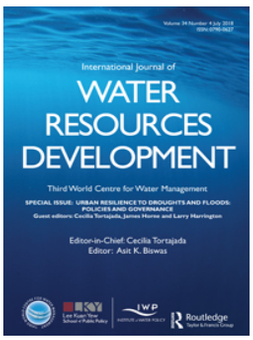

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Rainproof cities in the Netherlands: approaches in Dutch water governance to climate-adaptive urban planning

Liping Dai[a,b], Rebecca Wörner[c] and Helena F. M. W. van Rijswick[b]

[a]School of Law, Hubei University of Economics, Wuhan, China; [b]Utrecht Centre for Water, Oceans and Sustainability Law, Faculty of Law, Economics and Governance, Utrecht University, The Netherlands; [c]Utrecht University School of Law, The Netherlands

ABSTRACT

Due to increasingly frequent incidents of pluvial flooding of public spaces and private properties, climate-adaptive building and urban water management are gaining momentum in Dutch water governance. This study assesses the Dutch approach to urban water management by looking at the governance approaches of three of the largest Dutch municipalities: Amsterdam, Rotterdam and Utrecht. By analyzing the municipalities' governance approaches in a holistic way, paying attention to knowledge, organization and implementation, the research provides good practices in terms of different aspects of resilience as well as lessons regarding setting performance indicators in service levels, clarifying responsibility division, applying binding rules instead of soft policies, and more.

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Climate adaptation; urban planning; governance; rainproof; sponge cities; urban flooding; Netherlands

Introduction

Incidents of exceptionally heavy rainfall in recent years were a wake-up call for the Netherlands. They reminded the Dutch government of the urgent need to face the challenges stemming from changing weather patterns which confronted residents with the serious aftermath of flooding. As a consequence of climate change, annual precipitation in the Netherlands rose by approximatively 26% between 1910 and 2013. In addition, the intensity of weather conditions has significantly increased (KNMI, 2015).

Urban areas are among the most vulnerable human habitats concerning the consequences of climate change (Francesch-Huidobro, Dabrowski, Tai, Chan, & Stead, 2016). In terms of pluvial flooding, extreme rainfall affects cities more due to the large percentage of areas covered with asphalt or other sealing materials (OECD, 2014). Traditional infrastructure in Dutch cities such as canals and sewerage systems lack the capacity to cope with the increase of stormwater. Especially in dense urban areas, the infiltration systems do not sufficiently drain off the rainwater (Boer, 2012). Heavy rainfall causes large-scale economic

CONTACT Liping Dai l.dai@uu.nl

damage. This is due not only to the destruction of buildings and their interiors (Albers et al., 2015), but also to secondary economic damage that may occur through power, data and telecom cuts as well as business and traffic interruption and other implications such as the under-performance of public infrastructure (Runhaar et al., 2016).

The increasing incidents of pluvial flooding of public spaces and private property have led to stronger advocacy of climate adaptation and a new focus on urban water storage in Dutch water governance (Showstack, 2014). This is an acknowledgment of the necessity for cooperative spatial planning and flood management (Gilissen, 2015; van Doorn-Hoekveld et al., 2016; Ward, Pauw, van Buuren, & Marfai, 2012).

The Netherlands is a decentralized unitary state where different governmental levels share responsibilities for spatial planning and flood risk management. Formal responsibilities and policy instruments are based on the Water Act (Dutch National Government, 2009), the Spatial Planning Act (Dutch National Government, 2006) and the Environmental Management Act. At the national level, a National Adaptation Strategy and a Delta Programme based on the Water Act have been adopted in close cooperation with decentralized government agencies to develop policies concerning adaptation to climate change. Guiding principles for the Delta Programme are solidarity, flexibility and sustainability. Part of the Delta Programme focuses on spatial adaptation policies, taking into account that the formal responsibilities for spatial planning, land use planning and urban water management are municipalities' responsibilities. The abovementioned acts provide municipalities and regional water authorities a set of powers and policy instruments that enable them to deal with the effects of climate change, such as flash floods. However, dealing with pluvial flooding is also a shared responsibility of the local government and residents. Furthermore, municipalities have a large margin of appreciation regarding the choice of policy instruments such as local regulations and permit systems or more informal ones such as subsidies and facilitating participatory projects (Mees et al., 2016).

Dutch municipalities have made a conscious choice to introduce 'smart' measures in the form of cooperation with residents and multi-functional infrastructure. Technical solutions like drastically increasing sewerage systems' capacity is very costly. Since building and extending sewerage systems is a municipal responsibility in the Netherlands, municipalities are hesitant to choose this option, as it will increase local taxes. Separating the sewerage system from the rainwater drain system is another option to reduce heavy rainfall's effects. This needs to be done in cooperation with residents, since this process often affects private property. It is also easier to implement this in newly built areas because one can take the necessary space into account when designing them.

One of the key underlying concepts of Dutch water management is the Three-Step Approach, which entails the capturing, storing and draining of water – similar to the function of a sponge (Dai, van Rijswick, Driessen, & Keessen, 2017). It means that precipitation should be held as long as possible in the catchment area where it falls. When this is no longer possible, the storage areas created for this purpose should temporarily store the water. Excess water should be drained only when the former options have been used to their full potential. This approach was first introduced as a coordinated strategy for river (sub-)basins, but it is now increasingly applied in urban areas to increase their capacity to absorb rainwater (Commissie Waterbeheer, 2000). The novelty of the capturing, storing and draining approach lies in the first and second steps. Instead of immediately discharging rainwater through the drainage system, it is captured and stored. This is done by means of public infrastructure

such as water plazas in public places but also through measures on privately owned land by installing green roofs, separating rainwater from the sewerage system or placing a water reservoir in a garden.

Aim, approach and methods

Since each policy instrument has its pros and cons with respect to legitimacy, effectiveness and efficiency (Mees et al., 2014), the realization of such so-called sponge projects requires a mix of measures and policy instruments as discussed above – i.e., technical measures, separating the sewerage system from the rainwater drain system and alternative solutions for storing water. Furthermore, the projects are based on various policy fields such as urban planning, building requirements and urban water management (Massey et al., 2015; Mees, Driessen, & Runhaar, 2014; Mees et al., 2016).

This article applies an assessment framework for sustainable water governance (van Rijswick, Edelenbos, Hellegers, Kok, & Kuks, 2014) as a method to discuss the strategies of three of the largest Dutch cities when managing pluvial flooding. This method includes 10 relevant elements generated from diverse disciplines including economics, public administration, legal science and civil engineering and hydrology (Figure 1). These elements form an integral and holistic methodology to evaluate the governance of a specific water issue. The method seeks to create a common understanding to find pathways to improvement. The starting point is the policy aim or goal defined in a service level agreement, depending on the water governance issue at hand. The assessment contains three steps that are closely

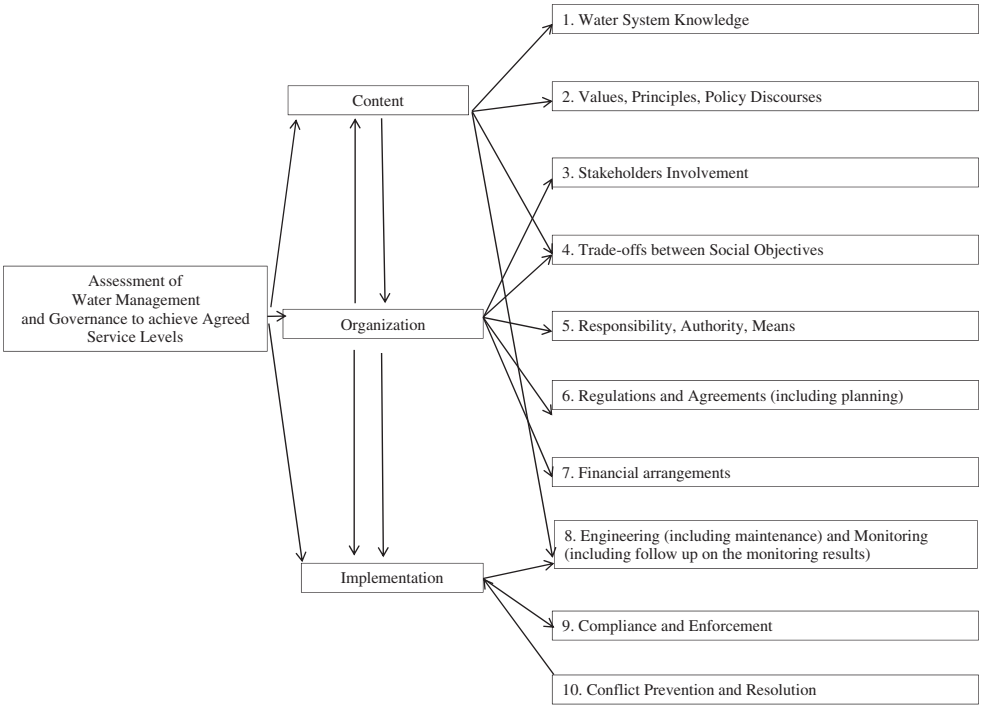

Figure 1. Multiple dimensions of water management and governance. Source: van Rijswick et al. (2014).

related. First, it assesses content knowledge about the water system, values, principles and policy discourses. Second, it assesses the organizational process by looking at stakeholder involvement, trade-offs between social objectives, the attribution of responsibilities, and regulations and agreements. Finally, it assesses the implementation of the agreed service level through adequate infrastructure, enforcement and conflict resolution. In this way, it is possible to identify (1) the gaps in the knowledge base, (2) the weaknesses in the organization process, and (3) the problems that may arise when implementing an agreed service level. The method is diagnostic and enables one to identify the strengths and especially the weaknesses in water governance that need further attention to address water issues in efficient, effective and legitimate ways (van Rijswick et al., 2014).

Besides an analysis and a comparison of the ways in which the three municipalities in question are trying to adapt to climate change, the article also provides a selection of best practices that may be useful for other cities that must cope with extreme precipitation.

To this end, the municipalities of Amsterdam, Rotterdam and Utrecht were chosen as case studies for the following reasons. First, these three Dutch cities – together with The Hague – form part of the highly urbanized Randstad area and are undergoing the most visible urbanization in the Netherlands (CBS, 2014). Second, they are located in differing hydrologic settings: near a large lake (Amsterdam), near the coast (Rotterdam) and inland (Utrecht). Third, all of them have experienced incidents of exceptionally heavy rainfall in the last decade. Finally, each municipality has developed its own mode of governance to address these issues that could serve as examples of the Dutch approach.

The aim of the development towards rainproof cities is to decrease vulnerability and to increase urban resilience. Resilience is defined by the United Nations Office for Disaster Risk Reduction (UNISDR) as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (Priest et al., 2016; UNISDR, 2009). Building on earlier research within the EU STAR-FLOOD project (Hegger et al., 2014; STAR-FLOOD, n.d.), resilience requires the capacities to resist, to absorb and recover, and to adapt. The capacity to resist refers to the strategies that societies develop to reduce the probability of flooding. The capacity to absorb and recover acknowledges that floods cannot always be prevented and that additional measures should be in place to flexibly respond to flooding when it occurs. The capacity to adapt focusses on an effective learning process, which can be stimulated through adaptive governance and room for experimentation (Huitema et al., 2009). The involvement of public and private parties provides different types of knowledge. The assessment method used in this article allows us to assess the above-mentioned elements of resilience. Furthermore, the assessment itself is meant to be a source of learning, improving governance to increase cities' resilience when faced with climate change's impacts.

Given the wide spectrum of interests involved in the governance of rainproof cities and the fact that improving urban resilience requires knowledge from different disciplines (Albers et al., 2015), a multidisciplinary approach has been adopted. This combines classical legal research, which involves the study of primary and secondary legal sources (legislation, case law, policy documents and analysis and the commentary thereon), and nine semi-structured in-depth expert interviews.

The interviewees were selected based on their expertise with the aspects included in the assessment method of van Rijswick et al. (2014). Policy experts from the public sector as well

as practitioners from the private sector were consciously chosen to gain insight into the policy framework and to be able to identify best practices and pitfalls from people in the field. The group of interviewees included three policy makers who work in water management and climate-adaptive building for the municipalities of Utrecht, Amsterdam and Rotterdam. The other interviewees were two landscape architects who work for the landscape architecture firms H+N+S (n.d.) and OKRA (n.d.); two policy advisors who work for different Dutch municipalities in the field of climate adaptation, and a jurist and an engineer who are employed at the engineering consultancy Movares (n.d.). Transcripts of the interviews are on file with authors.

Assessment of the three municipalities

Service level agreements and adaptation strategies

The three cities formulated their aims or service level agreements in different ways. They take slightly different approaches to the selection of measures and policy instruments.

Amsterdam

Amsterdam's objective is to cope with rainfall of 60 mm/hour by 2020 without damage to buildings and vital infrastructure, and to be fully rainproof by 2050.

The public enterprise Waternet, which is the water company for Amsterdam and its surroundings, has developed its climate adaptation strategy and established the policy programme Amsterdam Rainproof, which contains several measures to address increased rainfall. To comply with its service level agreement, it chooses soft policy instruments such as encouraging, informing and activating residents, business owners, government officials and knowledge workers to work on the design of roofs, streets, gardens, parks and squares that can better handle intensive rainfall. Amsterdam avoids large infrastructural investments and does not use regulatory instruments to make the city more climate-proof.

Amsterdam Rainproof serves as a temporary platform to mainstream the issue in all municipal policies (Municipality of Amsterdam, 2014; Uittenbroek, 2014). The city council has reported that 'The programme is being implemented in close cooperation with the various stakeholders – governments and private parties – and serves as an example of a "vital infrastructure adaptation strategy" for the Amsterdam city' (Municipal Council of Amsterdam, 2015).

Rotterdam

Rotterdam's tradition of 'protecting itself against and living with water' has shaped the development of the city. The city's adaptation programme, Rotterdam Climate Proof, forms part of the Rotterdam Climate Initiative. It operationalizes the municipality's aim to make Rotterdam 100% climate-proof by 2025.

Rotterdam is located in the delta of the Rhine and Meuse rivers. Part of the city lies in outer-dike areas, and the inner-dike city of Rotterdam proper is mostly well below sea level. In outer-dike Rotterdam, adaptive construction and design are applied. Examples include 'flood-proof' buildings, construction of flood-proof public areas, floating communities and 'building with nature' projects. Within the dikes, there are measures to capture and store rainwater, to delay drainage and help restore the sponge function of the city. These measures

include green roofs and façades, less paving and more flora in the public streets and neighbourhoods, water squares and infiltration zones which form part of the infrastructure (Rotterdam Climate Change Adaptation Strategy, 2012).

Utrecht

The service level agreement in the city of Utrecht entails that in public areas the municipality shall prevent the flooding of streets and guarantees that public infrastructure remains usable in cases of rainfall under 20 mm/hour. Where the rainfall is more than 60 mm/hour, the municipality shall prevent serious obstacles to traffic.

Utrecht's urban adaptation policy is laid down in the policy paper *Gemeentelijk Plan Water Taken 2016–2019* (Municipality of Utrecht, 2016a). The adaptation measures are different in public and private areas. For public spaces, the municipality will take measures, including replacing asphalt with green spaces or water-permeable tiles.

The municipality establishes working groups of municipal officials and local residents to manage flooding problems in flood-prone areas. For example, to address the problems resulting from an extreme downpour in 2014, different working groups were set up in the two hardest-hit areas. The groups included residents who had taken part in the decision-making process to make their areas rainproof. The approach is rather ad hoc and on a case-by-case basis. Whereas this kind of 'tailor-made' approach may be beneficial where the problems vary significantly, one of the interviewees – a policy maker employed by the municipality of Utrecht – has expressed concern at the lack of efficiency.

Analysis of service level agreements and this first introduction of the adaptation strategies show that service level agreements are formulated in a way that makes evaluation of the programmes' effectiveness possible. However, what rainproof or climate-proof exactly entails is not clear, nor are there any milestones that must be met at particular times. Quantifiable indicators of progress are largely missing when targets are set in a general way, such as 100% climate-proof in 2025 (Rotterdam) or 100% rainproof in 2050 (Amsterdam). Furthermore, what the acceptable risk levels are before reaching the final targets is also unclear in Rotterdam and Amsterdam.

To assess the adaptation strategies, the following sections discuss the relevant elements using the above-described assessment method.

Water system knowledge

Good policy making presupposes a clear definition of the problems at hand. In the case of pluvial flooding, it is therefore salient for a municipality to have location-specific risk data and sufficient knowledge of specific (practical) issues, such as the soil type (sand or clay for example), land subsidence and the housing type per area. Each city faces different problems. For instance, low-lying inner courtyards in Rotterdam and basement apartments in Utrecht are particularly prone to flooding after heavy rainfall.

Obtaining water system knowledge implies an awareness of the physical circumstances of a given urban area. A city's natural underground, topographic and other natural conditions must be taken into account to make a city secure from the impact of increased rainfall, since sensitivity to flooding as well as the most suitable adaptation strategy largely depend on local conditions (Termeer et al., 2011). It is the soil texture, for instance, that determines how quickly the rain can permeate through the surface (Boogaard, 2015). Rotterdam lies mainly

on clay, for which the infiltration of rainwater is limited and the runoff levels are considerably higher than in areas with different soil characteristics (van de Ven et al., 2011). Utrecht, too, is on soil that is less permeable than in other Dutch regions in terms of rainwater infiltration (Municipality of Utrecht, 2016a). Amsterdam's ground is peat soil, which makes it difficult to extend the sewerage system. This is one of the reasons that Amsterdam's adaptation strategy focusses on its rainwater storage capacity rather than on drainage (Municipality of Amsterdam, 2014).

It is also necessary to have a clear oversight of the city's existing infrastructure and its capacity. Whereas historic city centres like Amsterdam and Utrecht have a traditional system of canals, Rotterdam does not. Moreover, it is necessary to identify the areas which are the most asphalted. Large stretches of asphalt are root causes of urban pluvial flooding since they interfere with the natural water infiltration. A lack of knowledge with regard to any of the related issues should be properly addressed by the governments.

Knowledge is provided by national institutions such as RioNed, which mainly investigates sewage systems, as well as consultancy firms which focus on local situations (Sterk Consulting, 2015; Wareco ingenieurs, 2016). Furthermore, environmental agencies (Omgevingsdiensten), which work for several municipalities, offer the required expertise for a broad group of stakeholders and, together with the national institutions, contribute to the knowledge provision in the area of climate adaptation.

The three municipalities that form the case studies of this research are in a position to gather the required knowledge. They do so by means of diverse mapping strategies and computer simulations. Amsterdam has conducted a thorough study to identify the consequences of rainfall of more than 60 mm/hour. Based on the results, which were made visible through computer simulation, it appears that there are considerable differences between districts (Claassen, Uittenbroek, & Hartog, 2013). Rotterdam has developed the computer program 3Di, with which the municipality is able to make various water-related calculations (Delta Rotterdam, 2014). Utrecht has drawn up a map based on aerial photographs but has also specifically asked residents to report damage to identify problem areas.

Values, principles and policy discourses

Throughout the last decade, the Dutch government has attached increasing importance to climate-adaptive strategies. To better understand the specific policy choices made by the municipalities, it is useful to take a closer look at the general principles for climate adaptation that underlie these policies.

Solidarity, flexibility and sustainability are important values that are reflected in the majority of Dutch policy discourses and the Delta Programme. The need for cooperation and exchange of good practices as well as the idea that landowners and other relevant actors should not shift water problems to neighbouring areas lie at the heart of Dutch water management (Keessen et al., 2016). This is also reflected in municipal policies stipulating that the owner of a plot of land may not redirect rainwater to land belonging to a neighbour (Municipality of Utrecht, 2016b).

Long-term thinking is another important value in climate-adaptive urban planning in the Netherlands. Typically, climate-adaptive measures focus on the long-term effects, but also take into account opportunities to integrate urgent, short-term matters. A combination of long-term goals (i.e. making a city climate-proof) with short-term functions is embodied in,

for instance, green roofs and water plazas (Ward et al., 2012). The double or even multi-functionality of (public) space is a principle that is closely connected to long-term thinking and is represented in all three cities' climate adaptation programmes, as will be discussed below. The pragmatic rationale behind this concept is the limited space that Dutch municipalities can offer to urban developers.

An important shift in Dutch water management has occurred at the local, national and the EU regional levels since the beginning of the twenty-first century (Dutch National Government, 2009; European Parliament and the Council, 2000, 2007). Governments have moved towards Integrated Water Resources Management (IWRM), which is defined as 'a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems' (Hassing, Ipsen, Clausen, Larsen, & Lindgaard-Jørgensen, 2009). Dutch urban water management embodies the paradigm of IWRM (Van Rijswick & Havekes, 2012) and is reflected in all three municipalities' policy strategies.

Amsterdam

Amsterdam has chosen to frame the issue of climate adaptation as an opportunity rather than as a hindrance. It stresses the added aesthetic value of the inclusion of water in the townscape such as the canals and the waterfront area (van de Veur & de Gans, 2013). The city's website presents and advertises the achievements of Amsterdam Rainproof, including photographs of a resident's rainproof rooftop garden and a long green strip in a residential area which absorbs rainwater (Amsterdam Rainproof, n.d.).

Rotterdam

Rotterdam extensively advertises its climate adaptation strategy and engages in city branding. Such branding is all about the associations that a place evokes based on its 'visual, verbal and behavioural expression' (Kavaratzis & Hatch, 2013). Rotterdam also considers climate change as an opportunity and advertises itself as a safe, climate-proof innovation and climate-knowledge hub (van Buuren & Warner, 2014). It showcases infrastructural projects like the Benthemplein water plaza, and considers them as assets.

Utrecht

Utrecht has experienced urban flooding in recent years after heavy rainfall, yet it does not have a campaign like Amsterdam Rainproof or the Rotterdam Climate Initiative. Utrecht takes part in a coalition formed by several nearby governmental entities, which have issued a non-binding agreement to address climate change. The coalition itself has recognized the lack of visibility of its work compared to Amsterdam Rainproof and the Rotterdam Climate Initiative (Moens, van Bree, & Blom, 2016).

The analysis of the three cities' policy relating to climate adaptation shows that Dutch society, in general, shares common values of solidarity, flexibility, sustainability, long-term thinking and IWRM in the field of water management. However, the policies are framed differently at the municipal level. Rotterdam and Amsterdam present climate change and their adaptation policies as opportunities to brand the city or to raise awareness. Utrecht is lagging behind without a clear discourse available that explains or legitimates its climate policies.

Stakeholder involvement

During the last two decades (since 2000) municipalities nationwide have increasingly involved residents in the design of spatial planning projects and stimulated 'bottom-up' projects through subsidies (Mees et al., 2016). The role of the municipality thereby shifts from an 'initiator' and an 'orchestrator' to a 'facilitator' (Municipality of Rotterdam, 2013). To facilitate the bottom-up process and to stimulate residents' own responsibilities, the national government is decentralizing governmental competences and is vesting them in the municipalities. The rationale behind this decentralization is that municipalities are closer to the residents and are better equipped to cooperate with them (Mees, 2014; Vermeij, van Houwelingen, & de Hart, 2012).

However, it is still unclear whether this new approach is effective, as there is hardly any empirical research available. It is also not clear whether the municipalities will return to a more active role if this new mode of governance does not appear to be effective. This may depend on awareness-raising regarding the impacts of climate change, the political context, and the effectiveness of new integrated legislation (the Omgevingswet), which is planned to come into force in 2019. This new act regarding environmental management, water management and spatial planning takes a different approach by offering more flexibility and policy discretion to decentralized government bodies and by shifting more responsibilities onto private actors. In other words, it will be a shift from government to governance. However, research by Mees et al., (2014) suggests that a more mandatory approach would be more effective.

The approach examined in the three cities shows that a governance approach that involves stakeholders in rainproofing projects is generally applied in two forms. The first comprises measures that aim to stimulate residents and businesses to take action on their own plot of land. The most common techniques are awareness campaigns via online and traditional media, information evenings and door-to-door information leaflets. The goal is to create awareness of climate change and to remind residents that, under Dutch environmental law, they are responsible for dealing with rainwater on their own plot of land. A further step is the facilitation and subsidizing of resident-led bottom-up projects. Both of these issues are discussed in more detail below.

In terms of raising the awareness of residents, the Rotterdam Climate Initiative and Amsterdam Rainproof serve as helpful and recognizable platforms. The projects highlighted on the websites of the Rotterdam Climate Initiative and Amsterdam Rainproof show examples of the residents of the two cities applying preventive measures and taking a proactive stance (Amsterdam Rainproof, n.d.; Rotterdam Climate Initiative, n.d.). Utrecht, on the other hand, takes a more reactive stance. For example, the recorded actions by residents were a reaction to concrete (structural) damage to their houses and the infrastructure in their neighbourhood.

The second form of involvement occurs in the design and implementation phases of spatial planning projects in public areas. Over the last two decades, an important policy shift has taken place with regard to this type of stakeholder involvement (van Buuren & Warner, 2014). The government gradually became aware that involving the stakeholders at an earlier stage of the projects could reduce reluctance towards spatial planning and water-related infrastructure.

Examples are the Benthemplein water plaza in Rotterdam and the involvement of residents in Utrecht. For the former, several groups of stakeholders were actively engaged in the design of the water plaza. Since the Benthemplein is next to a school, the architects of the plaza worked closely with students to include facilities that would benefit the users of the plaza. In the latter example, the municipality of Utrecht set up working groups with the residents in flood-prone areas to develop specific solutions and measures they could implement themselves – such as installing check valves and diverting rainwater from roofs into gardens (Municipality of Utrecht, 2016b).

Engaging stakeholders in the design and implementation turned out to be beneficial for both parties. Where the government could avoid costly legal proceedings, the affected residents were heard and to some extent able to influence the further course of the project. Where residents have the opportunity to engage in planning and/or implementation, they are generally more eager to accept the project and even maintain it.

Social trade-offs

In the governance of climate-adaptive cities, numerous questions arise. How much weight should be given by the municipal councils to specific efforts on the overall political agenda? Which interests and concerns are at stake, and how much weight should be given to them? How are the burdens that might follow the choice for a specific service level agreement or a social objective to be dealt with (van Doorn-Hoekveld et al., 2016)? These questions necessitate a balancing act concerning the level of policy making and the level of a specific project itself.

As for the social trade-offs that policy makers have to take into account, two factors play important roles. First is the weight that is given to climate adaptation on the political agenda in comparison to other issues. Depending on the geographic and demographic circumstances, the importance of adaptive building will vary.

Rotterdam serves as an illustration. Rotterdam's demographics differ from Amsterdam and Utrecht, as the city houses more low-income families. It makes sense to prioritize efforts to climate-proof the city, since these initiatives typically help turn the city into a greener and more inviting place. It may attract families with higher incomes and provide an investor-friendly, safe environment for businesses. Spatial planning can therefore serve multiple purposes, resulting in a more prominent position on the city's political agenda.

Urban politics play a decisive role. In Utrecht, for instance, the municipality's executive board consists of politicians from a wide range of parties. Many of the decisions related to spatial planning in the current board's period of tenure fall under the competence of a conservative executive board member, who focuses on private approaches to climate adaptation instead of public investments. This shows that the margin of appreciation municipalities have results in different approaches to climate change adaptation depending on political preferences.

The second important factor is the risk acceptance demonstrated in the agreed service level concerning urban flooding. Facing increased probability of heavy rainfall incidents, municipalities must balance their policy choices. At one end of the spectrum is a target to make a city rainproof – reducing the possibility of pluvial flooding to zero – whereas at the other end is the acceptance of the consequences, which shifts the responsibility towards private actors. A municipality has different tools at its disposal to address such trade-offs. It

can choose to pay financial compensation in cases where the balancing has resulted in an individual or a group of individuals bearing disproportionate costs (van Doorn-Hoekveld et al., 2016; Mees et al., 2014). Another option is to stimulate certain behaviour by various subsidies to promote adaptation measures (van Doorn-Hoekveld, 2014; Mees et al., 2014).

Our case-study cities have made a specific choice for a cost-effective approach, resulting in strategic funding and an acceptance of a certain flooding risk beyond the agreed service level, based on efficiency arguments for economic losses and an effectiveness argument related to casualties. Factors that underlie the choices in such a balancing act are, for instance, the existing infrastructure, public safety, public health, the availability of funding, the imminence of the threat, political preferences and the urgency of other (social) issues.

Responsibility, authority and means

As for the division of responsibilities in the context of climate-adaptive spatial planning legislation, two relationships are particularly relevant. First, on the governmental level, the Dutch regional water boards and the municipalities are involved. According to Article 3.8 of the Dutch Water Act, these two bodies share responsibility for urban water management. When municipalities initiate spatial planning projects, they are required to consult the water boards in the preparatory phase. This advisory 'water test' procedure is based on the Spatial Planning Act and obliges municipalities to take into account the consequences of spatial measures for water management. Although municipalities do not have to follow the water boards' advice, the procedure reflects the importance given to water in Dutch spatial planning (Dutch National Government, 2009) and is an example of an institutional system of shared responsibilities.

The second relationship concerns the public/private division of responsibility. There are several reasons why the government should play a strong role in climate-adaptive building. From a constitutional perspective, the Dutch government has a duty of care to consider climate change adaptation for spatial planning projects. This flows from Article 21 of the Dutch Constitution, which states: 'It shall be the concern of the authorities to keep the country habitable and to protect and improve the environment.' In accordance with Article 3.5 of the Dutch Water Act, the municipality bears a duty of care with regard to the collection and processing of rainwater. As stated above, the municipalities have discretion when they formulate the scope of their duty of care for urban water management. From a legitimacy perspective, the public/private division of responsibilities needs to be clear because of the principle of legal certainty which requires clarity of the responsibilities of residents.

Amsterdam stresses that its duty of care focusses on assisting residents in taking their own responsibility instead of ensuring that the municipality meets the service level agreements (Waternet, 2016). Rotterdam states that it effectively infiltrates the water in the ground or via storm drains into the canals and other water bodies and provides infrastructure for residents to collect the water and discharge it into the city's water bodies (Municipality of Rotterdam, 2016). Utrecht is more specific in the phrasing of its duty of care. It explicitly acknowledges that the type of soil that underlies the majority of houses is not suitable for water infiltration on private ground, and it therefore facilitates drainage with public infrastructure such as gutters and storm drains. It furthermore distinguishes between rainfall below and above 20 mm/hour. For rainfall below this level, the municipality will process all water without any water being left on the streets. For rainfall above 20 mm/hour, the

municipality will prevent water from flowing into buildings when the ground-floor level is higher than the surface of the road outside.

Municipalities have a legal duty of care to manage urban water based on the Water Act, the Environmental Management Act and the Spatial Planning Act. Residents are responsible for rainwater on their own plots. The scope of the public responsibilities is formulated in more detail in municipal policy plans. However, the three municipalities have persistently chosen to act beyond their formal duty of care and have taken over private responsibilities. Consequently, residents often rely on the municipalities and are unaware that they also bear a formal responsibility for taking care of rainwater on their land. In response, to encourage residents to fulfil their responsibilities and to involve private actors in making their city rainproof, all three cities use awareness campaigns, including practical examples of how to make houses and plots of land more rainproof. However, in terms of workforce and the budget available to finance rainproofing measures, this is largely a question of political choice (see the previous section on 'Social Trade-Offs').

Regulations and agreements

As for the rules on adapting the cities to heavier rainfall, there is the national legal framework as well as municipal sewerage regulations based on the Environmental Management Act, whereby municipalities have considerable policy discretion. Consequently, there are a few 'hard' rules stemming from national and municipal water and environmental law, combined with 'softer' rules laid down in policy documents and declarations of intent.

The binding legislation that is relevant to this research stems from the EU and national levels. In accordance with the EU Floods Directive (European Parliament and the Council, 2007), member states must take adequate and coordinated measures to reduce flood risk but have discretion in deciding how to realize this obligation. On the national level, Articles 2.1 and 3.1 of the Spatial Planning Act require the municipality to determine strategic development plans and legally binding spatial zoning plans. Articles 4.22–4.23 of the Environmental Management Act oblige them to determine a policy for their sewerage systems and to specify their duties of care.

Municipalities have three different duties of care with regard to water management: to collect and process rainwater in accordance with Article 3.5 of the Dutch Water Act, to prevent 'a structurally adverse influence by the groundwater level' as stated in its Article 3.6, and to effectively collect and transport urban wastewater based on Article 10.33 of the Environmental Management Act. Responsibility for the collection, infiltration and/or processing of rainwater on private ground lies with the landowners. Only to the extent 'that the person who disposes of it, intends to dispose of it or must dispose of it cannot, in all fairness, be expected to recharge such rainwater run-off on or into the ground or into the surface water' are municipal authorities responsible in accordance with section 3.5 of the Dutch Water Act (Gilissen, van Rijswick, & de Gier, 2010). Landowners can choose to remove paving from their gardens or increase infiltration capacity (Kaufmann, van Doorn-Hoekveld, Gilissen, & van Rijswick, 2016). In principle, the duty of care obliges the municipality only to provide facilities to discharge the runoff and to efficiently process the water (Dutch Parliament, 2006).

The formulation of rules is a delicate issue as, on the one hand, legal certainty is required, but on the other, too many rules may have a paralyzing effect or diminish necessary flexibility or adaptability. For instance, clear rules on subsidy schemes and mandatory arrangements

have proven to be most efficient by using the full potential of green roofs (Mees, Driessen, Runhaar, & Stamatelos, 2012). The law on financing municipal water-related duties (Dutch National Government, 2010) enables municipalities to designate the revenue from taxes and levies to fulfil their duty of care with regard to their urban water tasks and gives the municipality the option to invest more in climate-adaptive building (Keijsper, 2013).

Most agreements in the field of climate adaptation in Dutch spatial planning, e.g. Amsterdam Rainproof Rotterdam Climate Initiative, and the Utrecht Gemeentelijke Plan Water Taken 2016–2019, are based on a pragmatic choice for soft law and policies rather than legally binding rules (Mees et al., 2014). The paradigm of 'soft whenever possible, tough when necessary' underlies Dutch law and policy making (van Rossum, 2016).

Financial agreements

The programmes Amsterdam Rainproof and Rotterdam Climate Proof and the policy programme of the municipality of Utrecht are financed by different means. Typically, the funding stems from sewage levies, as well as national, EU and international sources. An example is the EU LIFE Programme for the Environment and Climate Change 2014–2020 (European Parliament & the Council, 2013).

Amsterdam

Amsterdam has designated €1.75 million of a total budget of €70–77 million for the period of 2016–2021 to start the Amsterdam Rainproof policy (Waternet, 2016). This amount does not include the actual implementation of the project but merely costs such as salaries, research and meetings. Sewage levies provide most of the designated budget for Amsterdam Rainproof. Besides these, the municipality also uses other funds to co-finance green projects, such as the budget for transport (Municipality of Amsterdam, 2015).

Rotterdam

Sewage levies also largely finance Rotterdam's projects for the collection and processing of rainwater (Municipality of Rotterdam, 2016). As replacing sewage pipes is costly, the municipality reserves a set amount of money to ensure the programme's long-term efficiency. It also receives financial aid from the national government for its Climate Initiative as well as the 100 Resilient Cities programme, which the Rockefeller Foundation pioneered (Climage KIC, 2016). Between 2016 and 2020, the municipality will be annually investing €5.8 million in rainwater collection and processing (Municipality of Rotterdam, 2016).

Utrecht

Since 2008, the municipality of Utrecht has had a savings fund, annually complemented with sewage levies for replacement works on the sewage system. The municipality aims to pay off its debts more quickly so that it can repay previous loans by 2053, which in turn enables the municipality to finance the work on the sewage system and extra measures to address extreme rainfall (Municipality of Utrecht, 2016a). In each of the years 2015 and 2016, the municipality invested €6 million to improve and replace parts of the sewage system and €1 million to replace asphalt with green spaces and the separation of the sewerage system from the rainwater drain system (Municipality of Utrecht, 2016a).

Engineering, maintenance and monitoring

All three cities use infrastructure projects to meet their climate-adaptive water management targets. Amsterdam invests in green roofs on public buildings, green spaces in residential areas, and water plazas (Amsterdam Rainproof, n.d.). Rotterdam is a clear front-runner in this area, as the city invests and promotes large-scale projects such as the Benthemplein water plaza and a parking garage that incorporates rainwater storage (Rotterdam Climate Initiative, n.d.). Utrecht invests in projects of a smaller scale, including replacing asphalt with green spaces. All three cities implement green roofs.

For a project to be a success, good engineering is not sufficient. In climate-adaptive spatial planning, engineering concerns not only construction but also maintenance, monitoring and a follow-up phase that highlights the lessons learnt.

The Benthemplein water plaza in Rotterdam illustrates this well. The plaza itself is equipped with innovative technology (Delta Delta Rotterdam, 2014). Even though the municipality carried out initial stakeholder involvement, the lack of continuity of involved students has made the square's maintenance costly. Littering and clogging of pipes have become a serious problem, with cleaning costs higher than originally reserved. In terms of the monitoring and maintenance phase, it is important to identify the pitfalls and lessons at an early stage to implement an adaptive governance approach. Rotterdam publishes monitoring results on its website, yet the results are rather general and the last update was in 2013 (Rotterdam Climate Initiative, n.d.).

A good practice is pilot projects and subsequent evaluations, which all three municipalities do to some extent. In an ideal case, the new data are linked back to earlier phases of knowledge building, determining social trade-offs, dividing responsibilities and funding, and ultimately developing new policies and rules.

Although engineering in the three municipalities is visible, in none of them can general conclusions be drawn from maintenance and monitoring, since almost all the pilot projects are still in their infancy.

Compliance and enforcement

The compliance and enforcement phase is linked to the division of responsibilities, to the types of agreements and regulations, the monitoring mechanisms and the capacity and available means to enforce agreements and regulations. It is critical that the scope and division of responsibilities is clear and transparent (van Rijswick et al., 2014). Insufficient clarity as to who enforces (within an agency or a group of individuals, for instance) hampers the process and may lead to delays. This holds true for the relationship between the municipality and the water authority as well as the division of responsibilities between public and private parties.

With regard to the types of agreements and regulations, it is generally easier to enforce rules that are binding and are clear in what they oblige and the consequences of non-compliance. Soft policies such as the three municipalities' initiatives are hardly enforceable since the focus lies more on raising awareness, city branding, facilitating cooperation or stimulating actions by private actors. Furthermore, the initiatives lack indicators to measure progress towards the agreed service levels. It is not always clear who is responsible for achieving the

final targets, what actions are obligated and who enforces. Therefore, it is difficult to evaluate whether these initiatives are effective.

In the case of more informal agreements, there are different ways to ensure compliance, such as negotiations and emphasis on the effectiveness of good practices. As the three municipalities' deadlines for the agreed service levels are still years away and many projects are still in a developing phase, it is not presently possible to evaluate the enforcement of the adaptation policies.

Conflict resolution

In an ideal situation, addressing the issues discussed in the previous building blocks can prevent conflicts. Stakeholder involvement, the recognition of their interests and values, clear and transparently formulated agreements and regulations, a good balance among social trade-offs, clearly articulated provisions on projects' funding and sufficient certainty of the division of responsibilities are all crucial factors for the successful management of water-related climate-adaptation projects (van Rijswick et al., 2014). Considering all can prevent the escalation of conflicts in the first place. This practice is both time- and cost-efficient in the long run. Specifically, court proceedings will not always lead to a better outcome and can be time-consuming and costly, especially given the plurality of stakeholders in climate-adaptive building projects and the complexity of the issues.

However, conflicts can never be completely avoided, although there are no noticeable conflicts in our case-study cities to date. Conflicts between different political parties in the policy-making process are generally discussed in the municipal council. Means of conflict resolution range from negotiation, mediation and arbitration to formal court proceedings. In general, legal proceedings before a Dutch administrative court are accessible to a wide public. The costs are low because individuals do not need legal representation. However, since the majority of the agreements that are relevant in the context of climate-adaptive building are not legally binding, many of the applicable rules are not enforceable by the courts. Formal conflict-resolution mechanisms such as legal proceedings are regulated at the national level, so there are no observable differences among the municipalities in this regard.

Overview of the governance approaches of the three municipalities and the findings, and concluding remarks

Governance approaches of the three municipalities

In response to the increasingly visible consequences of climate change, each of the studied municipalities has introduced different measures (Table 1).

All three municipalities have taken action in response to heavy-rainfall incidents and defined service level agreements. However, although the targets are clear in the three case studies, no performance indicators are available to monitor progress in the implementation of the developed policies. All three municipalities have recognized the benefits of capturing, storing and discharging water for the urban context. They are each equipped to gain location-specific risk data and have each initiated city-scale campaigns. In Amsterdam and Rotterdam, these campaigns are proactive and take place under the umbrella of larger

Table 1. An overview of the Rainproof City Assessment in the Netherlands

	Amsterdam	Rotterdam	Utrecht
Service Level Agreement	Cope with rainfall of 60mm/hour by 2020 without damage to buildings and vital infrastructure; fully rainproof by 2050.	100% climate proof by 2025	Declaration of intent to address climate change; different levels of care for rainfall under and above 20 mm/hour
Water System Knowledge	National level: RioNed Regional level: environmental planning agencies		
	Computer simulation	3Di	Mapping, damage reports
Values, Principles and Policy Discourse	National level: solidarity, flexibility, sustainability, long-term thinking, IWRM		
	Amsterdam Rainproof	Rotterdam Climate Initiative	Gemeentelijk Plan Water Taken 2016-2019
Stakeholder Involvement	National level: decentralisation and increasing focus on stakeholder involvement		
	Enhancing residents' awareness proactively;	Enhancing residents' awareness proactively; Engaging stakeholders at an early stage	Responding to damage retroactively; engaging stakeholders in affected areas in the decision-making process
Social Trade-Offs	No information available	Giving priority to climate-proof measures on the political agenda	Giving weight to the allocation of private responsibilities
Responsibility, Authority and Means	National level: shared responsibility between municipalities and regional water boards; Local level: specification of the duty of care of municipalities The three cities in common: awareness campaigns concerning rainproof strategies		
	Duty of care focusing on the efforts by the municipality not the results	Clear allocation of the municipality's duties	Clear allocation of the municipality's duties
Regulations and Agreements	EU level: Floods Directive National Level: Legislation: Constitution, Spatial Planning Act, Environmental Management Act, Water Act; Soft rules: National Adaptation Strategy, Delta Programme		
	Amsterdam Rainproof	Rotterdam Climate Initiative	Gemeentelijk Plan Water Taken 2016-2019
Financial agreements	Funding generally stems from sewage levies		
	Sewage levies & Funds from other green projects	Sewage levies, national financial aid, 100 Resilient Cities Initiative	Sewage levies
Engineering, maintenance and monitoring	Engineering focuses on building adaptive infrastructures, no information regarding maintenance and monitoring at this stage.		
Compliance and Enforcement	Negotiations and emphasize on good practices, current initiatives are difficult to enforce		
Conflict Resolution	Ranging from negotiation to formal court proceedings in case of binding obligations		

initiatives with their own name and branding strategy (Amsterdam Rainproof and the Rotterdam Climate Initiative), whereas in Utrecht the measures are based on the municipal Plan Water Taken and have been implemented on a more ad hoc basis and on a smaller scale.

All the campaigns in the three municipalities have raised public awareness of the need to make their city rainproof, although through different means. Since improvements in climate-adapting the cities happens 'on the ground', campaigns need to be combined with measures taken by public and private actors leading to concrete results. As part of this, the municipalities have constructed their showcases, e.g. green roofs and floating districts. Local government still plays a dominant role, and the funding of projects mainly stems from sewage levies.

Because of climate change, more extreme and frequent rainfall is occurring in the Netherlands. This trend has implications for the governance of urban spaces, in the Netherlands as well as in cities worldwide. Policy makers should consider rainfall extremes in the ongoing urbanization process to prevent damage to public infrastructure and private property. The three municipalities here taken as examples of the Dutch approach have employed various strategies to adapt to climate change and to increase resilience. Table 2 gives an overview of how the municipalities address the several aspects of resilience. It is too early to conclude which governance approach will be most effective in the long run. Probably a combination of different strategies will be most beneficial. As suggested in the literature (Hegger et al., 2014), resilience can best be improved by addressing capacities to resist, to absorb and recover, and to adapt; making use of stakeholder participation; and improving policies based on new knowledge and lessons learned. The cities address these three aspects of resilience, although to slightly different extents.

Within Dutch environmental, water and spatial planning law, several legal policy instruments are available, such as water management plans, municipal sewerage plans, local regulations with a permit system, and building requirements. Furthermore, law has established a clear division of responsibility between public and private actors. However, the municipalities have chosen to focus on taking adaptation measures themselves and soft policy instruments such as awareness campaigns, participation, facilitating private actor engagement and subsidies. The clearly defined service level agreements of the Amsterdam and Utrecht municipalities can serve as good practice. They formulate measurable targets to assess whether policy goals will be met in time. Referring to the various aspects of resilience, we conclude that drastically increasing the capacity of pipes could enhance the

Table 2. Increasing resilience by Amsterdam, Rotterdam and Utrecht.

Capacity	Amsterdam	Rotterdam	Utrecht
To resist	Separating wastewater system from rainwater drain system; replacing sewerage pipes		
To absorb and recover	Small scale projects (e.g. green roof gardens and green strips in residential areas)	Developing multifunctional measures based on geographic and demographic conditions	Small-scale spatial planning projects (e.g. replacing asphalt with green spaces or water-permeable tiles)
To adapt	Clearly defined service level agreement. General policy programme Amsterdam Rainproof that serves to engage residents combined with a specific sewerage plan that has to be updated every six years	Service level agreement defined in a very general way. General policy programme Rotterdam Climate Initiative that serves to engage residents combined with a specific sewerage plan that has to be updated every six years	Clearly defined service level agreement. No overall policy programme for climate adaptation. Specific sewerage plan that has to be updated every six years. Stakeholder involvement as a response to past incidents of heavy rainfall

capacity to resist. Even though such a technical solution is certainly employed whenever necessary – mostly when pipes need to be replaced or repaired or the sewerage system can be separated from the rainwater drain system – this is very costly.

To increase the capacity to absorb and recover, the smarter 'sponge' initiatives –such as those that the three municipalities are implementing – serve as good practices. Instead of immediately discharging the water into a sewerage system, it is first captured and stored, using a sponge as a model. Integrating water-storing facilities in residents' daily lives and developing multi-functional measures such as water plazas to store water amounts to good practice. The 'sponge function' can be embodied in the infrastructure in public places but can also be achieved by means of small-scale projects on private property like green roofs, which are being promoted in all three municipalities.

Tailor-made solutions are needed when it comes to climate-adaptive building. As each city has a different landscape, infrastructure and social demographics, it is important to apply measures and policies that are specific to local circumstances. Within a municipality itself, this case-by-case approach may work as well, but it can be costly and inefficient if taken too far.

The capacity to learn and adapt can be improved by using the applied assessment method in this study, because it provides a systemic way to discuss the relevant elements of a policy approach without the risk of too much emphasis on one element. The method makes clear which elements of a climate-adaptation policy are already performing well and which elements can be further improved.

The adaptation literature often has a strong focus at the beginning of the policy cycle, mainly discussing discourses (van Buuren & Warner, 2014) and stakeholder involvement (Mees et al., 2016), sometimes also paying attention to the public/private division of responsibilities (Mees et al., 2016). Clarity about the public/private responsibility is important. Urban space in the Netherlands is often privately owned and residents are legally obliged to collect rainwater on their own plot of land. Consequently, a lack of awareness concerning this private responsibility hampers effective adaptation. This problem becomes worse when municipalities act beyond their formal duty of care by taking additional measures to avoid flooding. A municipality that is too active can result in passivity among residents. To address this problem, a societal debate on the effects of climate change in urban areas and the underlying values and principles that will steer future policies is important.

A more thorough look at other important elements, such as the chosen policy instruments and the form of agreements and regulations for the implementation phase, are often lacking (Buijze, 2015; Buijze, Salet, & Van Rijswick, in press; Mees et al., 2016). This may lead to diminishing effectiveness in the long run. Binding rules instead of soft policies may be beneficial. Binding rules lend clarity to the division of responsibilities and obligations and increase legal certainty (Mees et al., 2014). They also make compliance and enforcement easier. Although the non-binding nature of soft policies can contribute to the flexibility of action for municipalities, implementing measures and accountability mechanisms need to be in place. This is currently missing in the rainproofing initiatives in the three municipalities examined here. Combining these soft initiatives with binding regulatory instruments could provide a more solid foundation for a municipality to implement 'green plans' irrespective of the political climate. However, the choice of clear binding rules over softer policy instruments is also a political choice.

The capacity to adapt and learn can be improved by the development of indicators to measure the progress made between the setting and achievement of the goals within the

proposed period. The lack of performance indicators, periodic assessment mechanisms and accountability mechanisms in all initiatives in the three municipalities makes compliance and enforcement, and therefore adaptive governance, less effective.

The 10 aspects that this article has addressed and listed in Table 1 should be considered together rather than separately. A recognition of the relationships among content knowledge, the organizational process and the implementation phase, including monitoring, compliance and enforcement, is necessary to make policies not only more adaptive but also more effective and legitimate. More assessment frameworks have been developed, putting all attention on specific elements of governance approaches (Koop et al., 2017). The good practices discussed here and the lessons for improvement may serve other municipalities, both within and outside the Netherlands, which want to make their cities rainproof.

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