derived from the literature review in Chapter 2 have had less influence than expected on the six considerations in urban adaptation practice. There is only one challenge with a clear influence in two of the three cases: uncertainty seems to create market failure both in the green roof and in the adaptive building cases. Alternatively, the predominant considerations appear to have been mainly influenced by existing policy routines and ways of working in the city of Rotterdam or in Dutch society more generally. The adaptive building case, for instance, is first and foremost a case of 'area development' (translated from Dutch: 'gebiedsontwikkeling'). A very common way of working on area development in the Netherlands is through the creation of an interactive arrangement, in which the involved public and private actors are accustomed to forming partnerships and to sharing responsibilities for the development of the area. So even if the responsibilities for adaptation in Rotterdam are quite clear as stated in the previous section, the research results suggest that they are allocated rather automatically and routinely rather than deliberately and in a well-considered way. This can be deduced from the fact that only a limited number of considerations influenced the divisions of responsibility. Furthermore, the challenges to the governance of adaptation have hardly had a dominant influence on the divisions of responsibility between public and private actors. I argue that, as a result, opportunities are overlooked for developing promising governance arrangements for climate adaptation that are tailored for these challenges. This point will be further addressed in section 7.7.

Fifth, tensions between the considerations are inherent in decisions on responsibility divisions. Each of the three adaptation cases in Rotterdam shows signs of these tensions. In the green roof case the dominant efficiency rationale has repercussions on fairness and legitimacy. From the perspective of the public authority it may be efficient to leave the financing of installations with citizens and business, but this might mean that socially deprived areas remain relatively vulnerable to excessive rainfall because those citizens simply cannot afford a green roof. From the perspective of the public authority it may be efficient not to involve the private sector in the policymaking for green roofs, but this could result in a lack of legitimacy for the policy. The adaptive building case is characterised by a tension between efficiency and securing adaptation action. Again the public authority may find it efficient to leave the implementation of adaptive measures with the private sector, but this could result in lower levels of adaptation action than actually needed. In the heat stress case the consideration of personal empowerment has some drawbacks on the considerations of securing adaptation action and fairness. The right of an individual to decide over his/her own health might result in vulnerable people not being sufficiently protected against heat stress.

Sixth, when focussing on differences between the three adaptation measures the following findings come to the fore. It is remarkable that the consideration of securing adaptation action has activated public responsibilities for the cases of green roofs and adaptive building, but not for heat prevention in Rotterdam. A likely explanation is that the sense of urgency regarding heat stress is very low among policymakers and other stakeholders: heat-waves have only occurred incidentally in the Netherlands, and there is a lack of pressure from the Dutch public because citizens are not aware of the potentially high rates of mortality and morbidity of heat-waves (Salcedo Rahola et al., 2009; Wardekker et al., 2012), while the Dutch have ample experience with (near) floods. Another remarkable difference is that, contrary to the other two cases, efficiency is not the primary consideration underlying private responsibilities for the implementation of healthcare measures in Rotterdam. This can be explained by the fact that the issue of responsibilities in the domain of healthcare is first and foremost an issue of individual versus collective responsibility (rather than public versus private, a distinction that holds in case of collective responsibility). Personal empowerment for decisions over one's own health is an important additional consideration for individual responsibility, as Chapter 5 has highlighted.

Finally, a few differences between Rotterdam and the foreign cities were found in the green roof case. In Basel and Stuttgart the consideration of 'fairness', in the sense of the creation of a level playing field, was an additional consideration for the public authorities to take on responsibility for the role of enforcement of green roofs. In contrast to the other cities, in Basel efficiency was a primary consideration for the creation of a public-private partnership to promote green roofs and to develop industry norms and quality labels for green roofs.

7.5. THE EFFECTIVENESS, LEGITIMACY AND FAIRNESS OF GOVERNANCE ARRANGEMENTS

RQ4. *For each of the three adaptation issues, which consideration is most relevant and how do the divisions of responsibility perform against this consideration?*

Now that emerging governance arrangements for urban adaptation to climate change have been mapped, analysed and explained, their evaluation is the focal point of this section. As stated in Chapter 1, each division of responsibility may have different normative consequences in terms of efficiency, legitimacy, fairness, accountability etc. It is a primary reason for why it matters to make informed decisions on the division of responsibility for climate adaptation. The six considerations from section 7.2 can be used for the evaluation of the performance of responsibility divisions, to measure the success of governance arrangements for adaptation. The six considerations are quite commonly applied as criteria for (environmental) policy evaluation (e.g. Adger et al., 2003; Crabbé and Leroy, 2008) and also reflect common criteria of good governance (e.g. Botchway, 2001; Lockwood, 2010). For each of the three empirical research projects the most important consideration for that specific adaptation issue/measure was deduced from the literature and discussed in the separate chapters. Consequently, based on this relevant consideration, the emerging governance arrangements are evaluated. The main findings are discussed below for each of the three cases of adaptation measures. Based on the three cases of adaptation measures, the following overall conclusion is presented.

Overall conclusion: public responsibility in the first stage of the policy process tends to enhance the effectiveness (green roofs), legitimacy (adaptive building) and fairness (heat stress prevention) of the governance arrangements.

7.5.1. *THE EFFECTIVENESS OF GREEN ROOF ARRANGEMENTS*

For the case of green roofs as a measure for water retention, the most relevant consideration is securing adaptation action (as the operationalisation of effectiveness; see also section 3.2.2 in Chapter 3). This is because there is considerable uncertainty on the return on investment of green roofs (there is limited knowledge of the costs and benefits of green roofs), and this deters private actors from installing green roofs (e.g. Carter and Fowler, 2008; Clark et al., 2008; Niu et al., 2010). Furthermore, those private actors are unable to recoup the benefits gained by society at large, such as the water retention capacity. The above instances of market failure make the consideration of securing sufficient levels of adaptation action most relevant.

A first major finding from Chapter 3 in the case of green roofs, is that securing ány meaningful adaptation action (regardless of the level of action) is only achieved by public authorities taking responsibility in the first stage of the policy process. They need to initiate some kind of policy to stimulate green roof uptake by private actors. A second major finding is that hierarchical arrangements with predominantly public responsibilities throughout the policy cycle and with a mix of policy instruments (stick & carrot) as found in Basel and Stuttgart are significantly more effective in reaching high levels of green roof implementation. They are, therefore, more effective in securing sufficient levels of adaptation action. The major conclusion from this research project is that public responsibility is necessary for those adaptation measures that largely depend on their implementation by private actors (such as adaptation measures to individual buildings), and that are characterised by instances of market failure, so that autonomous implementation is hampered. Ideally, this public responsibility is taken on in various stages of the policy process as observed in Basel and Stuttgart, but in any case in the Plan stage (in particular agenda setting, policy initiation and strategy making which is taken on by public authorities in all of the studied cities), so as to secure adaptation action.

7.5.2. *THE LEGITIMACY OF ADAPTIVE BUILDING ARRANGEMENTS*

In the case of adaptive building for water safety, legitimacy is regarded as the most relevant consideration (see section 4.1. in Chapter 4). Adaptive building necessarily requires the bearing of responsibility by private actors, for instance for the flood proofing of individual buildings, for flood preparation and for the recovery of damage. In environmental governance literature, the private responsibility for a public issue is claimed to raise legitimacy concerns (such as the democratic deficit as posed by for instance Bäckstrand, 2006; Lemos and Agrawal, 2006; Dingwerth, 2007; Biermann and Gupta, 2011). Moreover, in most countries in Europe and North America, for issues of national security such as water safety, the government has always had automatic and exclusive legitimacy to carry responsibility for the common good. Legitimacy is, therefore, regarded as an important consideration wherever responsibilities for water safety are transferred to citizens and project developers, as is the case with adaptive building measures.

A first major finding from Chapter 4 in the case of adaptive building, is that different divisions of responsibility can all be legitimate in different ways. The research results indicate that a large degree of public-private responsibilities can raise legitimacy, in particular throughput legitimacy (i.e. legitimacy resulting from a high level of access to and influence on the decision-making), through extensive participation and deliberation, as the Rotterdam case shows. A large degree of public responsibilities can raise legitimacy, in particular output legitimacy (i.e. legitimacy derived from a high level of stakeholders' acceptance), through a proper clarification of responsibilities (on what is expected of public authorities, and what is expected of private actors such as developers, housing associations and residents) and through continuous transparent communication on these responsibilities, as the Hamburg case shows. The findings of Chapter 4 suggest that a large degree of private responsibility for flood damage control and recovery is legitimate, provided that residents have sufficient sense of urgency of flood risks and have the capacity to take action on flood remediation. The Hamburg case shows that a private responsibility for flood damage control and recovery is properly supported by a public responsibility for flood risk communication to make the arrangement legitimate in terms of output legitimacy. A second major finding is that, irrespective of the type of governance arrangement found for adaptive building, in the three studied cities a public responsibility for the ratification of adaptive building plans by elected representatives such as aldermen/senators remains important for achieving sufficient input legitimacy (i.e. equal and inclusive representation of interests). It appears that involving the traditional elected representatives in such a ratification step is currently still needed to overcome the 'democratic deficit' owing to the direct involvement of private actors in adaptive building.

7.5.3. *THE FAIRNESS OF HEAT PREVENTION ARRANGEMENTS*

In the case of healthcare and built environment measures to prevent heat stress, a relevant consideration is fairness in terms of the protection of the weakest in society, i.e. those citizens/groups most vulnerable to heat stress (see section 5.1 in Chapter 5). These citizens are faced with a severe increase in the risk of morbidity and mortality during heat events, but they are often unable to protect themselves due to social determinants of vulnerability such as isolation, deprivation etc. Therefore, fairness in 'putting the most vulnerable first' (e.g. Paavola and Adger, 2006; Paavola, 2008) is an important consideration for governance arrangements that deal with the prevention of heat stress.

A first major finding from Chapter 5 in the case of heat stress prevention measures, is that some responsibility is taken by public authorities (as witnessed in the 10 foreign cities) as well as considered necessary by stakeholders (as witnessed in the two Dutch cities of Rotterdam and Arnhem) to protect the most vulnerable against extreme heat. This public responsibility is particularly applicable to the role of the development of targeted policies to actively reach out to vulnerable citizens. This is because local authorities can fairly and impartially weight the different societal interests and are best able to guard the interests of the most vulnerable citizens, according to the stakeholders in the two Dutch cities. A second major finding is that this fairness principle of putting the most vulnerable first can, nevertheless, clash with legitimacy concerns: the help from public and private actors in taking responsibility for the protection of a vulnerable citizen can be perceived as paternalism and encroachment on the right to decide over one's own health, as witnessed in the Dutch cities.

7.6. POLICY INSTRUMENTS FOR ADAPTATION TO CLIMATE CHANGE

RQ5. *How can policy instruments be selected to support public and/or private responsibilities for the realisation of urban adaptation measures?*

This research question is primarily addressed in Chapter 6. As stated in Chapter 1, the use of selected policy instruments is another important reason for why the issue of the division of responsibilities among public and private actors matters. Different policy instruments achieve different levels of adaptation implementation, and public and private actors have different policy instruments at their disposal to support the implementation of adaptation. Public and private policymakers can decide to develop and implement adaptation policy themselves, or they can stimulate and activate other actors to do so by employing certain policy instruments. Hence, policy instruments can be used to delegate responsibilities to other actors. In Chapter 6 policy instruments are positioned as a means for local public policymakers to bring about new or support existing responsibility divisions. As such they are a crucial element of a governance arrangement (e.g. Treib et al., 2007, Driessen et al., 2012).

Chapter 6 elaborates on a step-by-step method for the deliberate and deliberative selection of policy instruments. The method is based on the logic of the design-oriented approach of the conceptual framework as depicted in Figure 2.2. The six considerations are used as criteria for the selection of policy instruments. The consideration of Rule of Law is interpreted slightly differently to make it suitable as a criterion for the selection of policy instruments. It is interpreted as legal certainty (internationally

recognised as a central requirement for the rule of law) and operationalised as the ability of a policy instrument to offer legal certainty through stable, understandable rules. In the method, the four challenges to the governance of adaptation are taken into account in two ways: 1) they shape the formulation of the considerations, resulting in nine selection criteria, and 2) they influence the weight of the considerations in the policy instrument selection process (see Chapter 6). It is argued that this deliberate selection, based on a specific account of the adaptation challenges and the holistic set of six considerations, stimulates out-of-the-box thinking and reduces the likelihood of a routine selection of policy instruments. The step-by-step approach also encourages the involvement of stakeholders and experts in the selection process, which enables a deliberative selection of policy instruments. Chapter 6 discusses the application of the method to the three cases of adaptation measures in the city of Rotterdam so as to illustrate how the method works and what kind of results may be expected in terms of policy instrument mixes. The overall conclusion and key findings are discussed below.

Overall conclusion: The deliberate and deliberative selection of policy instruments may encourage the development of new divisions of responsibility among public and private actors. The interactive policy instrument of a contractual agreement seems to be able to deal best with the challenge of spatial diversity and differential vulnerabilities inherent in urban climate adaptation. The use of contractual agreements provides a route to developing interactive arrangements with joint public-private responsibilities as promising alternatives to the more public arrangements found in the adaptation practice of today. Legal instruments are promising alternative instruments in case the uncertainties and risks of climate effects further increase.

A first finding is that, just as there is not one but various ways in which responsibilities are divided, the application of the method by experts to the three cases in this research suggests that there is probably no one-size-fits-all policy instrument(mix) for adaptation to climate change. The four adaptation challenges manifest themselves to different degrees in the three cases, and therefore they may trigger different criteria for the selection of policy instruments. Of the three adaptation cases, heat prevention measures are most appropriately supported by a (wide) mix of different policy instruments. This is because the adaptation challenge of social complexity is most prevalent in heat prevention, and the different target groups of heat prevention policy need to be steered in different ways. Vulnerable citizens, for instance, require the employment of certain instruments that stimulate them to alter their behaviour, which are different from those instruments that stimulate community workers or health practitioners to help those citizens cope with the heat, or that steer the project developers to build heat-resilient homes for the elderly.

Second, there is one adaptation challenge with a relatively high prevalence in all three cases: spatial diversity. Based on the specific selection criteria related to spatial diversity (see Chapter 6, Table 6.6), the interactive policy instrument of a contractual agreement scores relatively well for all three cases, according to the expert judgment. This is in stark contrast to the current dominance of public arrangements and the use of public instruments found in the three cases of adaptation measures. The contractual agreement offers a promising alternative to these public instruments. The advantage of using contractual agreements between distinct sets of public and private actors is that they allow for a spatial differentiation of public-private arrangements, tuned towards the specific climate vulnerabilities of a certain neighbourhood, citizen group or region. Contractual agreements offer an

attractive combination of voluntariness and obligation. They are voluntary in the sense that the public and private partners are free to enter into the contract or not; they are obligatory in the sense that the mutual agreements oblige parties to deliver and this is laid down in a legal contract. However, in the existing adaptation practice, the use of contractual agreements has so far been limited to the case of adaptive building in Rotterdam (see Chapter 4). Chapter 6 shows that the application of the method opens up avenues for the selection of promising new policy instruments. It suggests that there is still some unexploited potential in the application of contractual agreements for urban climate adaptation.

Third, and in line with the previous finding, I argue that the application of a deliberately selected policy instrument(mix) for a certain urban adaptation measure may also provide an impetus for the development of new divisions of responsibility among public and private actors. As suggested above, the application of the contractual agreement may enable the creation of interactive arrangements through public-private partnerships in which specific public and private actors jointly take on the responsibility for developing and implementing adaptation policy. Thus, the deliberate and deliberative selection of policy instruments may prove to be an alternative route to achieving novel governance arrangements for urban climate adaptation.

Finally, a major finding is that legal instruments such as technical requirements and performance standards become promising alternative instruments as and when the effectiveness criterion of securing sufficient adaptation action becomes the key criterion for policy instrument selection. This could already happen in the near future when the projected effects of climate change get larger and are more unpredictable (IPCC, 2013a).

7.7. ALTERNATIVE ARRANGEMENTS

RQ6. *In view of the projected acceleration of climate impacts, which arrangements provide promising alternatives to the existing governance arrangements?*

There are three important reasons for considering alternative governance arrangements for urban climate adaptation. For one thing, section 7.4 already highlighted that the existing allocation of responsibilities often appears to be decided upon rather routinely, without consciously taking into account either the six considerations or the four specific challenges to the governance of adaptation. This implies that promising, well-informed alternative arrangements are being overlooked: other arrangements might be just as or even more effective, legitimate, and/or fair. Section 7.6 confirms this oversight, by showing that a deliberate and well-informed selection of policy instruments for adaptation, taking conscious account of the four challenges, signals towards other promising instruments than the predominantly applied instruments in the adaptation practice of today. A second key reason is that climate change is accelerating and the projected effects of climate change are going to worsen in the course of the 21st century (IPCC, 2013b). This means that the four challenges to the governance of adaptation will increase, and along with it the adaptation task. Uncertainties will increase as the climate effects become more uncertain and potentially disastrous. Controversies are likely to increase as more people, city districts and whole metropolitan areas become seriously affected. There will be even more disparity in vulnerabilities, so the spatial diversity

of climate impacts will also increase. Social complexities will increase because all societal resources will be needed to reduce or prevent the impacts of climate change; it requires the involvement of all. So, even if the existing arrangements currently perform well, they have not been put to the test under more extreme climate circumstances. We do not know if those arrangements are sufficiently effective, legitimate and/or fair to cope with those climate extremes. A third key reason for considering alternative arrangements now is that planned adaptation requires taking action now in view of long-term investment, and particularly investment in the urban built environment.

Based on the results of this PhD research, the exploration of alternative governance arrangements for climate adaptation can be informed in two ways:

- By applying the design-oriented approach of the conceptual framework as elaborated in Chapter 2, taking conscious note of the four challenges and the six considerations for decisions on responsibility divisions;

- By applying the method for policy instrument selection as elaborated in Chapter 6, taking conscious note of the four challenges and the six considerations for instrument selection, which in turn can (re)direct divisions of responsibility.

By combining these two approaches, promising alternative governance arrangements can be explored for any climate adaptation issue in any city. Promising, in this respect, means that the most relevant adaptation challenges and considerations are consciously taken note of and weighted. For illustration purposes, in the next sub-sections this exploration is discussed for each of the three cases of adaptation measures by taking the existing arrangement for the city of Rotterdam as the starting point. Wherever applicable, the existing arrangements of the foreign cities (the cross-city comparison from Chapters 3, 4 and 5) or the existing arrangements for the other two adaptation measures (cross-issue comparison) are given as real-life examples of these promising alternatives. These alternatives are limited to the adaptation measure at hand. Alternative measures (e.g. water plazas instead of green roofs for storm-water retention) fall outside of the scope of this exercise.

> ***Overall conclusion: Interactive arrangements with shared public-private responsibilities and supported by a contractual agreement seem promising because they take good note of the adaptation challenges and considerations. Public arrangements with legal policy instruments are promising when climate change induces huge uncertainties and risks, thus triggering the securing of sufficient adaptation action as the decisive consideration. The twin approach for the exploration of (new) arrangements has the potential to enrich the debate on public and private responsibilities for climate adaptation, and help policymakers to make well-informed decisions on responsibility decisions and on instrument selection.***

7.7.1. *ALTERNATIVE ARRANGEMENTS FOR GREEN ROOFS*

The current arrangement in the city of Rotterdam is characterised by a combination of a predominantly public arrangement in the first stages and a predominantly private arrangement in the later stages of the policy process. The public authorities initiate policy and activate the private sector to take on responsibility for the implementation of green roofs via a financial incentive programme. The projected increase of the intensity and frequency of rainfall for the Netherlands by 2050 and 2080 (KNMI, 2014) will put a substantial additional burden on the substantial storm-water retention task already faced by Rotterdam (Rotterdam, 2007). This task cannot be solely fulfilled by traditional infrastructure (sewage and canals), and requires innovative measures such as green roofs. It is less costly to install green roofs during building constructions or renovations, and they can be integrated into long-term renovation and development cycles of the city. The existing arrangement has indeed encouraged green roofs to some extent (see Chapter 3), but the current speed of installations is likely to be too low to secure sufficient storm-water retention capacity in the near future.

When applying the design-oriented approach of the framework, the huge *uncertainty* on the return on investment of green roofs will still deter private actors from installing green roofs. Therefore, public authorities will need to step in to secure sufficient adaptation action, i.e. storm-water retention, in the near future (see Table 2.2 in Chapter 2). In the empirical examples of green roof arrangements in other cities (cross-city comparison), such a more dominant public arrangement is indeed witnessed in Basel and Stuttgart. Here the public authorities have introduced a technical requirement for green roofs on new buildings with flat roofs. This technical requirement is combined with a yearly reduction of the storm-water fee so that the installation costs are reimbursed over time. Consequently, in Basel and Stuttgart the public responsibility has necessarily extended to the Check stage, to include the monitoring and enforcement of green roof installations. In these cities the arrangements have proven to be a factor 25-fold more effective in green roof installations to secure sufficient adaptation action (see Chapter 3). Furthermore, they have been shown to create efficiencies; they create a large market for green roofs in which competition does its work in terms of driving costs down and raising benefits, thus improving the return on investment. Finally, these arrangements are considered fair because they create a level playing field and safeguard the interests of citizens in the near future.

Based on the method for the selection of policy instruments, the legal instruments of technical requirements and performance standards appear to be very promising (see Table 6.6 in Chapter 6). These two policy instruments can only be deployed by public authorities, pointing towards an increased public responsibility. Again the arrangements in Basel and Stuttgart offer real-life examples of the application of a technical requirement for green roofs. A second-best promising policy instrument would be the contractual agreement. This is because the contractual agreement is a suitable policy instrument to deal with a high extent of *spatial diversity*. For green roofs the spatial diversity is quite high; their effectiveness heavily depends on the specific location, type of building, slope of the roof etc.; and the risk of surface water flooding is also spatially diversified (for instance, areas that lack green space are more prone to surface-water flooding). In the empirical examples such a contractual agreement is observed for the adaptive building arrangement in Rotterdam (cross-issue comparison). Here a public-private partnership has been formed, which has taken on responsibility for several key roles in the early stages of the policy process, and which has resulted in a contractual agreement between the public and private partners. For green roofs such partnerships can be built between the local authority and one or more major project developers or housing associations, in which they agree to implement green roofs

for a specific new development or large renovation project and lay this down in a contractual agreement. In this way specific vulnerable areas can be targeted that are faced with storm-water flooding and a lack of (open) green space. A major advantage of such an arrangement is that it raises legitimacy, in particular the throughput legitimacy, because the relevant stakeholders have access to and influence on the decisions. If legitimacy is a decisive consideration (also in case a technical requirement is not well-accepted), the design-oriented approach also points towards an interactive arrangement with public-private responsibilities. Moreover, an interactive arrangement supported by a contractual agreement is likely to be quite effective in securing adaptation action for these specific vulnerable neighbourhoods (although a public arrangement with a technical requirement would probably be more effective in achieving sufficient levels for the city as a whole, should this be needed), and it is a fair arrangement because it puts the most vulnerable first.

7.7.2. *ALTERNATIVE ARRANGEMENTS FOR ADAPTIVE BUILDING*

The emerging arrangement of Heijplaat in Rotterdam is predominantly interactive, characterised by a large extent of joint public-private responsibilities and supported by a contractual agreement between the relevant public and private stakeholders. The current level of protection against flooding conforms to a norm of 1/5 years, which will be raised to 1/250 years for the old part of Heijplaat and 1/4,000 years for the new to-be-developed part of Heijplaat under the contractual agreement of the emerging arrangement (see Chapter 4 and the online case study report[10]). The arrangement will significantly increase the water safety of all citizens in Heijplaat, and currently there is no sign of *controversy* regarding the different protection levels that will be in place in the near future between the old and the new part. Nevertheless, this might change in future if (near) floods occur, and the citizens of the old village suffer high(er) material damages. In any case the *spatial diversity* due to different vulnerabilities will increase, and this might lead to fairness concerns in the long run.

Based on the design-oriented approach of the framework, an increased weighting of the consideration of fairness from an increased spatial diversity and disparity in vulnerability would result in an alternative arrangement with a high extent of public responsibility, so as to guarantee a fair division of responsibilities and risks according to the carrying capacities of the citizens (see Chapter 2 and Table 2.2). Such a public arrangement is indeed observed in the two foreign cities studied for adaptive building (see Chapter 4). In the cities of Hamburg and Helsinki the local authorities have taken on the responsibility for policy initiation and development. The authorities have deployed the legal instrument of a technical requirement, which obliges private actors to implement adaptive building measures (such as for instance the mandatory elevation of the ground level in both cities, and the installation of flood doors in Hamburg). This requirement applies to all, and hence is fair because it guarantees the same level of flood protection to all, as well as to future citizens.

Based on the method for policy instrument selection, the contractual agreement has proven to be a promising instrument, thus confirming the appropriateness of the emerging arrangement in Rotterdam. The green roof arrangement in Rotterdam does not offer a promising alternative arrangement (cross-issue comparison). Such an arrangement with more extensive private responsibilities and supported by a financial incentive programme would not be very effective in securing sufficient levels of adaptation action due to its voluntary character. It would probably not be very fair either, because it would not differentiate between the more and less vulnerable parts of Heijplaat, Rotterdam.

7.7.3. *ALTERNATIVE ARRANGEMENTS FOR HEAT STRESS PREVENTION*

A fully-fledged local arrangement for heat stress prevention does not currently exist in Rotterdam (or any other Dutch city). The results as portrayed in Chapter 5 are based on what the key public and private stakeholders think the local arrangement should look like. The arrangement for heat prevention preferred by those stakeholders is a combination of a public arrangement in the first stage, and a public-private arrangement in the later stages of the policy process. Public responsibility is prominent in policy initiation and development and in risk communication, and public-private responsibilities are viewed as particularly helpful for the implementation of healthcare measures and of measures in the built environment at the neighbourhood scale. Based on the latest climate projections for the Netherlands, the numbers of hot days and heat-waves are expected to increase (KNMI, 2014). Nevertheless, Dutch people are hardly aware of the risks of heat stress and the fact that vulnerable people may even die from heat stress. A shock event such as the 15,000 excess deaths in Paris in August 2003 has not yet occurred in the Netherlands. This adaptation theme is particularly challenged by a large extent of *spatial diversity* from different levels of vulnerability. Furthermore, of the three cases of adaptation measures it is the case in which the *social complexity* is fiercest. This is because of the number of different people that are involved, but even more because some of those people (vulnerable persons, their family, friends and peers) are difficult to steer.

Applying the design-oriented approach of the framework points towards public responsibility on the one hand, and public-private responsibility on the other hand (see Chapter 2). Public responsibility results from the consideration of fairness, which is triggered by spatial diversity and differential vulnerabilities. Public-private responsibility results from the consideration of legitimacy, which is triggered by social complexity; the more different groups of people are affected and involved in the protection of vulnerable people, the more it makes sense to engage those people in (decisions on) the implementation of measures. This result is in line with the perceptions of the Dutch stakeholders (see Chapter 5). The majority of governance arrangements found in the 10 foreign cities (cross-city comparison), provide examples of such arrangements. These arrangements have a similar combination of responsibilities (public responsibility in the early stages, and public-private or private responsibilities in the implementation stage). Via the design-oriented approach, the challenge of spatial diversity also triggers the consideration of efficiency, which in turn triggers private responsibility; customized solutions are needed to deal with the diversity of climate impacts, and it is therefore efficient to involve the affected people since they know best what works for them. This drive for customised approaches is observed in the 10 foreign cities; they form inspiring examples of the different ways in which targeted healthcare responses are developed for different vulnerable groups, in terms of: 1) who should approach vulnerable people (family/friends, peers, community workers, health practitioners, public health/social service officers etc.); 2) how these vulnerable people are identified and registered (by a voluntary system of subscription, by a screening through GPs, by a registration of hospital admissions etc.); and 3) how these vulnerable people are approached during a heat-wave (by telephone, house visit, mail, SMS-alert etc.).

The application of the method for policy instrument selection for the heat stress case points towards the use of contractual agreements, taking account of both spatial diversity and social complexity. Again this points towards public-private arrangements. Think for instance of contractual agreements between public health officials, healthcare professionals and community workers. Different arrangements can be made with different stakeholders for an active outreach targeted at different vulnerable groups (as the 10 foreign cities already show). As Chapters 5 and 6 indicate, the prevention of heat stress is best dealt with through a combination of governance arrangements as well as through different policy instruments for the steering of different target groups.

7.7.4. *CONCLUSION*

The use of the two approaches appears to be corroborative and helpful in the exploration of new arrangements and alternatives to existing arrangements for adaptation to climate change. Its value lies in the systematic exploration of arrangements, based on the holistic set of considerations from three different rationales, and based on the specific challenges to the governance of adaptation. Hence, it enriches the debate on the issue of the division of responsibilities for adaptation to climate change. It also has the potential to stimulate the debate on arrangements for environmental governance more generally. The holistic set of considerations is generally applicable; the governance challenges can be made specific for each environmental issue. The twin approach also allows policymakers to make well-informed choices on responsibility divisions and on policy instruments, taking conscious account of these considerations and challenges instead of making more automatic choices based on existing policy and administrative routines.

END NOTE

10] *This report is available at http://promise.klimaatvoorruimte.nl/pro1/publications/show_publication.asp?documentid=7859&GUID=c8c2aff8-89d6-4d0c-9846-75395a545e3f*

NRC Weekend Zaterdag 3 november & Zondag 4 november 2012

Het klimaat keert zich tegen New York

New York staat weer op na de verwoestende orkaan Sandy – maar het oceaanpeil rond de havenstad blijft stijgen, zegt John Gapper.

baarheid van New York is nog rijpender dan van de meeste andere steden. Manhattan is een eiland. Brooklyn en Queens liggen aan de rand van Long Island. Staten Island spreekt voor zichzelf. New Orleans zou zijn dijken kunnen verhogen en Londen zou zijn rivier kunnen afdammen, maar New York is omsingeld.

Het wordt steeds kwetsbaarder

Producten uit ondergelopen supermarkten in Brooklyn worden verzameld om weg te gooien Foto AP

van Red Hook als ze te horen zouden krijgen dat ze moeten verhuizen naar Park Slope. De bouw van stuwen in de rivieren zou duur en envolmaakt zijn.

Misschien bespeuren concurrenten een kans in de beproevingen van de stad – sommigen zullen werkgevers en effectenbeurzen influisteren om te verhuizen naar een veiliger en droger oord – maar New York is niet de enige wereldstad die aan de kust of een getijdehaven ligt. We zien hier de toekomst voor ons.

John Gapper is economisch columnist en redacteur van de *Financial Times*.

14 AD BUITENLAND

maandag 16 mei 2011

Duizenden huizen onder water om steden te redden

LOUISIANA ZET NOODSLUIZEN OVERVOLLE MISSISSIPPI OPEN

ROTTERDAM/NEW ORLEANS • **Voor het eerst in bijna veertig jaar zijn bij Morganza in de Amerikaanse staat Louisiana de noodsluizen geopend. Daarmee moet worden voorkomen dat de steden New Orleans en Baton Rouge en olieraffinaderijen en chemische fabrieken kopje-onder gaan.**

HANS VAN ZON

Met het openen van de noodsluizen zoekt een deel van de overvolle rivier Mississippi zich een weg via de rivier Atchafalaya, moerassen en bayous, oftwel moerassige rivierarmen, naar de Golf van Mexico. Om de drukbebouwde delta te behoeden voor het gevaar van desastreuze overstromingen, moet wel een prijs worden betaald. Ruim 25.000 Franssprekende inwoners van de dunbevolkte 'overlaat' moeten het gebied verlaten. Duizenden huizen komen helemaal onder water te staan. Het water kan er een hoogte bereiken tot 7,6 meter.

Toen de sluizen opengingen, baande het water uit de Mississippi zich met donderend geweld een weg via de alternatieve route. Binnen een halfuur stond een gebied ter grootte van 90 hectaren al ruim 30 centimeter onder water. Tot 7770 vierkante kilometer land, meer dan Gelderland en Noord-Holland bij elkaar, wordt onder water gezet.

De opening van de Morganzasluizen moet de dreiging wegnemen voor de steden Baton Rouge en New Orleans en talrijke olieraffinaderijen en chemische fabrieken die stroomafwaarts aan de oevers van de machtige rivier Mississippi liggen. Vooral voor New Orleans werd gevreesd. Als de noodsluizen dicht bleven, zo waarschuwden ingenieurs, zou de stad meer schade oplopen dan de orkaan Katrina in 2005 aanrichtte. „We gebeuiken elk middel om de stad te redden", zei generaal Michael Walsh van de Amerikaanse genie, nadat was besloten 'Morganza' open te zetten.

SMELTWATER

De noodsluizen zijn onderdeel van een beveiligingssysteem dat werd gebouwd na enorme overstromingen in 1927. Daarbij kwamen honderden mensen om het leven. De schade was enorm. Dat de noodsluizen na veertig jaar weer open worden gezet, bevestigt volgens Amerikaanse media de ernst van de situatie. Het waterpeil in de Mississipi is enorm gestegen door smeltwater en hevige slagregens.

Het Rode Kruis heeft voorzieningen getroffen om duizenden evacués op te vangen. Krotz Springs is een van de stadjes aan de rivier Atchafalaya die gevaar lopen na het openen van de Morganza-sluizen.

De noodsituatie riep herinneringen wakker aan de overstromingen van 1973. „Toen hoorden we het water met geweld langsrazen", zegt Monita Reed (56). Bijna veertig jaar later slepen reddingswerkers opnieuw zandzakken aan.

In totaal worden 25.000 mensen en 11.000 huizen, winkels en bedrijven getroffen door wateroverlast. Als eerste werd de Cajun, het gebied tussen New Orleans, Lake Charles en Alexandria, geëvacueerd. Verderop stroomafwaarts, wacht Morgan City (12.000 inwoners) mogelijk eenzelfde lot.

De overheid heeft de mensen in het overstromingsgebied bedankt voor het offer dat zij brengen. De inwoners worden er elk jaar in een brief aan herinnerd dat zij wonen in een gebied dat gevaar loopt als de noodsluizen van Morganza moeten worden geopend.

Om een overstroming in New Orleans en Baton Rouge te voorkomen, zijn in Louisiana noodsluizen geopend.

De noodsluizen bij Morganza (125 stuks over een lengte van bijna 1300 meter) zijn opengezet. FOTO AFP

1] NRC Handelsblad 03&04-11-2012

2] AD Amersfoortse Courant 16-05-2011

8 CONCLUSIONS AND REFLECTIONS

8.1. INTRODUCTION

Climate change will have serious effects on society and in particular on urban society (IPCC, 2013b). Urban areas are relatively vulnerable to the effects of climate change and house large concentrations of human, financial and cultural capital (Hunt and Watkiss, 2011; IPCC, 2013b). Dealing with the impacts of climate change requires the planning of adaptation to climate change and the implementation of collective adaptation action now and in the future, and these processes need to be governed.

This dissertation is focussed on the governance of adaptation to climate change. Specifically it deals with the issue of public and private responsibilities in the governance of adaptation to climate change in urban areas. In Chapter 1 three reasons are given for the relevance of doing research on the issue of the division of responsibilities for adaptation. First, I argue that a clear allocation of responsibilities helps to get adaptation off the ground. The adaptation literature suggests that responsibilities for adaptation are often vague, fragmented and/or ambiguous (e.g. Preston et al., 2011; Gilissen, 2013; Wamsler and Brink, 2014), and that this leads to stalemates and therefore a lack of adaptation planning and action (e.g. Urwin and Jordan, 2008; Fünfgeld, 2010; EUROSAI, 2012; Williams et al., 2012). Secondly, I argue that it matters because each division of responsibilities between public and private actors has consequences in terms of effectiveness, legitimacy, fairness and so on. And thirdly, it is a relevant issue because each division of responsibilities influences the deployment of different policy instruments for climate adaptation (because different types of actors have different types of instruments at their disposal), which in turn influences the effectiveness, legitimacy, fairness, etc.

Adaptation to climate change is a new and emerging environmental policy field. In view of the scientific debate in public (environmental) policy on the shift from government to governance and the mixing of responsibilities between the public and the private sectors, adaptation to climate change is an interesting policy field to study. In Chapter 1 I argue that such a shift is more likely to be witnessed in a new policy field such as adaptation to climate change, because the boundaries between public and private responsibilities are not yet crystallized and this would open windows for novel governance arrangements rather than traditional government. Furthermore, in addition to traditional measures for water management, adaptation action requires innovative adaptation measures which cannot be implemented without the involvement of private actors such as citizens, project developers, businesses, etc. The three adaptation measures that were selected as cases for this dissertation typically represent the types of innovative measures where responsibilities are assumed to be less stipulated and where public and private benefits come together. Therefore the expectation was that both joint public-private responsibilities and private responsibilities would be pertinent to urban adaptation to climate change.

The objective of the research of this dissertation was to explore, analyse and evaluate existing and alternative governance arrangements for adaptation to climate change for three key urban adaptation issues. In doing so, it aimed to contribute to the emerging scientific debate on public and private responsibilities for adaptation to climate change. Scholars from various scientific disciplines have started to discuss different rationales for assuming responsibilities with public and with private actors (e.g. Berkhout, 2005; Mendelsohn, 2006; Stern, 2007; Aakre and Rübbelke, 2010a; Osberghaus et al., 2010). However, there has been no systematic analysis of the divisions of responsibilities of a diverse set of empirical cases for different adaptation issues in different contexts, and based on multiple rationales. The research filled this knowledge gap by making a systematic analysis based on a multiple, cross-national comparative case study design for three different urban adaptation measures: green roofs for storm-water retention, adaptive building for water safety, and health and built environment measures for heat stress prevention. The empirical analysis was systematically conducted through a conceptual framework as presented in Chapter 2, which links the issue of responsibilities with six underlying considerations from three scientific rationales as well as with four specific challenges to the governance of adaptation. The three cases of adaptation measures are innovative alternatives to the default solutions for urban adaptation, and therefore may provide an opportunity for the development of novel arrangements between public and private actors. In total 20 governance arrangements (five for green roofs, three for adaptive building and 12 for heat prevention measures) in 15 different European and North-American cities were analysed and compared (see Figure 1.1). The city of Rotterdam, a frontrunner in The Netherlands in climate adaptation planning and one of the hotspots of the Dutch Knowledge for Climate research programme, was the base case unit for each case study. This allowed an additional analysis and comparison across the three cases of adaptation measures within the same institutional context.

Chapter 2 elaborated on the conceptual framework, which was then applied to the three cases of adaptation measures. Each case was discussed in a separate chapter (green roofs in Chapter 3; adaptive building in Chapter 4; heat prevention measures in Chapter 5). Chapter 6 elaborated on a method for the selection of policy instruments for adaptation to support/steer certain divisions of responsibility. Chapter 7 provided a synthesis of conclusions and major findings across the different research projects, structured along the six research questions posed in Chapter 1. Based on those conclusions and findings, in this chapter the overall conclusion is presented in section 8.2. Section 8.3 reflects on the conceptual framework, the research methods, as well as more generally on the contribution of this PhD research to the adaptation and environmental governance literature. Finally, section 8.4 provides recommendations for future research, and section 8.5 reflects on what responsible climate adaptation should look like.

8.2. OVERALL CONCLUSIONS ON EXISTING AND ALTERNATIVE GOVERNANCE ARRANGEMENTS

In accordance with its objective, this dissertation has analysed and evaluated *existing* governance arrangements by means of the explanation-oriented approach of the conceptual framework. The research has also illustrated the scope for *alternative* arrangements using the design-oriented approach of the framework and using the empirical arrangements of the cities as on-the-ground materialisations of these alternatives. The four challenges to the governance of adaptation and the six considerations contained in the framework play a crucial role in the issue of responsibility divisions. The four challenges of *uncertainty, spatial diversity, controversy, and social complexity* determine the different weightings of considerations for different adaptation issues and for different timescales (the magnitude of the challenges can vary over time). The six considerations of *securing adaptation action, efficiency, rule of law, fairness, legitimacy, and accountability* are important criteria for the success of the governance arrangements. Promising alternative governance arrangements for adaptation to climate change can be derived from an optimal balance of relevant considerations in view of the specific challenges for a specific adaptation issue.

A key conclusion of this research is that the responsibility for local urban climate adaptation is currently primarily taken on and borne by local public authorities. Existing governance arrangements for local urban climate adaptation are dominated by a large extent of public responsibility at all stages of the policy process. Private responsibility mainly becomes apparent in the financing and implementation of adaptation measures; joint public-private responsibility is still rather rare. The two dominant considerations for this public responsibility are: i) effectiveness in terms of securing sufficient adaptation action, and ii) rule of law in terms of the duty of care of local authorities for flood management, and the health and living environment of citizens. The dominant consideration for allocating responsibility with private actors is efficiency. These three dominant considerations, in turn, are less influenced by the four challenges to the governance of adaptation than I hypothesised at the beginning of this dissertation. It appears that decisions on responsibility divisions are not taken very deliberately; path dependencies from existing ways of working, and policy routines from the related policy fields of urban planning and water management have been more influential on the dominance of certain considerations, and hence on determining the divisions of responsibilities among local public and private actors.

The dominance of public responsibility is somewhat surprising, in light of the expectation that the emerging policy field of climate adaptation would be more likely to elicit the development of new governance modes, the more so since the case studies were selected for not being the default solution and for bringing public and private benefits together. On the other hand, perhaps it is not so odd after all that a more traditional hierarchical steering with predominant public responsibilities has materialised. There are still many uncertainties and there is a lack of a real sense of urgency, which deters the private sector from taking action. This makes the consideration of securing adaptation action particularly relevant at this point in time, leading to a public responsibility for several key roles such as agenda setting, policy initiation and strategy making. This raises the question of whether this dominance of the public sector is a temporary situation, or whether it is a more permanent requirement for adaptation to climate change. Will a shift towards more public-private or private responsibilities eventually appear as the policy field matures?

Based on another key conclusion of this research, namely that public responsibility in the first stage of the policy process tends to enhance the effectiveness, legitimacy and fairness of governance arrangements for urban adaptation to climate change, one could conclude that a large extent of public responsibility is a good thing and that there is no need to change anything. However, as section 7.7 in Chapter 7 has clearly pointed out, there is every reason not to be complacent, sit back and wait. By falling back on existing routines and by not taking conscious note of the four adaptation challenges and all six considerations, other (perhaps even more) promising alternatives are overlooked. Furthermore, the projected acceleration of climate change will pose serious threats to urban societies in a few decades; it might aggravate the four adaptation challenges, and increase the urgency for adaptation planning and action now (in light of long-term investments in the built environment) and well into the future. In future, when put under strain, existing arrangements might turn out not be climate-proof in terms of being able to handle more extreme climate impacts.

The application of the twin approach for the exploration of alternative arrangements in Chapter 7 has shown that this exploration can and should be done on a case-by-case basis, since each adaptation issue in each city may trigger different challenges and considerations. Based on the illustration of the twin approach to the three cases contained in this research, it can be concluded that interactive arrangements with shared public-private responsibilities are quite promising for urban adaptation to climate change because they take note of the following relevant adaptation challenges and considerations: spatial diversity which triggers the consideration of fairness; and social complexity and controversy which trigger the consideration of legitimacy. This could take the form of policy networks in which responsibilities would become a joint obligation between the relevant public and private actors, culminating in covenants or contractual agreements as the key supporting policy instruments. These networks could be case- and space-specific; depending on the exposure, sensitivity and adaptive capacity of a specific area or neighbourhood, different actors could join the network, and they could jointly decide on the adaptation goals to be set and adaptation measures to be taken to reach these goals. Ultimately, this could lead to several co-existing networks for one and the same adaptation issue, each tuned to the vulnerability of a specific part of the city or citizen group. Nevertheless, the illustrations in Chapter 7, section 7.7 also made clear that if climate change further exacerbates uncertainties, thus triggering securing adaptation action as a decisive consideration, a promising alternative would be to develop hierarchical arrangements with predominant public responsibilities, and supported by more coercive legal policy instruments such as requirements, building codes, and performance standards.

Returning to the central thesis in this dissertation, namely that a clear allocation of responsibilities is important for getting climate change adaptation planning and action off the ground, I can now conclude that this thesis appears to hold. Contrary to the literature that argues that climate adaptation is characterised by vague and ambiguous responsibilities, in the 20 studied governance arrangements the responsibilities were allocated quite clearly between the relevant public and private actors. It is also quite obvious that the arrangements have managed to get adaptation planning and action off the ground, albeit to different degrees. Having ascertained this, based on the research results I posit a second thesis to move the scientific debate forward: A clear *and deliberate* allocation of responsibilities, that is well-informed by the four challenges and the six considerations, is important for getting adaptation off the ground *and for making cities future climate-proof*. The conceptual framework developed in this dissertation can help inform deliberate and deliberative processes for decisions on responsibilities and for decisions on the selection of policy instruments for adaptation to climate change.

8.3. REFLECTIONS

8.3.1. *REFLECTIONS ON THE CONCEPTUAL FRAMEWORK*

The conceptual framework of this dissertation (see Figure 2.2) has had two functions: 1) to characterise and explain divisions of responsibilities for climate adaptations (the explanation-oriented approach), and 2) to support the design of alternative divisions of responsibilities (the design-oriented approach).

The application of the explanation-oriented approach of the conceptual framework to the empirical reality of urban climate adaptation has led to the following reflections. Regarding the four *adaptation challenges* in the conceptual framework it can be concluded that the hypothesised relations between those challenges and the six considerations have had a moderate value in explaining the divisions of responsibility in existing governance arrangements. The effect of the challenge of uncertainty on the consideration of securing adaptation action, which in turn has led to certain public responsibilities, is the strongest relationship that has materialised in both the green roof and the adaptive building cases. The explanatory value of the other three adaptation challenges to the considerations has been modest in the studied arrangements. The main explanation for this is that decisions on responsibility divisions are not necessarily taken very consciously; there is a tendency to fall back on familiar arrangements and known ways of working. Cultural factors such as existing administrative routines from the related policy field of urban planning (path dependencies cf. e.g. Howlett, 2009) have tended to be more influential on the considerations. The four adaptation challenges prove their value in the design-oriented approach of the conceptual framework. It may encourage policymakers to make deliberate and deliberative choices for promising alternative responsibility divisions (Chapter 2) and for promising alternative policy instruments (Chapter 6), taking explicit account of the four specific challenges to the governance of adaptation as well as the six considerations and their mutual trade-offs. As stated before, this may lead to a more optimal balance of considerations and may make the arrangement more future climate-proof because the specific challenges of an adaptation issue are taken on board in the decision-making.

Regarding the six *considerations* in the conceptual framework, it can be concluded that they explain public versus private responsibility where it concerns the domain of collective responsibility, but that it does not entirely explain divisions of individual versus collective responsibility. The case of heat prevention has demonstrated that measures in the area of healthcare contain this extra dimension of individual versus collective responsibility. Moreover, it has shown that decisions on individual responsibility are mainly triggered by an extra consideration that is not covered in the framework. This is the consideration of personal empowerment and independence, or the right to decide whether one wants to take adaptive measures to improve one's (heat) health or not. This implies that 1) the dimension of individual versus collective responsibility should be taken into account in issues that concern the health effects of climate change, and that 2) an additional consideration for individual responsibility should be taken into account, i.e. personal empowerment and independence.

The application of the design-oriented approach of the framework, in combination with the method for policy instruments selection as portrayed in Chapter 7, has proven to endorse a systematic exploration of governance arrangements for any adaptation issue in any context. It contributes to the scientific debate on public and private responsibilities by showing the value of a set of considerations based on three different rationales (the economic, political and juridical rationale) rather than using just one rationale which is common in the literature, and of a set of specific challenges to the issue under exploration. It contributes to adaptation practice by offering policymakers a tool to make (more) deliberate and deliberative decisions on governance arrangements for climate adaptation.

8.3.2. *REFLECTIONS ON THE RESEARCH STRATEGY, CASE SELECTION AND METHODS*

The multiple, comparative case study research strategy has proven to be instrumental in the comparison of existing governance arrangements across a range of adaptation issues and across a variety of different economic, cultural and political contexts. The research strategy has substantially increased the external validity of the research. The comparison with other foreign cities was also insightful for the policymakers of Rotterdam. It provided a mirror to the Rotterdam arrangements and several policy-relevant lessons could be drawn from the study of other cities.

As stated before, the three cases of adaptation measures were strategically selected in the expectation that they would show a range of different mixtures of public and private responsibility, including joint public-private and private responsibilities. It would have been helpful to include more of the same cities across the three cases of adaptation measures (similar to the city of Rotterdam). This would allow a thorough comparison across the different adaptation measures in similar cultural, political and economic contexts. At the time of doing the research this was difficult to do because urban adaptation planning and implementation is not yet widely developed, in comparison to mitigation (Runhaar et al., 2012; Bulkeley, 2013; Hoppe et al., 2014). This will, however, become possible as and when the adaptation practice expands across urban areas.

The combination of document analysis and in-depth interviews proved to be beneficial to the internal validity; insights into formal responsibilities as laid down in policy documents could be complemented with on-the-ground experiences from different stakeholders' perspectives (thus combining a top-down with a bottom-up perspective as described by Urwin and Jordan, 2008).

8.3.3. *REFLECTIONS VIS-À-VIS THE ENVIRONMENTAL AND ADAPTATION GOVERNANCE LITERATURE*

The conclusion that the governance of adaptation to climate change in urban areas is characterised by a large extent of public responsibility seems to be confirmed by other empirical studies which conclude that urban climate adaptation is often government led (Johnson and Priest, 2008; Berrang-Ford et al., 2011; Mees and Driessen, 2011; Runhaar et al., 2012; IPCC 2013b). However, this conclusion does not resonate well with the shift from government to governance as claimed in (environmental) governance literature, which is said to entail a decline of the role of (national) governments and a rise of new governance modes such as policy networks, which put more emphasis on public-private and private responsibilities. Empirical research in other more established domains of environmental policy has also pointed out that such a shift from government to governance does not necessarily manifest itself everywhere (see e.g. Howlett et al., 2009 for forest conservation policy in Canada; Hysing, 2009 for forest conservation and transport policy in Sweden; Driessen et al., 2012 for urban environmental policy in the Netherlands; Weber, 2013 for noise policy in The Netherlands; Lieberherr and Truffer, 2014 for the water utilities sector). It seems rather striking though, that climate adaptation as a new environmental policy field (Massey and Huitema, 2013), is not (yet) widely taken up through new modes of governance in which private actors have more pronounced roles and responsibilities. This research contributes to the academic governance debate by showing that these new governance modes have not yet widely entered the policy field of urban climate adaptation. The research results show that this seemingly contradictory phenomenon can be explained by the dominant considerations of Securing Adaptation

Action and Rule of Law that underlie public responsibilities. In policy studies, laws and regulations are considered structural factors that explain stability in policy (True et al., 2007). It is plausible that the existing laws for flood management and healthcare in the three studied cases explain why certain responsibilities for adaptation have remained with the public sector. Although it was not part of this research, it is worthwhile exploring theories in policy studies that could explain change in the policy field of climate adaptation, such as for instance shock events (e.g. Sabatier and Weible, 2007; True et al., 2007) and change agents (e.g. Caldwell, 2003; Meijerink and Huitema, 2010).

The conclusion of this research, that public responsibility in the first stage of the policy process tends to enhance the effectiveness, legitimacy and fairness of governance arrangements for urban adaptation to climate change, provides a nuanced view on the proclaimed advantages of new governance modes and the positive effect attributed to increased private responsibilities for environmental governance. In the governance literature the private sector is often claimed to be more effective and efficient, while governments are seen as bureaucratic and unresponsive and have therefore lost their legitimacy (see e.g. Peters and Pierre, 1998; Lemos and Agrawal, 2006 for an overview of this debate). Scholars have also increasingly come to criticize these positive effects of new governance modes (Lemos and Agrawal, 2006 provide an extensive review). While the dominant stance of governance scholars is that the involvement of private actors in policy networks raises the commitment and therefore increases the effectiveness of policy, others point out that the lack of authoritative power of networks decreases their effectiveness (Driessen and Glasbergen, 2000; Lemos and Agrawal, 2006). While the dominant stance of governance scholars is that the involvement of private actors in policy networks raises the legitimacy, others have pointed out that it rather creates a democratic deficit because it tends to enhance the power of vested interests (Bogason and Musso, 2006; Lemos and Agrawal, 2006; Few et al., 2007; Schouten, 2013). This research contributes to the governance debate by demonstrating that more hierarchical arrangements with a large extent of public responsibility can also be effective, legitimate and fair.

8.4. AVENUES FOR FUTURE RESEARCH

As was noted in the previous section this dissertation has provided some valuable insights for the governance of climate change adaptation. Furthering the understanding of the effect of public and private responsibilities on the planning and implementation of adaptation action could provide additional insights for the acceleration of climate change adaptation, as well as understanding the normative consequences of different divisions among public and private actors. To enlarge the empirical base for climate adaptation, further research is recommended into public and private responsibilities for other pressing urban adaptation issues, such as water shortage/droughts and disturbances of critical infrastructure (energy, water, ICT), and for other adaptation themes, such as health and rural issues. Since it is argued by the IPCC (IPCC, 2012; IPCC, 2013b) that adaptation to climate change should become more integrated with disaster risk management, it makes sense to include the issue of the governance of extreme events such as heavy floods, heat-waves, energy and ICT black-outs, etc. into studies on the divisions of responsibilities. It is also valuable to explore whether and to what extent these kinds of shock events induce shifts in responsibility divisions.

Divisions of responsibilities among different levels of government (multi-level governance) also form an interesting topic for future research. Through guidelines (or lack thereof), higher governance levels will influence adaptation actions (or lack thereof) of lower levels of governance (Urwin and Jordan, 2008; Amundsen et al., 2010). Furthermore, alternative modes of governance such as community-based adaptation also form interesting objects of study, not only for the governance of climate adaptation but also for the governance debate more generally. In Europe some first examples are emerging of community initiatives such as, for instance, the building of a small district of floating houses, and citizens' initiatives for flood preparation and recovery. In particular it would be interesting to study how and why this form of self-governance emerges, and what the role of the (local) government could be in endorsing and up-scaling these kinds of initiatives. For each of these avenues, comparative case study research is recommended so that in-depth lessons can be drawn in different cultural, economic and political contexts, and best practices can be shared. Finally, a closely related research topic would be to study the issue of responsibilities in the light of a changing social contract between the state and its citizens for climate adaptation, an issue that is just emerging in the adaptation literature (O'Brien et al., 2009; Adger et al., 2013).

8.5. WHAT IS RESPONSIBLE CLIMATE CHANGE ADAPTATION?

Lastly, in light of the title of this dissertation I would like to give a brief reflection on what I believe to be *responsible* climate change adaptation. Responsible climate change adaptation requires deliberate and deliberative decisions on responsibility divisions between local public and private actors, as well as deliberate and deliberative decisions on supportive policy instrument mixes. Responsible climate change adaptation also means pivotal responsibilities for local public authorities. In their jurisdictions, local public authorities need to take on the responsibility for agenda-setting, policy initiation and policy coordination. The instrumental argumentation is that local authorities have certain policy instruments at their disposal that private actors simply do not have. The normative argumentation is that local authorities are gatekeepers of the fairness and legitimacy of the established governance arrangements, as the research results indicate. Nevertheless, in view of the projected acceleration of climate impacts and of the adaptation challenges, local authorities should strive to actively engage the private sector by initiating, facilitating and coordinating policy networks that include all the relevant local public and private stakeholders for the adaptation issue at hand. Ultimately both public and private resources are needed to cope with and adapt to the fiercest impacts of climate change.

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APPENDIX 1 | (CHAPTER 2)
OVERVIEW OF POLICY DOCUMENTS USED FOR THE DOCUMENT ANALYSIS

Document Name	Issue Date	By whom
General		
Coalitieakkoord Rotterdam 2010-2014 Ruimte voor Talent en Ondernemen	2010 (April)	Gemeente Rotterdam
Spatial planning		
Provinciale Structuurvisie. Samenvattingsdocument & Uitvoeringsagenda	2010 (July)	Provincie Zuid-Holland
Ruimtelijk Plan Regio Rotterdam 2020: Regio in Uitvoering & Tienpuntenplan	2005 (December)	Stadsregio Rotterdam
Stadsvisie Rotterdam. Ruimtelijke Ontwikkelingsstrategie 2030	2007 (November)	Gemeente Rotterdam
Verbonden Stad. Visie openbare ruimte binnenstad. Ruimtelijke ontwikkelingsstrategie 2030	2007 (September)	Gemeente Rotterdam
Climate change		
Maak Ruimte voor Klimaat! Nationale Adaptatiestrategie, beleidsnotitie & interbestuurlijke notitie	2007	Ministerie van VROM and others
Actieprogramma Klimaat & Ruimte 2009-2011	not dated	Provincie Zuid-Holland
Rotterdam Climate Proof: The Rotterdam challenge on water and climate adaptation	2008 (May)	Gemeente Rotterdam
Rotterdam Climate Proof: Adaptation Programme 2010	2010 (February)	Gemeente Rotterdam
Other		
Groene Daken Rotterdam. Uitvoeringsprogramma 2011-2025	2011 (December)	Gemeente Rotterdam
Rotterdam Groen van Boven: Toepassing van groene daken in Rotterdam	2006	Gemeente Rotterdam
Waterplan2. Werken aan een aantrekkelijke stad.	2007	Gemeente Rotterdam en aantal waterschappen
Droge voeten, gezonde stad. Gemeentelijk Rioleringsplan Rotterdam 2011-2015	2011 (June)	Gemeente Rotterdam
Consultatiedocument. Programma Duurzaamheid Rotterdam t/m 2014	2010 (November)	Gemeente Rotterdam

APPENDIX 2 | (CHAPTER 2)
OVERVIEW OF RESPONDENTS

Representatives of	Domain	Function
Rotterdam Municipal Works	Public	Advisor Water management
Rotterdam Municipal Works	Public	Project manager
Rotterdam Development Corporation	Public	Team coordinator Building maintenance
Rotterdam Urban Planning Department	Public	Advisor Landscape & Greening
Rotterdam Sustainability Office	Public	Staff member helpdesk green roofs
Water Board Hollandse Delta	Public	Advisor Sewage systems
Environmental Protection Agency Rijnmond	Public	Policy officer
Real Estate Company	Private	Head of Corporate Sustainability
Real Estate Company	Private	Technical Manager Buildings
Housing Corporation	Private	Head of Corporate Sustainability
Environmental NGO Rotterdam	Private	Project leader
Architectural Firm	Private	Architect
Green roof supplier	Private	Director
Horticulture industry association	Private	President
Horticulture industry association	Private	Secretary
Commission of Advise on Water Law	Expert	Secretary

APPENDIX 3 | (CHAPTER 3)
OVERVIEW OF RESPONDENTS

Title	Organisation
Basel	
Green roof consultant, leader of green roof branch	Zuricher Hochschule
Director	Green roof supplier
Politician, president of the Umwelt & Energy Commission	Canton Parliament
Partner, landscape architect	Landscape Architectual firm
Head of Fachstelle für Natur- und Landschaftsschutz	Canton Basel Stadt
Partner construction firm, president	Green roof industry association
Landscape architect	Green roof industry association
Architect	Architectural Firm
Project manager	Development/construction company
Management	Nature Conservation NGO
Head of Fachstelle Grundwasser	Canton Basel Stadt
Head of Energy Techniques*	Canton Basel Stadt
Chicago	
Green Projects Administrator*	Department of Zoning and Planning
Aide to one of the Aldermen	48th Ward, City of Chicago
Proposal Administrator/Manager	Consultancy firm in sustainable building
Deputy Commissioner	Natural Resources and Water Quality Division, Department of Environment
Assistant Project Coordinator	Chicago Center for Green Technology
Director	Environmental Exchange
President	Green roof supplier
Environmental Engineer	Department of Environment
Program Manager/ Projects Administrator Green Permit Program	Department of Buildings
Director	Green roof consultancy firm
Coordinator of Economic Development	Department of Zoning and Planning
London	
Green Roof Product Manager*	Green roof systems production company
Development and Flood Risk	Environment Agency
Planning Officer	City of London
Head of Sustainability*	Hammerson borough
Founder	Green roof instalment company
Founder	livingroofs.org
Green Roof Consultant	Green roof consultancy
Major Projects Officer	Environment Agency
Planning Officer (Urban Design)	City of London
Head of Sustainable Development	City of London
Program Officer Urban Greening- Transport & Environment	Greater London Authority
Rotterdam	
Advisor water management	Rotterdam Municipal Works
Project leader building	Rotterdam Municipal Works
Team coordinator technical management	Rotterdam Development Corporation
Advisor Landscape & Greening	Rotterdam Urban Planning Dept
Employee helpdesk green roofs	Rotterdam Sustainability Office
Advisor Sewerage	Water Board Hollandse Delta
Senior policy officer	Environmental Protection Agency Rijnmond
President of the CSR Commission	Real Estate Company
Technical Manager Buildings	Real Estate Company
Team leader Sustainability department	Housing Corporation
Project leader	Environmental NGO Rotterdam
Architect	Architectural Firm
CEO the Netherlands	Green roof supplier
President of the green roof & wall branch	Horticulture industry association
Secretary of the green roof & wall branch	Horticulture industry association
Secretary	Commission of Advise on Water Law
Stuttgart	
Former Department Head	Department of Urban Planning and Urban Renewal
Director	International Green Roof Association
Technical Director	Green roof systems production company
Managing Director	Landscape Architectual firm
Chemistry Engineer	Urban Climatology Division, Office of Environmental Protection
Urban Planner	Department of Urban Planning and Urban Renewal
City Councillor	City council
Department Head	Garden, Cemetery, and Forestry Office

*Represents interviews conducted over the phone

APPENDIX 4 | (CHAPTER 4)
OVERVIEW OF RESPONDENTS

City	Organisation	P/P
Experts n=4	Lector adaptive urban development, Managing Director Deltasync	n.a.
	Professor of Risk management, Climate change, and water resources management	n.a.
	Professor of Water Engineering and Director Business Development	n.a.
	Senior Researcher Water and Spatial Planning at Environmental Assessment Agency	n.a.
Hamburg n=13	Behörde für Stadtentwicklung und Umwelt	Public
	HafenCity Hamburg GmBH	Public
	Landesbetrieb Strassen, Brücken und Gewässer	Public
	Landesbetrieb Strassen, Brücken und Gewässer	Public
	Internationale Bauausstellung IBA Hamburg	Public
	Behörde für Inneres und Sport	Public
	HafenCity University Hamburg	Public
	Flutschutzgemeinschaft	Private
	GermanWatch, Hamburg affiliate	Private
	Boege-Lindler Architekts	Private
	DS-Bauconcept	Private
	Netzwerk HafenCity e.V.	Private
	Die Grünen Bürgerschaftsfraktion Hamburg	Private
Helsinki n=10	City Planning Department	Public
	ELY Uusima (Regional Environment Agency)	Public
	Economic and Planning Centre Helsinki	Public
	City Real Estate Department	Public
	Aalto University	Public
	JMV Research	Private
	Ramboll Finland	Private
	Marina Housing/Sito	Private
	Green council group Vihreat	Private
	National coalition group	Private
Rotterdam n=13	City Planning Development department	Public
	City Planning Development department	Public
	City Management department, water mgt	Public
	City Management department, water mgt	Public
	City Management department, water mgt	Public
	City Sustainabililty Program Group	Public
	Borough of Charlois	Public
	Stadshavens project office	Public
	Residents Association	Private
	Housing Association	Private
	Consultant, representative of residents	Private
	Consultant water management DHV	Private
	Port of Rotterdam (Havenbedrijf Rotterdam)	Private
	Doepel Strijkers Architects	Private
40	Total number of interviews	

APPENDIX 5 | (CHAPTER 4)
DETAILED OVERVIEW OF RESPONSIBILITIES

Hamburg

Policy stage	Roles per stage	Actors	Specifics
Public responsibilities			
Plan	Agenda-setting, initiation of policy for flood protection	Behörde für Stadtentwicklung und Umwelt (BSU)	BSU is the official Hamburg state authority with the duty of care for flood protection based on German federal law. The LSBG (see below) handles most of this responsibility in practice, but is not an official Behörde.
	Knowledge creation, risk assessments	Landesbetrieb Straßen, Brücken und Gewässer (LSBG)	This local government agency conducts regular research on climate change and expected sea level rise (LSBG, 2010).
	Target setting (norms for flood protection)	Landesbetrieb Straßen, Brücken und Gewässer (LSBG)	LSBG must secure sufficient levels of protection against storm surges and sea level rise. Sea level rise is taken into account as a serious factor that might increase the tidal activity of the Elbe.
Do	Strategy making: decision on a flood protection strategy for HafenCity and on policy instruments	Behörde für Stadtentwicklung und Umwelt (BSU)	Flood protection is legally secured via a specific "Flutschutzverordnung HafenCity" (HmbGVBlm 2002). The minimum height of the warft and the Objektschutz are also legally secured through a "Gesetz uber den Bebauungsplan Hamburg" (building code for each HafenCity neighbourhood).
	Project coordination for HafenCity	HafenCity GmbH development company of the city (100% city owned)	HafenCity GmbH is the master developer of HafenCity. It is responsible for the planning for the implementation of the HafenCity development; acting as liaison between the local government and investors/developers.
	Climate proofing of the urban infrastructure of HafenCity	HafenCity GmbH development company of the city (100% city owned)	Implementation/financing of measures for the flood proofing of urban infrastructure including elevated evacuation routes (public spaces are allowed to be flooded during storm surges)
Check	Monitoring of flood protection measures to buildings (Objektschutz)	Behörde für Stadtentwicklung und Umwelt (BSU)	In order to secure sufficient levels of flood protection buildings are checked at the design stage (building permission), and at completion (building approval).
Maintenance	Risk communication	Behörde für Inneres und Sport (BIS) and the boroughs (Bezirk Mitte for HafenCity)	Ongoing risk communication to citizens about flood risk and warning during a flood event, ensuring that inhabitants are continuosly aware of flood risk, and the responsibilities they have to prepare for and act upon flood events (e.g. BIS; 2010, BIS, 2012);
	Flood preparedness: disaster coordination, evacuation planning and emergency management		Ensuring that evacuations run smoothly in case of a flood event to avoid casualties and material damage.
Private responsibilities			
Do	Designing for, and implementation and financing of the elevation of their land parcel, as well as adaptive measures to their building(s)	Investors/developers/ property owners	The costs for flood protection on plot and building levels are borne by the private sector. Investors have some freedom to design adaptive measures to their buildings according to their needs and preferences.
Maintenance	Flood preparedness and damage control for private property: Yearly check of the functioning of adaptive building measures (flood doors); in case of a flood: closing of the doors and warning of the inhabitants	Flutschutzgemeinschaft (community of property owners that deals with flood protection on a collective basis)	The responsibilities of the Flutschutzgemeinschaft are legally secured in §§5-6 of the "Flutschutzverordnung HafenCity" (HmbGVBlm 2002). Each Gemeinschaft has a Flutschutzbeaufragte. This position is performed on a voluntary basis, but is accepted since it involves little work. Many property owners outsource this responsibility collectively per building to specialized agencies.
	Recovery of flood damage	Owners/inhabitants	Inhabitants are responsible for repairing the flood damage.

APPENDIX 5 | (CHAPTER 4)
DETAILED OVERVIEW OF RESPONSIBILITIES

Helsinki

Policy stage	Roles per stage	Actors	Specifics
Public responsibilities			
Plan	Agenda-setting, initiation of policy for flood protection in Helsinki	City Planning Department	Helsinki is the first city in Finland to have crafted a flood risk strategy, with help of the consultancy of Ramboll. City Planning is responsible for flood risk planning in the built environment and has initiated the development of the strategy.
	Knowledge creation, risk assessments, development of flood risk maps	Regional and national authorities	Many research programs (national, EU, Baltic region) have taken place to assess climate effects and its impacts on Finnish society at various scales/sectors. The 13 regional ELY centres are responsible for developing flood risk maps. The Finnish Marine Institute measures sea levels on continuous basis.
	Target setting (norms for flood protection)	Finnish Meteorological Institute/ City Planning Department	FMI makes recommendations for minimum building heigths for new developments across various regions in Finland. Helsinki City Planning has set the building heights at a slightly higher level for Kalasatama and related waterfront regeneration projects.
Do	Strategy making: decision on a flood protection strategy for Kalasatama and on policy instruments	City Planning Department	Minimum building height is regulated through the planning permission/building regulation process.
	Coordination of all work regarding the development of Kalasatama	City Economic & Planning Centre	One specific project manager for Kalasatama coordinates all activities of the different city departments, and isone of the main contacts for constructors/developers.
	Implementation/financing of land elevation of Kalasatama, incl public space. For the floating houses: building/ financing up to the shore line.	City Public Works Department	The city takes care of land elevation and charges the costs on to the developers through the rent/land prices. The infrastructure for the floating houses is built until the shore line, incl. the quay/retaining wall.
Check	Monitoring of minimum building heights; monitoring requirements of buildings, and of floating houses	Building regulation department, rescue department	Detailed plans per building are checked, as well as inspection upon completion. Special attention was given to the floating houses in order to secure access of emergency services to these houses.
Maintenance	Flood preparedness: disaster coordination, evacuation planning and emergency management	City of Helsinki Rescue Department	So far there is no risk communication to citizens. According to one respondent the city of Helsinki is preparing a flood risk communication leaflet. Current status is unknown.
Private responsibilities			
Plan	Agenda-setting for floating houses	Developers	The idea for floating houses was first presented to the city by potential developers.
Do	Designing, engineering for, and implementation and financing of the floating houses	2 selected developers: Marina Housing and JMV-Research	The developers have the expertise to build floating constructions and anchor systems. They are responsible for the flood protection of these houses, as well as for the infrastructure on/under the water (access roads, water, sewage, electricity etc)
	Flood damage control	Owners/inhabitants of buildings	According to the Rescue Act 468 (2003)owners of buildings are responsible for preventing hazards and should be prepared to undertake rescue measures and draw up an emergency plan to the best of their abilities (Kurkela et al., 2008).
Maintenance	Recovery of flood damage	Owners/inhabitants of buildings	Damage from sea flooding is not compensated by the National Government. Compensation for damage from inland flooding will end in 2012 and be replaced by an insurance system

Policy stage		Actors	Specifics
Public responsibilities			
Plan	Knowledge creation, risk assessments	City of Rotterdam (departments of Stadsontwikkeling & Stadsbeheer)	Modelling of climate scenarios; CBAs of flood magement options; assessing the risks/ costs of material damage, immaterial damage (societal disruption, loss of life)
	Target setting (norms for flood protection)		Setting water safety norms for areas outside of the major dike lines
	Initiation of policy for water safety in general		Developing a Rotterdam-wide strategy for areas outside of the dikes
Do	Implementation/financing of flood prevention measures		Building a small levy at the Heijsekade, and flood-proofing the vital infrastructure and public space in Heijplaat
	Evacuation routes and plans		This is not planned specifically for Heijplaat. Vertical evacuation is the preferred action, in light of the relatively superficial flooding of the area (no risk to lives)
Check	Assessment framework for adaptive building		Development of an assessment framework for the safeguarding of water safety measures of Heijplaat in existing urban planning procedures; identifying key check moments
	Monitoring of adaptation measures		Checking adaptive building measures during planning permission process
Maintenance	Risk communication		Informing inhabitants and house owners about the risks, and the potential measures to limit damage from water intrusion, recover from damage, and about evacuation routes
	Maintenance of public flood risk measures		Maintenance of the levy, and of the water proofing measures of the vital infrastructure and public space
Public-private responsibilities			
Plan	Agenda setting	SOK partnership	Informing governors and officers about the need to develop an alternative flood risk strategy
	Initiation of policy for the water safety of Heijplaat		Initiating discussions on the application of multiple strategies for dealing with flood risk
	Risk judgments		Discussing the risks of various flood risk strategies
	Checking and discussing options to manage risks		Discussing the options, and their feasibility in terms of costs, benefits, and risks
Do	Strategy making: decision on flood protection strategy and policy instrument selection	SOK partnership	Decision on the mix of flood strategies and submission to the governors for final approval. Development of a contractual agreement (SOK) to legally ground responsibilities and financial obligations; deciding on the use of a legal instrument (kettingbeding) to guarantee the implementation of adaptive measures to buildings and lots
	Planning and coordination of the implementation		Overseeing the implementation of actions agreed in the SOK; implementation plan early 2013
Private responsibilities			
Do	Ensuring the implementation of adaptive designs to the lots and to the buildings	Housing association	Developing a legal instrument (kettingbeding) which obliges project developers/house owners to implement adaptive measures
	Implementation/financing of adaptive measures related to the interior of the buildings	Inhabitants	Taking measures for damage control in case of floods
Check	Monitoring of adaptive measures to houses on a continuous basis	Housing association	The housing association is responsible for the adequate transfer of the legal instrument (kettingbeding) from one owner to the other
Maintenance	Flood damage control	Inhabitants	Owners/inhabitants of private property are responsible for taking precautionary measures to avoid/limit damage during a flood event
	Recovery of damage inside the house	Inhabitants	Inhabitants are responsible for repairing the flood damage

APPENDIX 6 | (CHAPTER 5) OVERVIEW OF ORGANISATIONS REPRESENTED IN THE TWO WORKSHOPS

Arnhem (12 September 2013)	**Rotterdam (30 September 2013)**
Subgroup Health care (13)	***Subgroup Health care (8)***
Hospital Rijnstate (real estate)	GGD Rijnmond (public health service)
STMG (Home care)	GGD Rijnmond (public health service)
TNO (research and consultancy institute)	RIVM (national health institute)
Seniorenraad (elderly interest group)	ANBO Rotterdam (elderly interest group)
Actiz (association of healthcare org)	ANGO Rotterdam (interest group for disabled)
Hospital Rijnstate (client advise)	Red Cross (disaster support)
B-Safe (safety consultancy)	Gemeente Rotterdam (municipality)
APCG (interest group for disabled)	Ministry of Health, Welfare and Sport
VGGM/GGD (public health service)	
VGGM/GGD (public health service)	
RIVM (national health institute)	
VGGM/GGD (public health service)	
Gemeente Arnhem (municipality)	
Subgroup built environment 1 (11)	***Subgroup built environment 1 (11)***
Volkshuisvesting (housing corporation)	TNO (research & consultancy institute)
Vebidak (association of roof suppliers)	Ministry of Infrastructure and the Environment
Lichte Bries (consultancy	VVE (association of individual house owners)
Vastbouw (construction company)	Woonbron (housing corporation)
Poelmans Reesink	Gemeente Rotterdam (municipality)
Hogeschool Arnhem (University)	Gemeente Rotterdam (municipality)
Gemeente Arnhem (municipality)	Gemeente Rotterdam (municipality)
Gemeente Arnhem (municipality)	Gemeente Rotterdam (municipality)
Bureau voor mens en natuur	Independent architect
Koninklijke Ginkel Groep (green roof supplier)	Dutch Green Building Council
Waterschap Rivierenland (water board)	Field Optimizer (consultancy landscape & urbanism)
Subgroup built environment 2 (11)	***Subgroup built environment 2 (9)***
University of Wageningen	Kennis voor Klimaat (knowledge platform climate adaptation)
Technical University Delft	Rotterdam Climate Proof
Vivare (housing corporation)	Gemeente Rotterdam (municipality)
CROW (expertise centre public space, infrastructure and traffic)	BGSV (consultancy for urban planning & landscape architecture)
Grontmij (consultancy & engineering built environment)	Platform 31 (knowledge platform for sustainable innovations in cities)
Eco-Makelaar (consultancy in sustainable solutions)	Woonstad (housing association)
Next architecten (architect)	RIVM (national health institute)
Klimaatverbond (alliance of decentral government institutions for climate policy)	Vebidak (association of roof suppliers)
Gemeente Arnhem (municipality)	Haaglanden (The Hague city region)
Gemeente Arnhem (municipality)	
Koninklijke Ginkel Groep (green roof supplier)	

APPENDIX 7 | (CHAPTER 5)
OVERVIEW OF ACTIVITIES IN THE 10 FOREIGN CITIES

City	Problem analysis: Vulnerability Assessment	Policy making: Plan development	Policy implementation: Healthcare Measures	Policy implementation: Built Environment Measures
Chicago USA	1) Identification of hotspot areas (measurements of surface area temperatures) 2) Senior/Disabled at Risk Checklist (EHWOP, 2006)	City of Chicago Extreme Weather Operations Plan In the Climate Action Plan it is mentioned that the revised version of the plan will focus on vulnerable populations (CCAP, p. 40)	Alert to the Senior Citizens Advisory Sub-Committee and various other organised community groups (e.g., religious senior citizen groups, senior clubs, financial institutions, travel agencies, etc.) to initiate telephone trees in an attempt to check on the well-being of senior citizens in the district.	Generic measures: 1) mandatory requirement of albedo roofs for flat roofs with min. reflection values; 2) green roof incentive program (grants, green permit program); 3) tree planting; 4) Green Alleys Initiative. Specific measure: cooling centres
Kassel Germany	1) Mapping of microclimate data & socio-demographic data (WHO, 2010) 2) Database of vulnerable elderly people based on voluntary self-registration (Klimzug, 2011)	Heat response plan at the Bundesland level (Baden-Württemberg)	Establishment of a "Netzwerk Hitzeprävention". During a heat wave vulnerable citizens in the database are called by the "Hitzetelefon Sonnenschirm", operated by Diaconessen nurses and Senior volunteers (Klimzug, 2011)	Commitment of housing cooperatives and building societies to develop health environments for the elderly (WHO, 2010)
London UK	1) Identification of hotspot areas 2) Identification of high-risk individuals by the Primary Care Trusts working together with local authorities community staff (LRHP, 2011, p. 15)	London Resilience Heatwave Plan pays considerable attention to vulnerable groups such as the elderly and disabled	Visits & phone calls to high risk individuals (LRHP, 2011, p. 11)	Cooling the Tube program during heat waves
New York City USA	Unknown	Heat response plan at the level of New York State	Active outreach to homeless people (NYC, 2011)	Generic measure: mandatory requirement of albedo roofs on new buildings through local building code; "NYC °Cool Roofs" program Specific measures: 1) cooling centres, 2) Airco instalments for low income vulnerable elderly NYC, 2011)
Paris France	CHALEX (Chaleur Extreme) database of vulnerable elderly based on voluntary self-registration following an invitation letter of the Mayor (Cadot et al., 2007)	Paris has a specific heatwave plan for vulnerable people ("Plan de prévention canicule de la Ville de Paris pour les personnes fragiles")	During a heatwave the people in the CHALEX database are called by the local authorities' social service agency every other day (Cadot et al., 2007; ETC, 2010)	Generic measures: all kinds of greening initiatives Specific measure: 20 hotels are changed into refreshment areas for vulnerable people

APPENDIX 7 | (CHAPTER 5)

OVERVIEW OF ACTIVITIES IN THE 10 FOREIGN CITIES

City	Problem analysis: Vulnerability Assessment	Policy making: Plan development	Policy implementation: Healthcare Measures	Policy implementation: Built Environment Measures
Philadelphia USA	Information about high-risk individuals and locations with concentrations of them (Kalkstein et al., 2009)	City of Philadelphia Heat Emergency Plan pays considerable attention to vulnerable groups, in particular elderly and homeless	Operation of a heat line by the Philadelphia Corporation for Aging; buddy system that relies on community volunteers such as block captains to check up on vulnerable individuals; Health department mobile field team ready to conduct home visits; outreach to homeless and replacement to cooling centres (Kalkstein et al., 2009;	Generic measure: cool roof requirement, and tax credit for green roofs Specific measure: cooling centres (extending operation hours of senior centres)
Rome Italy	Registration of vulnerable individuals through records of hospital admissions, and information of general practitioners (WHO, 2007)	Rome heat health action plan (Matthies & Menne, 2009)	GPs perform active surveillance (home visits) on their at-risk patients (WHO, 2007)	unknown
Stuttgart Germany	Climate Atlas for Stuttgart region (Kazmierczak & Carter, 2010)	Heat response plan at the Bundesland level (Baden-Württemberg)	unknown	Generic measures: based on the Climate Atlas, establishment of ventilation corridors of open green areas, that are protected in the local land use plan; mandatory requirement for green roofs in certain parts in the city (CIRCLE, 2013; Kazmierczak & Carter, 2010)
Tatabanya Hungary	unknown	Local heat and UV warning system as part of the local climate change strategy and action plan (CIRCLE, 2013)	22 public and private organisations are activated during a heat alert and who give assistance to ill and elderly people (Tatabanya, nd)	Specific measure: availability of acclimatized buildings in the city; distribution of drinking water at no cost at various locations in the city
Toronto Canada	Very advanced, NASA aided, assessment and mapping of different types of vulnerable population groups (TPH, 2011a)	Specific policy document for the protection of vulnerable people (TPH, 2011b), on top of Toronto's hot weather response plan	Operation of a heat line, establish direct contact with at risk individuals and increased outreach to homeless (Kalkstein et al., 2009)	Generic measures: mandatory requirement for green roofs through a local by-law; cool roof incentive program; program to double the tree canopy; program to green surface parking lots. Specific measures: cooling centres; cool room pilot project in a high-rise building in a deprived neighbourhood

APPENDIX 8 | (CHAPTER 6)
GENERAL ASSESSMENT OF A TECHNICAL REQUIREMENT

Criteria at risk	Criteria to assess a policy instrument(mix): Extent to which it	Score	Argumentation
Effectiveness	… steers towards supplying sufficient levels of adaptation goods/services	high	High certainty that the adaptation goal is reached through the coercive nature of the instrument, as long as its application is monitorable and enforceable to a high extent (e.g. fines for non-compliance).
Fairness	… steers towards supplying sufficient levels of adaptation goods/services for everybody now and in the future	medium	High certainty that adaptation goods are guaranteed for all, since it generally is inclusive in nature. However, some particularly vulnerable groups might still receive less adaptation goods than needed, while others receive more than needed.
Legal certainty	… offers legal certainty through clear, understandable and stable rules that people can conform to	high	Generally speaking technical requirements offer legal certainty; people have access to the rules and should be able to know them because of the duty to publish legislation.
Efficiency	… promotes flexible adaptation solutions and measures that can be easily adjusted over time at lowest cost	low	One size fits all requirement, hence least costs suppliers are not selected at all. This instrument is very inflexible, in that it prescribes a specific adaptation measure without leaving freedom of choice on the type of measure. Moreover, such a requirement is difficult to change or abolish at short notice.
Fairness	… steers towards supplying sufficient levels of adaptation goods to hotspots most vulnerable to climate impacts	high	By limiting the requirement to specific zones, specific vulnerable geographic districts/ regions can be targeted. Therefore differential needs of regions can be taken into account.
Efficiency	… promotes diverse adaptation action that is tailored to a specific location	low	One size fits all requirement, hence least cost suppliers are not selected at all. This instrument is inflexible, in that it prescribes a specific adaptation measure without leaving freedom of choice on the type of measure.
Legitimacy Output	… stimulates acceptance of its impact by all relevant stakeholders	medium	Acceptance for this instrument is high because the measure applies to all (think of acceptability of Best Available Abatement Technology), but is low because it does not take into account personal heterogeneity -- the overall acceptability is thus deemed medium.
Legitimacy Input	… serves all relevant interests that are influenced by the policy without excluding actor(groups) that have something at stake	low	This instrument is universal. Apart from effectiveness and reasonable costs, there is no consideration for other interests.
Accountability	… supports the allocation and transparency of responsibilities for adaptation action for both the governors and the governed	high	This instrument ensures clear, transparent and accountable responsibilities for both the governor and those who are governed.

APPENDIX 9 | (CHAPTER 7)

SYNTHESIS OF RESPONSIBILITIES ACROSS THE THREE ADAPTATION MEASURES FOR THE CITY OF ROTTERDAM

Rotterdam	Green roofs (arrangement since 2008)	Adaptive building (arrangement since 2011)	Heat measures health (not yet implemented)	Heat measures built environment (not yet implemented)
Plan				
Agenda setting	Public	Public-private	Public	Public
	Private (green roof industry)			Private (building industry associations)
Risk/vulnerability assessments	Public	Public	Public	Public
Initiation of policy	Public	Public-private	Public	Public
Do				
Strategy making	Public	Public-private	Public	Public
Coordination of implementation	Public	Public-private	Public	Public
Financing & implementation	Public (subsidy for property owners)	Public (public flood defense)	Public-private	Public (city wide)
	Private (property owners)	Private (adaptive measures)	Private (individual)	Public-private (neighbourhoods)
				Private (individual buidling)
Check				
Monitoring	Public (tracking of installations)	Public (during planning permission)	Not applicable	Not applicable
	Private (norms for products)	Private (housing corporation otherwise)	Not applicable	Not applicable
Enforcement	Not applicable	Not applicable	Not applicable	Not applicable
Maintenance				
Maintenance of measure	Private (property owners)	Public (for public infrastructure)	Not applicable	Not applicable
	Public (for public buildings)	Private (property owners)		
Risk communication	Not applicable	Public	Public	Not applicable
Flood damage control	Not applicable	Private (inhabitants)	Not applicable	Not applicable
Recovery of damage	Not applicable	Private (inhabitants)	Not applicable	Not applicable

APPENDIX 10 | KNOWLEDGE FOR CLIMATE AND GOVERNANCE OF ADAPTATION

The Dutch research programme *Knowledge for Climate* focuses on the development of knowledge and services that assists in increasing the country's resilience to climate change and in making The Netherlands climate proof. In the programme, governmental organisations, businesses and research institutes closely collaborate and contribute by providing additional resources. Important aspects of the research programme are international cooperation, knowledge transfer and valorisation.

The research programme includes eight themes: Climate Proof Flood Risk Management, Climate Proof Fresh Water Supply, Climate Adaptation for Rural Areas, Climate Proof Cities, Infrastructure and Networks, High-quality Climate Projections, Governance of Adaptation and Decision Support Tools. Within each theme, a group of researchers aims to develop new insights, models, tools and/or measures that assist in understanding the impacts and consequences of climate change for The Netherlands. Furthermore, specific locations in The Netherlands are appointed due to their vulnerability to the impacts of climate change. These eight locations are the so-called hotspots and function as 'real life laboratories'.

This dissertation is part of the theme: *Governance of Adaptation*. This programme aims to integrate existing knowledge from the fields of public administration, economics, political science, spatial planning, law, environmental studies and psychology. Through close cooperation with hotspots, this programme adds new empirical evidence to test innovative theoretical propositions about the governance of climate adaptation. This interdisciplinary programme develops and tests governance arrangements that will contribute to developing and implementing adaptation options, and to increasing the adaptive capacity of society so that future climate changes can be confronted.

The Governance consortium consists of eight partners: Wageningen University (consortium leader), VU University Amsterdam, Radboud University Nijmegen, Erasmus University Rotterdam, Utrecht University, University of East Anglia, Carl von Ossietzky University Oldenburg and Stockholm University.

More information is available on the following websites:
http://knowledgeforclimate.climateresearchnetherlands.nl/governanceofadaptation (English)
http://kennisvoorklimaat.klimaatonderzoeknederland.nl/governance (Dutch)

NRC Handelsblad Vrijdag 28 september 2012

13

Steeds vaker overstromen de dorpen van Engeland, en dijken aanleggen helpt niet

Overstromingen in Engeland, zoals hier in York, zijn een terugkerend fenomeen. Langs rivieren en kanalen zou je dijken kunnen aanleggen, rond asfalt en betegelde tuintjes niet. Foto AFP

Alleen de St. Andrews kerk blijft droog

Grote delen van Engeland worden getroffen door zware regenval. Veel dorpelingen staan weer met de voeten in het water. 'Dit is een probleem dat niet weg gaat'.

Door onze correspondent TITIA KETELAAR

CONGRESBURY. Het is droog. In Congresbury, ten zuiden van de Britse stad Bristol, wordt opgelucht adem gehaald. Even dan. Want achter de Mendip-heuvels doemen de volgende donkere wolken op. En dat betekent opnieuw regen.

Sinds zondag weten de dorpelingen dat het gevaar dan niet alleen meer van de rivier Yeo en zijn zijtakken hoeft te komen. Toen viel er 73,5 millimeter regen – bijna net zoveel als normaal in heel september. Niet alleen de rivier en enkele beekjes overstroomden, maar van de heuvels „stortte de regen naar beneden", vertelt Leslie Whiting. De riolen konden het water niet aan, een deel van het dorp liep onder.

Met hond Tootsie overzier ze de schade: zes huizen stonden blank, de zandzakken staan nog voor de deur. Kapiaarzen zijn hier geen modeaccessoire, zoals in Londen, maar een broodnodige noodzakelijkheid. Ergens ligt een kleddernat tapijt in de tuin, huisraad ligt te drogen, en de speeltuin is tot nader order buiten gebruik. Van het klimrek zijn alleen de bovenste treden te zien.

Congresbury (3.400 inwoners) is niet uniek. In de driehoek tussen Bristol, Weston-super-Mare en Cheddar overstroomden tientallen dorpjes. De Avon, Yeo, Frome, Boyd en Chew liepen buiten hun oevers. In Noord-Engeland en Wales was het nog erger: daar staan meer dan 750 huizen blank, duizenden bewoners zijn uit voorzorg geëvacueerd, en wegen en sporen liepen onder. Het Environment Agency kondigde de afgelopen dagen meer dan tweehonderd overstromingswaarschuwingen af. En er is meer regen op komst.

De overstromingen hebben „diverse oorzaken", zegt een woordvoerder van het agentschap. Waaronder de uitzonderlijke regenval, maar ook de lente. Die was zo droog dat er sproeiverboden werden afgekondigd. Maar de grond is daardoor nu op sommige plekken zo snel verzadigd dat er „een beperkte absorptie" is.

Hij zegt dat het Environment Agency „dag en nacht bezig is met vrijmaken van blokkades in riolen en rivieren" zodat het water weg kan.

„En we hebben veel gewaarschuwd. We moedigen mensen die in gevarenzones wonen aan om zich op het alarmeringssysteem te abonneren."

Het is niet voor het eerst deze zomer, of voor het eerst dit decennium dat er op zulke grote schaal overstromingen plaatsvinden in Engeland. „Dit is een probleem dat niet weg gaat", zegt Simon McCarthy van het Flood Hazard Research Centre aan de Universiteit van Middlesex.

Want het gaat niet alleen om rijzend zeewater of rivieren die overstromen – daarregen zijn traditionele verdedigingen gebouwd die de waterstromen aankunnen. Maar veel van de plotselinge overstromingen, de zogenoemde *flash floods* die straten doen onderlopen, ontstaan doordat oppervlaktewater niet weg kan.

En dat komt „doordat er steeds meer tuinen worden bestraat", zegt McCarthy. „Het blokkeert de afvoer. Als die huizen ook nog in een gebied liggen dat geneigd is te overstromen, zoals uiterwaarden..." Hij maakt zijn zin niet eens af. Hij zegt: „Soms zie je een huis met de naam *Pond's End*, maar er is geen vijver. Vroeger was die er wel."

Het Environment Agency wil geen commentaar geven op de invloed van beton en huizenbouw op de overstromingen. Maar het probeert sinds grote overstromingen in 2007 gemeenten wel op het gevaar van bouwen in risicogebied te wijzen, en maakt regelmatig bezwaar tegen nieuwbouwplannen. In 2009 maakte het agentschap voor het eerst een overzicht: 5,2 miljoen huizen in Engeland loopt het risico te overstromen – dat is één op de zes.

McCarthy van het Flood Hazard Research Centre zegt: „Of we voorkomen dat men daar bouwt, óf we zorgen dat er adequate maatregelen worden genomen als het risico zich later heeft gemanifesteerd, bijvoorbeeld doordat de natuur is veranderd." Hij heeft het over sluizen, plastic platen die in de muren worden gemetseld, wc-pijpen die maar van één kan open kunnen.

„De vraag is wie dat moet betalen: de huiseigenaar of de overheid." De eerste wil bovendien soms dergelijke voorzieningen niet treffen, want het afzienderd potentiële kopers op het feit dat het huis in een gevarenzone ligt."

Maar zelfs met voorbereidingen kan het water verrassen. In Congresbury waren er al eerder overstromingen geweest – 30 procent van Noord-Somerset loopt risico. In de pub wordt verteld over 1968, toen het water tot twee meter hoog kwam en honderd huizen onder liepen. Nu heeft het dorp 'flood wardens', die in dagelijks contact staan met het Environment Agency dat een paar kilometer verderop het waterniveau van de Yeo peilt, en die de rest van het dorp kunnen waarschuwen.

Sterker nog: voor volgende week staat – nog steeds – een rampenoefening gepland. „We hebben overheidsgeld gekregen voor een proefproject", vertelt Nick Yates van de gemeente. Congresbury test of lokale evacuatieplannen kunnen helpen het aantal slachtoffers zo klein mogelijk te houden. Scouts hebben de folders al uitgedeeld, vrijwilligers kennen hun rol, en de dorpelingen weten dat St. Andrews-kerk bij een grote overstroming als enige droog zal blijven.

Ze erg was het nu nog niet – maar de regen blijft komen.

Natte driehoek ten zuiden van Bristol

Drie doden

Volgens het Met Office, het Britse weerinstituut, zijn de stormen die Engeland en Wales nu teisteren, de ergste sinds 1981. In Engeland en Wales staan meer dan 750 huizen blank, duizenden bewoners zijn uit voorzorg geëvacueerd, en wegen en sporen zijn onder water gelopen. De rivier Ouse, bij York, was woensdag vijf meter boven de normale stand. Drie mensen zijn om het leven gekomen: een jong stel dat een hond probeerde te redden in de rivier Clywedog in Noord-Wales, en een vrouw die tijdens een wandeling in Kew Gardens in Londen een tak op haar hoofd kreeg. Het aantal waarschuwingen voor overstromingen is afgenomen, maar het Met Office voorspelt dat ook volgende week het land nog last heeft van harde regen en windstoten.

1] NRC Handelsblad 28-08-2012

SUMMARY

INTRODUCTION

Climate change is already affecting cities and their citizens in multiple ways: for instance by river or sea flooding from increased river discharge levels, storm surges and sea level rise; by surface water flooding from more frequent and intense rainfall; and by heat stress from extreme hot days and heatwaves. The impacts of climate change are expected to increase in the near future. Key urban issues related to climate change, therefore, are water safety, storm-water retention and heat prevention. Consequently public actors, such as city governments, and private actors, such as developers and citizens, are planning for and taking action on adaptation to climate change. In the climate adaptation practice, however, the implementation of adaptation plans and actions is hampered because the division of responsibilities for adaptation to climate change between public and private actors remains rather vague, fragmented and ambiguous. In this dissertation it is argued that a clear and deliberate allocation of responsibilities, based on a conscious weighting of different considerations underlying this allocation of responsibilities, is necessary to get adaptation planning and action off the ground. Moreover, the allocation of responsibilities to certain public and/or private actors has implications for the effectiveness, legitimacy, and fairness of the subsequent governance arrangements. It therefore matters to study the issue of public and private responsibilities for climate adaptation.

Nevertheless, the issue of public versus private responsibilities is underexplored in the adaptation literature, despite a substantial increase of work on the governance of climate adaptation. A systematic analysis and evaluation of emerging arrangements between public and private actors, based on multiple cases and on multiple theoretical perspectives, has been lacking. This dissertation aims to contribute to the scientific debate and the adaptation practice, by systematically studying existing governance arrangements between public and private actors, as well as promising alternatives to these arrangements. The objective of this dissertation therefore is:

> ***To explore, analyse and evaluate existing and alternative public and/ or private governance arrangements for the three key urban adaptation issues of stormwater retention, water safety and heat prevention.***

This systematic exploration, analysis and evaluation was performed through a multiple, cross-city and cross-issue comparative case study design for three innovative adaptation measures and their associated policy instruments for three key urban adaptation issues, i.e. green roofs for storm-water retention, adaptive building for water safety, and a variety of measures for heat stress prevention. The research included 20 governance arrangements in 15 cities in 10 countries in Europe and North America. Data was collected through the content analysis of over 100 policy documents, through 97 in-depth interviews, and through two multi-stakeholder workshops and one focus group. The details of the research background, problem outline, research questions, research strategy, case selection and research methods can be found in *Chapter 1*.

CONCEPTUAL FRAMEWORK

To guide the empirical work, a conceptual framework of responsibilities is proposed and elaborated upon in *Chapter 2*. The framework was used as an analytical device to explore and analyse existing arrangements between public and private actors, as well as to design alternative arrangements. The three key elements of the framework are: 1) responsibilities, 2) considerations, and 3) challenging factors for adaptation.

Responsibilities are instrumentally operationalised as the different roles that actors can take on or assign to others in the four main stages of the policy process (see Table 2.1 for an elaboration). These roles can be taken on by local authorities/city governments (public responsibility), private actors (private responsibility), or as a shared public-private responsibility through partnerships and network arrangements.

Considerations are the underlying reasons for an actor(group) to take on or assign a certain responsibility to himself or another actor(group). They serve to explain why certain responsibilities are assigned to certain actors. These considerations were extracted through a literature review, from three different rationales on public policy, stemming from three scientific disciplines. In total six considerations were included: rule of law and fairness from legal studies, effectiveness (here referred to as securing adaptation action) and efficiency from economics, and legitimacy and accountability from policy/political studies.

Based on a literature review, several challenging factors for adaptation have been identified, which may influence the relevance of the six considerations and may therefore also indirectly influence the divisions of responsibility among public and private actors: uncertainty, spatial diversity, social complexity, and controversy. For instance, a high spatial diversity in the impacts of climate change leading to high vulnerability in certain citizen groups, may induce fairness to become a determining consideration for the allocation of responsibilities. In this case local governments may take on the responsibility of redistributing certain adaptation goods to those vulnerable citizen groups. In Chapter 2 several hypotheses are formulated with respect to how each of the four challenges may influence one or more of the six considerations, and ultimately may lead to a certain allocation of responsibility to a public or private actor(group) (see Table 2.2).

EMPIRICAL CHAPTERS

Chapter 3 discusses the green roof case. Five governance arrangements in Basel, Chicago, London, Rotterdam, and Stuttgart were analysed and compared in terms of the division of responsibilities and their underlying considerations. Furthermore, these five arrangements were evaluated for the extent to which they are able to secure sufficient adaptation action, the more so since local governments heavily depend on the private sector for green roof instalments on private property. The study shows that current arrangements are predominantly hierarchical with a large extent of public responsibility borne by local authorities in the early stage of the policy process. It also shows that a high extent of public responsibility throughout the policy process, as witnessed in Basel and Stuttgart, is not only salient for getting green roofs off the ground but is also far more effective in securing sufficient levels of adaptation action. Private responsibility has been shown to be important for raising efficiencies, in particular the innovation drive of the green roof industry.

Chapter 4 discusses the case of adaptive building. Three governance arrangements in Hamburg, Helsinki, and Rotterdam were analysed and compared. Furthermore, these three arrangements were evaluated for the extent to which they are able to gain legitimacy. This is because adaptive building requires a certain degree of private responsibility for flood risk governance, whereas responsibilities for water safety have traditionally been considered to be legitimately carried by public authorities in many countries in Europe and North America. In the literature a private responsibility for a public issue such as water safety is often associated with legitimacy concerns. The results show that there is indeed a shift from public to private responsibility and to public-private responsibility, although a certain degree of public responsibility remains quite pertinent. This shift alters the way in which legitimacy is gained for the governance arrangements; each arrangement has different mixes of input, throughput and output legitimacy. Even so, traditional public responsibility for the ratification of important decisions via elected officials remains critical for obtaining sufficient input legitimacy. Another important result is that private responsibility for flood preparation and flood damage control by citizens can only be legitimate if the public authorities take on the responsibility of continuous flood risk communication to these citizens.

Chapter 5 discusses the case of heat stress prevention. Different responsibility divisions were explored in two Dutch cities (Rotterdam and Arnhem) during two interactive workshops based on the perceptions of the different stakeholders involved. The resulting hypothetical arrangements were then compared against the actual arrangements of 10 foreign cities, retrieved from a desk research. Here fairness was taken as the primary consideration for these arrangements, in terms of the protection of vulnerable citizen groups such as the elderly and socially deprived. The results show that public responsibility in several stages of the policy process is salient to safeguarding the protection of the most vulnerable people. A major finding is that the issue of the protection of one's heat health is seen as an individual responsibility first, rather than a public or a private responsibility. This individual responsibility is fuelled by the consideration of legitimacy (collective public or private responsibility is viewed as paternalism and encroachment on one's privacy), and this can clash with the fairness concerns that may underlie a collective responsibility for the protection of vulnerable people. A major finding is that differentiated and customised approaches are needed for a targeted outreach to specific vulnerable groups and this approach is often served through public-private responsibilities organised in networks of local public, private and civil society groups.

Chapter 6 proposes a method for the selection of policy instruments for climate adaptation. Policy instruments can support the allocation of responsibilities with certain actors for the implementation of adaptation measures. They can also influence the effectiveness, legitimacy and fairness of governance arrangements, and as such they are an important element of governance arrangements for climate adaptation. The merit of the method is that it allows a deliberate selection of policy instruments for the implementation of a certain adaptation measure, while taking account of the six considerations and the four challenges to the governance of adaptation as incorporated in the conceptual framework in Chapter 2. Furthermore, the 4-steps method fosters a deliberative process of instrument selection among different groups of experts. The application of the method to the three cases of adaptation measures from Chapters 2-5 shows that the method opens up avenues for novel instrument mixes other than those applied in today's practice, which in turn may trigger a change in divisions of responsibilities among public and private actors. The application also shows that the instrument of a contractual agreement is a promising policy instrument for climate adaptation, since it can effectively overcome the challenges of spatial diversity and differential vulnerabilities in urban areas.

SYNTHESIS AND CONCLUSIONS

The synthesis across the different research projects as provided in *Chapter 7* reveals that existing governance arrangements for local urban climate adaptation are characterised by a large extent of public responsibility; by a moderate private responsibility that is often limited to the implementation of measures; and by a (very) limited extent of public-private responsibility. The dominance of this public responsibility is explained by two dominant considerations, i.e. effectiveness in terms of securing sufficient adaptation action, and rule of law in terms of the duty of care of local authorities for a healthy and liveable environment. The major consideration for private responsibility is efficiency. Legitimacy was the key consideration underlying the few instances of public-private responsibility that were witnessed in this research. At the same time, decisions on responsibility divisions have been taken quite selectively and routinely. This means that the extent to which considerations are taken into account or not, is a selective process influenced by path dependencies stemming from existing organisational routines, more so than taking explicit note of the adaptation challenges of uncertainty, spatial diversity, controversy, and social complexity. In other words, decisions on responsibility divisions do not appear to have been taken very deliberately, based on the whole set of considerations and the challenges to the governance of adaptation. Furthermore, the synthesis reveals that the large extent of public responsibility currently contributes positively to the effectiveness, legitimacy and fairness of existing governance arrangements.

Nevertheless, in view of the acceleration of climate impacts in the near future, public responsibility might not suffice and the local authorities will need to engage the private sector in adaptation planning and action. Therefore, interactive arrangements with shared public-private responsibilities and supported by contractual agreements, may offer promising alternative arrangements, since they take good account of the challenges to the governance of adaptation. In particular these types of arrangements are able to handle the social complexity and spatial diversity that characterise many urban adaptation issues. The heat stress prevention case is characterised by a large extent of social complexity, and therefore it makes sense to create interactive arrangements that include all relevant public and private stakeholders for the protection of certain specific vulnerable citizen groups. The green roof and adaptive building cases are characterised by a large extent of spatial diversity. Different public-private networks can be created to handle this spatial diversity. Likewise contractual agreements allow for a spatial differentiation: different contracts can be agreed upon among the different public-private networks for each vulnerable geographic location. Furthermore, contractual agreements offer a good balance between voluntariness and coercion.

Chapter 8 summarises and discusses the conclusions from the synthesis in Chapter 7. The conclusion, that current arrangements are predominantly public, is reflected against the expectation that a new and emerging policy field such as climate adaptation would be more inclined towards novel arrangements such as networks in which responsibilities are shared between the public and private sectors. It raises the question of whether a large extent of public responsibility is perhaps primarily the consequence of existing organisational and policy routines, or whether it is a more permanent requirement for adaptation to climate change in light of its positive effect on the effectiveness, legitimacy and fairness of existing arrangements for climate adaptation. The answer to this question remains to be seen. The scientific merit of this dissertation is that it has proved to offer a conceptual framework of responsibilities that takes account of a holistic set of considerations stemming from different scientific disciplines, as well as certain specific challenges to the governance issue at hand. This allows for both a systematic and more contextual analysis and evaluation of governance arrangements in terms of public and private responsibilities. The major contribution of this dissertation to the adaptation policy practice is that it provides methods for policymakers to enable deliberate and deliberative decisions on governance arrangements in terms of allocations of responsibilities and in terms of the selection of policy instruments, thus avoiding the trap of path dependencies. The chapter ends with the main thesis of this dissertation, namely that a clear and deliberate allocation of responsibilities, that is well-informed by the four challenges and the six considerations, is important for getting adaptation off the ground and for making cities future climate-proof, given the acceleration of climate change. In the end I argue that it is a clear and deliberate allocation of responsibilities that constitutes truly responsible climate change adaptation.

'Straks groeien er in Nederland olijfbomen'

■ Ingenieur: Droogte is groot probleem
■ 'Overheden onderschatten het'

INTERVIEW
Janne Chaudron

AMSTERDAM – „In de plannen die provincies, waterschappen en politici ontwerpen om Nederland veilig te houden, wordt meestal rekening gehouden met overstromingen. Droogte wordt in die plannen nooit gezien als het hoofdprobleem." Droogte kan op termijn grote schade veroorzaken. Nederland onderschat dit probleem. Dat zegt Johan Kabout van advies- en ingenieursbureau DHV. Kabout is adviseur op het gebied van waterbeheer, droogte en waterveiligheid.

De droogte van de afgelopen tijd toont volgens Kabout aan dat zelfs Nederland bij de inrichting van het landschap en de bouw van nieuwe steden rekening moet houden met droge periodes. Het neerslagtekort in Nederland bedraagt momenteel zo'n 150-200 millimeter, dat is bijna net zoveel als in de zeer droge zomer van 2003. „We zijn verwend met een schijnbare overvloed aan water. Daarnaast beschikken we over een uitstekende kwaliteit drinkwater voor een zeer lage prijs van ongeveer 1,50 euro per kuub. In de toekomst zullen we meer moeten doen om de kwaliteit op peil te houden."

De gevolgen van de droogte verschillen per gebied. „In Friesland en Twente is de watertoevoer slecht. In Friesland wordt water uit het IJsselmeer verplaatst naar de Friese polders." Twente heeft nog voldoende water, maar op termijn moet ook dit gebied bedenken hoe het zijn watervoorziening gaat inrichten. „Je zou bijvoorbeeld een gebied aan kunnen leggen dat water vasthoudt. Maar daar heb je wel een grote oppervlakte voor nodig. Aan grote stukken land ontbreekt het in Nederland."

Een ander deel van Nederland kan onder water komen te staan als er

NRC Handelsblad Vrijdag 6 mei 2011

16 Wetenschap

Aarde warmt op, oogst neemt af

Opbrengsten van tarwe en maïs nemen af, die van rijst en soja blijven gelijk

Van boven naar beneden: velden met tarwe, maïs, rijst en sojabonen.
Foto's Flip Franssen, NRCH Maurice Boyer en Bloomberg

Terwijl de temperatuur stijgt, is de wereldwijde opbrengst van maïs en tarwe gedaald. Dat blijkt uit opbrengstcijfers en klimaatgegevens van de afgelopen dertig jaar.

Door onze redacteur
MARCEL AAN DE BRUGH

ROTTERDAM. Eigenlijk moet de wereldwijde voedselproductie de komende decennia fors stijgen, gezien de verwachte groei van de menselijke populatie en de stijging van de welvaart. Maar als gevolg van klimaatverandering dreigt juist het tegenovergestelde te gebeuren.

Dat is de conclusie van een artikel dat vandaag is gepubliceerd in het wetenschappelijk tijdschrift *Science*. Amerikaanse onderzoekers tonen daarin aan dat de wereldwijde opbrengst van twee belangrijke gewassen, tarwe en maïs, in de afgelopen dertig jaar is gedaald door de stijging van de gemiddelde temperatuur op aarde.

Volgens de drie onderzoekers voorspelt het weinig goeds voor de toekomst. De snelheid van de temperatuurstijging neemt in de komende decennia naar verwachting toe. Het negatieve effect op de opbrengsten van tarwe en maïs groeit daarmee ook. De onderzoekers waarschuwen daarom aan het eind van hun artikel: als de mens zijn landbouw niet sneller aanpast aan klimaatverandering, dreigen er ernstige voedseltekorten en grote economische schade.

Rik Leemans, hoogleraar milieusysteemanalyse aan de Wageningen Universiteit, noemt de studie alarmerend. Ondanks alle verbeteringen in de landbouwpraktijk – veredelde gewassen die meer opbrengen per hectare, betere toepassing van kunstmest – is het negatieve effect van klimaatverandering in de afgelopen decennia sterker geblekken.

Leemans vindt het onderzoek van de drie Amerikaanse wetenschappers bijzonder. Voor het eerst is er op basis van gegevens uit de praktijk een verband gelegd tussen de wereldwijde temperatuurstijging en het effect daarvan op de landbouwproductie. In het verleden is deze relatie al vaker onderzocht, maar dan via computermodellen, waarin veel theoretische aannames worden gedaan. Dit keer hebben de onderzoekers bestaande gegevens uit het veld gebruikt. Zo hebben ze een database opgebouwd met cijfers over de wereldwijde opbrengst van de vier gewassen tarwe, maïs, rijst en sojabonen, in de periode 1980 tot 2008. In hun studie betrokken ze ook de locaties van de gewassen, de groeiseizoenen, en de maandelijkse temperatuur- en neerslagpatronen.

Voor tarwe blijkt de opbrengst vooral gedaald in Rusland, India en Frankrijk. Wereldwijd was er sprake van een oogstafname van 5,5 procent, vergeleken met een situatie waarin er geen klimaatopwarming zou zijn geweest. Voor maïs ging met name de oogst in China, Brazilië en, weer, Frankrijk achteruit. Wereldwijd daalde de opbrengst in de periode 1980 tot 2008 met bijna 4 procent.

Voor rijst en sojabonen blijkt de opbrengst in sommige gebieden gestegen, maar in andere gedaald. Netto bleef de wereldwijde opbrengst gelijk.

Er is ook kritiek op het onderzoek. Frank Ewert, hoogleraar gewaswetenschappen aan de Universiteit van Bonn, ziet de nodige onzekerheden in de studie. De cijfers over de wereldwijde oogstopbrengsten zijn afkomstig van de Wereldvoedselorganisatie en die krijgt ze weer aangeleverd door de individuele landen. „Die rapporteren niet allemaal even nauwkeurig", zegt Ewert. Hij vraagt zich dan ook af of temperatuurstijging echt de oorzaak is van de daling in oogstopbrengsten. De onderzoekers kunnen andere factoren over het hoofd hebben gezien. Neem politieke instabiliteit. „In de jaren na de val van de Berlijnse Muur in 1989 daalde de landbouwproductie in de voormalige Sovjet-Unie", zegt hij.

Leemans uit Wageningen houdt wel dat de analyse goed is uitgevoerd, en dat er een relatie is aangetoond tussen klimaatopwarming en daling van de opbrengst. Hij benadrukt dat een van de auteurs van het Science-artikel, David Lobell van de Stanford University, onlangs hetzelfde al een keer heeft gedaan, alleen dan op kleinere schaal. Voor Afrika. Lobell gebruikte toen gegevens van 20.000

De landbouw is wel verbeterd, maar kan de opwarming niet aan

veldproeven die in de periode 1999-2007 in het zuidelijk deel van Afrika zijn uitgevoerd met maïs. Hij verkreeg de data via het CIMMYT, een instituut in Mexico dat maniercen zoekt om de opbrengst van maïs en tarwe te verhogen. In het artikel, dat op 13 maart is gepubliceerd in *Nature Climate Change*, beschrijven Lobell en drie onderzoekers van het CIMMYT de effecten van temperatuurstijging op de maïsoogst. Vooral bij temperaturen boven de 30 graden Celsius gaan de maïsplanten lijden. Elke 24 uur dat de temperatuur extra boven de 30 graden Celsius kwam, vergeleken met een situatie zonder klimaatopwarming, daalde de oogst met 1 procent. Tenminste, onder omstandigheden van ideale regenval. Bij droogte daalde de opbrengst sterker, met bijna 2 procent. De onderzoekers concludeerden dat een watertekort de schade door hogere temperaturen verergert. Ze vermoeden dat de schade onder meer veroorzaakt wordt tijdens de bloei van maïs, een proces waarbij water belangrijk is.

Uit dit artikel leidt Leemans af dat er veel meer moet gebeuren aan, wat hij noemt, droogtemanagement. Boeren moet de vochtigheid van de bodem beter bewaken, onderzoekers moeten planten meer veredelen op weerstand tegen droogte. Er is een hoop extra inspanning nodig om tot een groei van gewasopbrengsten te komen. „Gebeurt dat niet, dan eten we in Europa over vijftig jaar misschien geen tarwebrood meer."

1] Trouw 16-07-2010

2] NRC Handelsblad 06-05-2011

SAMENVATTING

INTRODUCTIE

Klimaatverandering heeft nu al gevolgen voor steden en stedelingen, zoals overstromingen door zeespiegelstijging en hogere rivierstanden, wateroverlast door frequentere en intensivere regenbuien, en hittestress door tropische dagen en hittegolven. Men verwacht dat deze gevolgen zullen toenemen in de nabije toekomst. Belangrijke stedelijke thema's in het kader van klimaatverandering zijn waterveiligheid, (regen)waterberging en hittebestrijding. Publieke partijen zoals lokale overheden, en private partijen zoals projectontwikkelaars en burgers, moeten dus plannen maken en actie ondernemen om steden aan te passen aan klimaatverandering. Dit wordt ook wel klimaatadaptatie genoemd. In de praktijk wordt de uitvoering van die plannen en activiteiten echter belemmerd, omdat de verdeling van verantwoordelijkheden voor klimaatadaptatie tussen publieke en private partijen redelijk vaag, gefragmenteerd en dubbelzinnig is. In dit proefschrift wordt betoogd dat een bewuste toewijzing van verantwoordelijkheden, gebaseerd op een nauwgezette afweging van verschillende overwegingen die ten grondslag kunnen liggen aan die verantwoordelijkheden, nodig is om de planning van en activiteiten voor klimaatadaptatie van de grond te krijgen. Bovendien heeft de toewijzing van verantwoordelijkheden aan bepaalde publieke en/of private partijen gevolgen voor de effectiviteit, legitimiteit en billijkheid van de daaruit voortvloeiende sturingsarrangementen. Het doet er dus toe om het vraagstuk van publieke en private verantwoordelijkheden voor klimaatadaptatie te bestuderen.

Niettemin is het vraagstuk van publieke en private verantwoordelijkheden ondervertegenwoordigd in de klimaatadaptatieliteratuur, ondanks een behoorlijke toename van studies over de sturing van klimaatadaptatie. Het ontbreekt aan een systematische analyse en evaluatie van de ontstane sturingsarrangementen, gebaseerd op verschillende case studies en op verschillende theoretische perspectieven. Dit proefschrift beoogt bij te dragen aan het wetenschappelijke debat en aan de adaptatiepraktijk, door het systematisch bestuderen van bestaande arrangementen tussen publieke en private partijen, evenals van veelbelovende alternatieven voor deze arrangementen. De doelstelling van dit proefschrift is:

> ***Het verkennen, analyseren en evalueren van bestaande en alternatieve arrangementen tussen publieke en private partijen voor de drie belangrijke stedelijke klimaatadaptatie thema's van waterveiligheid, waterberging en hittebestrijding.***

Deze systematische verkenning, analyse en evaluatie is verricht door middel van vergelijkend case studie onderzoek voor drie innovatieve adaptatiemaatregelen en de bijbehorende beleidsinstrumenten voor de drie bovengenoemde klimaatadaptatiethema's: te weten groene daken voor regenwaterberging, adaptief bouwen voor waterveiligheid, en diverse maatregelen voor hittebestrijding. Het onderzoek omvatte 20 sturingsarrangementen in 15 steden in 10 landen in Europa en Noord-Amerika. Data zijn verzameld door middel van het analyseren van meer dan 100 beleidsdocumenten, 97 diepte-interviews, twee multi-stakeholder workshops en een focusgroep. In *Hoofdstuk 1* van dit proefschrift zijn de achtergrond van het onderzoek, de probleemstelling, de onderzoeksvragen, de onderzoeksstrategie, de selectie van de cases en de onderzoeksmethodes meer uitvoerig beschreven.

CONCEPTUEEL RAAMWERK

In *Hoofdstuk 2* wordt een conceptueel raamwerk gepresenteerd en uitgewerkt, dat gebruikt is voor het empirische werk. Dit raamwerk is gebruikt als analytisch kader voor het verkennen en analyseren van bestaande arrangementen tussen publieke en private partijen en voor het ontwerpen van alternatieve arrangementen. De drie kernelementen van het raamwerk zijn: 1) verantwoordelijkheden, 2) overwegingen, en 3) specifieke kenmerken van het klimaatadaptatievraagstuk.

Voor dit onderzoek zijn verantwoordelijkheden op instrumentele wijze geoperationaliseerd als de verschillende rollen die partijen op zich kunnen nemen of kunnen toewijzen aan andere partijen (zie Tabel 2.1 voor een uitwerking van die rollen). Die rollen kunnen opgepakt worden door lokale overheden/gemeenten (publieke verantwoordelijkheid), door private partijen (private verantwoordelijkheid), of als gedeelde publiek-private verantwoordelijkheid door middel van partnerships en netwerkarrangementen.

Overwegingen zijn onderliggende redenen of motieven die een partij kan hebben om een verantwoordelijkheid op zich te nemen of om die aan een andere partij te geven. Overwegingen geven verklaringen voor de vraag waarom bepaalde verantwoordelijkheden bij bepaalde partijen liggen. Op basis van een literatuurstudie zijn deze overwegingen afgeleid van drie verschillende rationales voor beleid afkomstig uit drie verschillende wetenschappelijke disciplines. In totaal zijn er zes overwegingen geidentificeerd: rechtmatigheid en billijkheid vanuit de rechtswetenschap, effectiviteit (hier aangeduid als het zeker stellen van klimaatadaptatie actie) en efficiëntie vanuit de economische wetenschap, en legitimiteit en accountibiliteit vanuit de beleidswetenschap.

Op basis van een literatuurstudie zijn ook vier specifieke kenmerken of uitdagingen van het vraagstuk van klimaatadaptatie afgeleid: t.w. onzekerheid, ruimtelijke diversiteit, sociale complexiteit en controverse. Deze kenmerken kunnen de relevantie van de zes overwegingen beïnvloeden, en daarmee dus indirect ook de verdelingen van verantwoordelijkheden tussen publieke en private partijen. Een grote mate van ruimtelijke diversiteit in termen van klimaateffecten resulterend in verschillen in kwetsbaarheden, bijvoorbeeld, kan ervoor zorgen dat billijkheid een doorslaggevende overweging wordt voor de toewijzing van verantwoordelijkheden. In zo'n situatie zouden gemeenten de verantwoordelijkheid op zich kunnen nemen om adaptatiemaatregelen zodanig uit te voeren dat ze vooral ten goede komen aan de meest kwetsbare bevolkingsgroepen in de stad. In Hoofdstuk 2 wordt een aantal hypothesen geformuleerd ten aanzien van hoe elk van de vier factoren van invloed kan zijn op een of meerdere overwegingen, en uiteindelijk op de toewijzing van bepaalde verantwoordelijkheden bij publieke of private partijen (zie Tabel 2.2).

EMPIRIE

Hoofdstuk 3 bespreekt het onderwerp 'groene daken'. Vijf sturingsarrangementen in Basel, Chicago, London, Rotterdam en Stuttgart zijn geanalyseerd en vergeleken op het gebied van verantwoordelijkheidsverdelingen en de onderliggende overwegingen. Bovendien zijn deze vijf arrangementen geëvalueerd op basis van hun vermogen om voldoende klimaatadaptatiemaatregelen zeker te stellen. Dit laatste is belangrijk omdat lokale overheden in belangrijke mate afhankelijk zijn van de private sector bij het installeren van groene daken op particulier onroerend goed. Deze studie laat zien dat het bij groene daken vooral om hiërarchische arrangementen gaat met een grote mate van publieke verantwoordelijkheid, die gedragen wordt door de lokale autoriteiten in het begin van het beleidsproces. Ook laat de studie zien dat een hoge mate van publieke verantwoordelijkheid gedurende het gehele beleidsproces, zoals aangetroffen in Basel en Stuttgart, niet alleen noodzakelijk is om groene daken van de grond te krijgen, maar ook vele malen effectiever is in het zeker stellen van voldoende klimaatadaptatie-actie (lees: het installeren van groene daken). Uit de studie blijkt voorts dat private verantwoordelijkheid belangrijk is voor het verhogen van de efficiëntie, en dan vooral via de innovatieve impuls van de groene daken industrie.

Hoofdstuk 4 bespreekt het onderwerp 'adaptief bouwen'. Drie sturingsarrangementen in Hamburg, Helsinki en Rotterdam zijn geanalyseerd en met elkaar vergeleken. Bovendien zijn deze arrangementen geëvalueerd op hun vermogen om legitimiteit te verkrijgen. Dit omdat adaptief bouwen een zekere mate van private verantwoordelijkheid voor waterveiligheidsbeheer met zich brengt, terwijl in veel Europese en Noord-Amerikaanse landen de verantwoordelijkheid voor waterveiligheid juist geacht wordt gedragen te worden door publieke autoriteiten. In de literatuur wordt een private verantwoordelijkheid voor een publiek goed als waterveiligheid vaak geassocieerd met legitimiteitskwesties. De resultaten van dit onderzoek laten zien dat er bij adaptief bouwen inderdaad sprake is van een verschuiving van verantwoordelijkheden naar de private sector, ook al blijven bepaalde publieke verantwoordelijkheden bestaan. Deze verschuiving verandert de wijze waarop legitimeit wordt verkregen voor de verschillende arrangementen. Ieder arrangement heeft zijn eigen mix van input-, throughput- en output-legitimiteit. Desondanks blijft een traditionele publieke verantwoordelijkheid bestaan in de vorm van het formeel goedkeuren van belangrijke besluiten door gekozen vertegenwoordigers (wethouders en/of raadsleden), om voldoende input-legitimiteit te verkrijgen. Een ander belangrijk resultaat is dat een private verantwoordelijkheid voor evacuatieplanning en het beperken van overstromingsschade door burgers alleen legitiem is als de lokale publieke autoriteiten de verantwoordelijkheid oppakken voor continue risicocommunicatie richting die burgers.

In *Hoofdstuk 5* staat het onderwerp 'hittestress preventie' centraal. Hiertoe werden gedurende twee interactieve workshops de verschillende mogelijke verantwoordelijkheidsverdelingen verkend in de steden Rotterdam en Arnhem op basis van de percepties van verschillende deelnemende publieke en private belanghebbende partijen. De resulterende hypothetische arrangementen zijn vervolgens vergeleken met de resultaten van bestaande arrangementen van 10 buitenlandse steden, voortgekomen uit een desk research. In dit onderzoek is billijkheid als belangrijkste overweging meegenomen in het kader van het beschermen van specifieke kwetsbare groepen, zoals ouderen en sociaal zwakkeren. Uit de resultaten blijkt dat een hoge mate van publieke verantwoordelijkheid in verschillende fasen van het beleidsproces van belang is voor het veiligstellen van de bescherming van de meest kwetsbaren. Een belangrijke bevinding is dat het vraagstuk van gezondheidsbescherming

in eerste instantie wordt gezien als een individuele verantwoordelijkheid in plaats van een publieke of private (collectieve) verantwoordelijkheid. Deze individuele verantwoordelijkheid wordt gevoed door legitimiteitsoverwegingen: een collectieve publieke of private verantwoordelijkheid wordt opgevat als paternalisme en een schending van de individuele privacy. Dit kan botsen met de billijkheidsoverwegingen die ten grondslag liggen aan een collectieve verantwoordelijkheid voor de bescherming van de zwakkeren in de samenleving. Een andere belangrijke bevinding is dat een gedifferentieerde en op maat gesneden benadering nodig is gericht op het bereiken van specifieke kwetsbare groepen. Deze gedifferentieerde benadering lijkt het meest gebaat bij gedeelde publiek-private verantwoordelijkheden in lokale netwerken (met deelnemendepartijen als gemeenten, gezondheids-, hulpverleners-, ouderenorganisaties, etc.).

Hoofdstuk 6 presenteert een methode voor de selectie van beleidsintrumenten voor klimaatadaptatie. Beleidsinstrumenten kunnen de verantwoordelijkheden voor de uitvoering van adaptatiemaatregelen bij bepaalde partijen neerleggen. Ze kunnen ook de effectiviteit, legitimiteit en billijkheid van het sturingsarrangement beïnvloeden. Als zodanig zijn ze een belangrijk element van een sturings-arrangement voor klimaatadaptatie. De waarde van de methode zit hem in het feit dat de methode een weloverwogen keuze van beleidsinstrumenten mogelijk maakt, waarbij rekening wordt gehouden met de zes overwegingen en vier specifieke uitdagingen van het klimaatadaptievraagstuk van het conceptuele raamwerk in Hoofdstuk 2. Bovendien maakt de stapsgewijze aanpak een proces mogelijk van overleg tussen verschillende groepen experts. De toepassing van de methode op de drie casussen van adaptatiemaatregelen uit de hoofdstukken 2 tot en met 5 demonstreert dat de methode de ogen opent voor nieuwe mixen van instrumenten die afwijken van wat er vandaag de dag in de adaptatiepraktijk gebruikt wordt. Deze nieuwe mixen van beleidsinstrumenten kunnen op hun beurt leiden tot nieuwe verantwoordelijkheidsverdelingen. De toepassing van de methode laat ook zien dat contractuele overeenkomsten veelbelovende beleidsinstrumenten kunnen zijn voor klimaatadaptatie, omdat deze effectief omgaan met de specieke uitdagingen van het klimaatadaptatievraagstuk, en in het bijzonder de ruimtelijke diversiteit en de daarbij behorende verschilende kwetsbaarheden in stedelijke gebieden.

SYNTHESE EN CONCLUSIES

Hoofdstuk 7 bevat een synthese van de resultaten van de verschillende onderzoeksprojecten. Dit hoofdstuk brengt aan het licht dat bestaande sturingsarrangementen voor stedelijke klimaatadaptie gekarakteriseerd worden door een hoge mate van publieke verantwoordelijkheid; door een bescheiden mate van private verantwoordelijkheid; en door een (zeer) beperkte mate van gedeelde publiek-private verantwoordelijkheid. De overheersend publieke verantwoordelijkheid kan worden verklaard door twee dominante overwegingen, te weten effectiviteit in de zin van het veiligstellen van voldoende klimaatadaptatiemaatregelen, en rechtmatigheid in de zin van de zorgplicht van lokale autoriteiten voor een gezonde en leefbare leefomgeving. De belangrijkste overweging voor private verantwoordelijkheid is efficiëntie. Legitimiteit is de belangrijkste overweging voor de weinig aangetroffen publiek-private verantwoordelijkheid. Tegelijkertijd is duidelijk geworden dat besluiten aangaande verantwoordelijkheidsverdelingen nogal selectief en routinematig genomen worden. Dit betekent dat de mate waarin overwegingen zijn meegenomen of niet, een selectief proces is dat vooral beïnvloed wordt door padafhankelijkheden via bestaande organisatorische routines, in plaats van dat er expliciet rekening wordt gehouden met de

adaptatiekenmerken van onzekerheid, ruimtelijke diversiteit, controverse en sociale complexiteit. Met andere woorden, besluiten over verantwoordelijkheidsverdelingen lijken niet heel bewust gemaakt te worden gebaseerd op een afweging van verschillende overwegingen en de specifieke kenmerken van het klimaatadaptatievraagstuk. Verder blijkt uit de synthese dat deze hoge mate van publieke verantwoordelijkheid momenteel een positieve bijdrage levert aan de effectiviteit, legitimiteit en billijkheid van de sturingsarrangementen.

Gezien het feit dat de gevolgen van klimaatverandering in de nabije toekomst zullen toenemen, zou een publieke verantwoordelijkheid echter wel eens ontoereikend kunnen zijn en zullen de lokale autoriteiten de private sector moeten betrekken bij klimaatadaptatie. Interactieve arrangementen met gedeelde publiek-private verantwoordelijkheden en ondersteund door contractuele overeenkomsten, kunnen veelbelovende alternatieve arrangementen opleveren, omdat ze rekening houden met de kenmerken van klimaatadaptatie. Meer specifiek kunnen dit soort arrangementen goed rekening houden met de sociale complexiteit en ruimtelijke diversiteit die zoveel stedelijke klimaatadaptatievraagstukken kenmerken. De casus 'hittestress' wordt bijvoorbeeld gekenmerkt door een hoge mate van sociale complexiteit, en daarom is het zinvol om interactieve arrangementen te ontwikkelen waarin alle relevante publieke en private belanghebbenden deelnemen om bepaalde kwetsbare burgergroepen te beschermen. De casussen 'groene daken' en 'adaptief bouwen' worden gekenmerkt door een hoge mate van ruimtelijke diversiteit. In zulke gevallen kunnen verschillende publiek-private netwerken worden ontwikkeld om met die ruimtelijke diversiteit om te gaan. Contractuele overeenkomsten kunnen eveneens omgaan met die ruimtelijke diversiteit: verschillende contracten kunnen worden overeengekomen door de verschillende publiek-private netwerken voor iedere kwetsbare lokatie. Bovendien bieden contractuele overeenkomsten een goede balans tussen vrijblijvendheid en verplichting.

Hoofdstuk 8 bevat een samenvatting van en discusie over de conclusies. De conclusie aangaande overheersende publieke arrangementen wordt gespiegeld aan de verwachting dat nieuw onstane beleidsterreinen zoals klimaatadaptatie zich juist zouden lenen voor nieuwere typen arrangementen, zoals netwerken waarin de publieke en private actoren verantwoordelijkheden delen. Het roept de vraag op in hoeverre een hoge mate van publieke verantwoordelijkheid vooral voortkomt uit bestaande organisatorische routines, of dat het hier een meer permanente vereiste voor klimaatadaptatie betreft. Dit ook gezien de positieve effecten op het gebied van de effectiviteit, legitimiteit en billijkheid van bestaande arrangementen voor klimaatadaptatie. Het antwoord op deze vraag ligt in de toekomst. De wetenschappelijke bijdrage van dit proefschrift is dat het een conceptueel raamwerk voor verantwoordelijkheidsverdelingen presenteert dat rekening houdt met een gebalanceerde set van overwegingen (afkomstig uit verschillende wetenschappelijke disciplines) én specifieke kenmerken van het klimaatadaptatievraagstuk. Hierdoor wordt een systematische analyse en evaluatie van sturingsarrangementen mogelijk gemaakt. De maatschappelijke bijdrage van dit proefschrift voor de adaptatiepraktijk ligt in het voorzien in methodes voor beleidsmakers om weloverwogen en in overleg met belanghebbende partijen beslissingen te nemen over sturingsarrangementen in termen van de toewijzing van verantwoordelijkheden en in termen van de keuze van beleidsinstrumenten. Hiermee wordt voorkomen dat men in de val van padafhankelijkheden trapt. Het hoofstuk sluit af met de belangrijkste these van dit proefschrift. Deze luidt dat een duidelijke en bewuste toewijzing van verantwoordelijkheden, die is gevoed door de vier kenmerken van het klimaatadaptatievraagstuk en de zes overwegingen, belangrijk is om klimaatadaptatie van de grond te krijgen en om steden klimaatbestendig te maken in het licht van de versnelling van klimaatverandering. Uiteindelijk beargumenteer ik dat een verantwoorde aanpassing aan klimaatverandering een duidelijke en weloverwogen toewijzing van verantwoordelijkheden behoeft.

CURRICULUM VITAE

Heleen Mees was born in Noordwijk aan Zee, the Netherlands, on February 19th, 1964. She completed her secondary education at the Johan van Oldenbarnevelt Gymnasium in 1982. She studied Spanish language and literature at Utrecht University for two years, but decided to switch to the University of Applied Sciences in Utrecht, where she obtained her Bachelor of Business Administration degree in 1988. Since then Heleen Mees has worked as an international marketeer in the fast moving consumer goods for several multinational companies for more than 15 years. In 2008 she decided to dedicate the second half of her work life to a cause she has always been passionate about, the environment. She enrolled in the research master Sustainable Development at Utrecht University, where she obtained her Master of Science degree in 2010. Her master thesis concerned the governance capacity for adaptation to climate change in urban areas. In September 2010 she started her PhD research at Utrecht University at the Copernicus Institute of Sustainable Development, as part of the Knowledge for Climate Research Programme.

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ABSTRACT

The allocation of responsibilities between public and private actors has become a key governance issue for urban adaptation to climate change. This dissertation analyses and evaluates who governs urban climate adaptation through an in-depth comparative case study of 20 governance arrangements in European and North-American cities for three key adaptation issues. The results reveal that existing governance arrangements are characterised by a large extent of public responsibility; by a moderate private responsibility that is often limited to the implementation of measures; and by a (very) limited extent of shared public-private responsibility. At the same time, decisions on responsibility divisions have been taken quite routinely. The results also reveal that the large extent of public responsibility currently contributes positively to the effectiveness, legitimacy and fairness of existing arrangements. Nevertheless, in view of the acceleration of climate change, interactive arrangements with shared public-private responsibilities offer promising alternative arrangements since they take good account of the specific challenges to the governance of adaptation. This dissertation offers a method for deliberate and deliberative decisions regarding responsibility divisions, taking account of those specific challenges. Ultimately, it is argued that it is a clear and deliberate allocation of responsibilities that constitutes truly responsible climate change adaptation.

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