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*Article*

# Pluvial Flooding in Utrecht: On its Way to a Flood-Proof City

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**Abstract:** Downpours are increasing in frequency and severity due to climate change. Cities are particularly susceptible to downpours because of their large share of impervious surfaces. Minimising pluvial flood risk requires all involved stakeholders to collaborate and overcome probable barriers. Simultaneously, an increase in citizen engagement in climate adaptation is preferred, whereas experiences with inclusive decision-making are still limited. The aim of this paper is to obtain a deeper understanding of how the capacity to govern pluvial flood risk can be developed through citizen engagement. We scrutinised the capacity of local actors to govern pluvial flood risk in the city of Utrecht, the Netherlands. For the analysis of Utrecht's problem-solving capacity, the Governance Capacity Framework provided a consistent assessment of governance components. The results indicate that Utrecht's capacity to govern pluvial flooding is relatively well-developed. Collaboration between public authorities is advanced, sufficient financial resources are available and smart monitoring enables high levels of evaluation and learning. However, citizen awareness and engagement in policy making is rather low. Accordingly, citizens' willingness to pay for flood adaptation is limited. Stimulating flood risk awareness by combining financial incentives with more advanced arrangements for active citizen engagement is key for Utrecht and other cities.

**Keywords:** citizen engagement; flood risk governance; governance capacity; climate adaptation

## 1. Introduction

Extreme weather events, such as heavy rainfall, are likely to increase in frequency and intensity as a consequence of climate change [1]. In the past decades, physical, societal and economic damages of natural disasters have increased considerably [2]. In particular, floods are expected to substantially threaten the quality of urban life in the nearby future [3,4], demanding sound flood risk management. Urban areas are particularly vulnerable to heavy downpours due to their impermeable surfaces such as roads, parking lots and roof tops, that prevent rainwater from infiltrating and, as a consequence, generate increased surface-runoff and thus increase the pluvial flood risk of urban areas [5]. Pluvial urban flooding may lead to large-scale economic damages, disarranged traffic and may induce irregularities in electricity provision [6-8]. In 2011 for instance, Copenhagen (Denmark) was hit by a severe downpour of 150 millimetre in less than three hours. The concomitant damage was estimated at nearly 1 billion US dollars [9]. Therefore, making cities more flood-resilient is an urgent challenge for sustainable urban living.

Urban expansion and insufficient water storage capacity regularly leads to rainfall runoff peaks that exceed the water system's drainage capacity, resulting in pluvial flooding [5,10,11]. This is a pressing issue in many Western-European cities, because the water infrastructure in these places is becoming increasingly obsolete and requires costly refurbishments [12,13]. These drainage systems are generally not designed for the climate change induced increase in frequency and intensity of storm events. Moreover, these systems are typically a combined drainage of storm water and sewerage (i.e., Combined Sewer System; CSS). This type of drainage system is more vulnerable to

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surface water flooding [4,14]. Thus, growing precipitation extremes together with a large percentage of impermeable urban surface and an increasingly obsolete drainage system, call for more advanced urban flood adaptation.

In most countries in Europe, solely governmental institutions have been responsible for flood risk management [15-17]. Their main objective is to ensure that floods do not affect economic growth, national security or welfare standards [18]. However, the intensity and frequency of storm events is changing and affecting all types of land use. Accordingly, also the division of responsibilities related to flood risk management is changing. A decentralising trend in flood risk management has been recognised [19], which results in a greater role for non-governmental actors [20]. These transformations are related to a more general trend, namely the shift from government to governance. This implies a relocation of power and authority both among governmental organisations, such as delegating certain tasks from the national government to local authorities, as well as from governmental organisations outwards to private actors [21]. This trend towards governance is widely adopted in, for instance, the EU Flood Directive, the EU Water Framework Directive and the Aarhus Convention [22]. These policies mandate the engagement of non-governmental actors in flood risk management [23]. The involvement of non-governmental stakeholders, such as citizens, project developers, housing corporations and businesses in local flood risk management is crucial in fostering climate adaptation in cities [21,24]. Especially, citizen engagement is increasingly important for adapting to climate-related risks, including pluvial flooding [25-27]. However, the specific responsibilities borne by public and private actors in climate adaptation and flood risk management are often unclear [8].

Even though citizen engagement in flood risk management is encouraged and acknowledged by global organisations (e.g. IPCC [1] and OECD [22]), it remains a challenge to effectively engage citizens in climate adaptation projects and decision-making of local governments [25]. To start, municipalities appear to have limited experience with citizen engagement in climate adaptation [28]. Wamsler [29] analysed city-citizen collaboration for climate change adaptation in eight German municipalities and concluded that this cooperation is 'practically non-existent' as individuals are insufficiently aided by city authorities and urban policy does not support collaboration. Accordingly, Brink and Wamsler [30] observed that Swedish municipalities rarely involve citizens in local flood or climate change adaptation. Moreover, a cross-country comparison between the United Kingdom, Italy and the Netherlands shows that overall citizen engagement is limited when examining the respective types of interactions between citizen and authorities and the impact of citizen engagement on decision-making [23]. In the Netherlands, citizens are legally held responsible for managing rainwater on their own property. In practice however, it has been found that Dutch residents often rely on local governments [31,32]. The downside of this national commitment to flooding is that citizens' initiatives in the implementation phase are considered as a 'backup strategy' in addition to collective flood risk measures [17]. Another consequence is that citizens lack awareness of their responsibility regarding rainwater on their own property [6]. The lack of clarity in duties, good examples and experiences with this more inclusive form of decision-making and implementation may explain the slow progress in citizen's engagement in climate adaptation that has been observed [8,33]. For example, citizens' motivation to participate does not only depend on their risk perception but also to their sense of self-efficacy and influence on the end-result of decision-making processes [34]. Thus, active citizen engagement in urban flood adaptation seems to be challenging in practice, whereas it is often claimed to be essential for implementing climate adaptation measures.

The overall capacity of stakeholders to collaborate and address water-related challenges together, such as pluvial flooding, in fact may be much more decisive than the capacity of individual organisations and stakeholders [35-37]. From this more holistic perspective, it becomes essential to scrutinise how citizens can contribute in formulating and implementing policies and objectives related to pluvial flooding.

Therefore, in this paper we assess urban water governance as a whole by implementing the Governance Capacity Framework. This framework enables a better understanding of specific (local) issues, underlying processes, citizen engagement and how to minimise negative consequences of pluvial flooding [38]. The framework consists of nine key conditions for good governance such as

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awareness, useful knowledge, continuous learning, stakeholder engagement and implementing capacity. This paper specifically addresses how citizen engagement can effectively contribute to each condition and thereby improve the overall capacity to govern pluvial flood risk. In this way, both the engagement of citizens in decision-making processes as well as the implementation of (individual) adaptation measures are scrutinised in the case study of Utrecht[1], the Netherlands. Accordingly, the aim of this paper is to obtain a deeper understanding of how the capacity to govern pluvial flood risk can be developed through citizen engagement. We first analyse Utrecht's capacity to govern pluvial floods and second, we scrutinise the role of citizen engagement in strengthening the governance capacity. In this paper, we use citizen engagement as a conceptual umbrella that captures both the participation of citizens within the local decision-making process and an active involvement in the implementation phase by taking climate adaptive measures.

Section 2 provides the conceptual framework, research methodology and case study description. Next, section 3 presents the results of the governance capacity assessment of Utrecht and specifically addresses the role of citizen engagement. Finally, section 4 and 5 cover the discussion and conclusion, respectively.

## 2. Conceptual framework

### *2.1 Governance Capacity Framework*

To assess the capacity of Utrecht to govern pluvial flood risk, we apply the Governance Capacity Framework (GCF), developed by Koop et al. [38]. The framework consists of three dimensions, nine conditions and is supported by 27 indicators (Table 1). The dimension *knowing* refers to the need to be aware, understand and learn about the risks and impacts of environmental challenges and policy. *Wanting* alludes to the willingness and motivation of various actors to cooperate, act upon ambitions and devote oneself to find solutions. *Enabling* refers to the network's ability to collaborate, coordinate and implement action plans through various policy instruments and available resources. The GCF provides a diagnosis of urban water challenges. These challenges generally require different organisations to collaborate and align their activities. The framework's 27 indicators are consistently scored according to an indicator-specific Likert scale ranging from very limiting (--) to very encouraging (++) regarding the governance capacity of Utrecht. The GCF has been applied to assess 41 water-related challenges in 15 cities across the globe [32,38-44]. A detailed description of all indicators based on literature findings and the Likert scoring can be obtained online [45].

**Table 1.** Overview of the Governance Capacity Framework (GCF) [38].

| Dimensions | Conditions | Indicators |
|---|---|---|
| Knowing | 1 Awareness | 1.1 Community knowledge<br>1.2 Local sense of urgency<br>1.3 Behavioural internalization |
| | 2 Useful knowledge | 2.1 Information availability<br>2.2 Information transparency<br>2.3 Knowledge cohesion |
| | 3 Continuous learning | 3.1 Smart monitoring<br>3.2 Evaluation<br>3.3 Cross-stakeholder learning |
| | 4 Stakeholder engagement process | 4.1 Stakeholder inclusiveness<br>4.2 Protection of core values<br>4.3 Progress and variety of options |
| | | 5.1 Ambitious and realistic management |

[1] By 'Utrecht', we refer to the local network of stakeholders (including local authorities and citizens), i.e. 'governance structure', within the administrative municipal area of Utrecht, the Netherlands.

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| | | |
|---|---|---|
| Wanting | 5 Management ambition | 5.2 Discourse embedding<br>5.3 Management cohesion |
| | 6 Agents of change | 6.1 Entrepreneurial agents<br>6.2 Collaborative agents<br>6.3 Visionary agents |
| Enabling | 7 Multi-level network potential | 7.1 Room to manoeuver<br>7.2 Clear division of responsibilities<br>7.3 Authority |
| | 8 Financial viability | 8.1 Affordability<br>8.2 Consumer willingness-to-pay<br>8.3 Financial continuation |
| | 9 Implementing capacity | 9.1 Policy instruments<br>9.2 Statutory compliance<br>9.3 Preparedness |

*2.2 Method*

The 27 indicators are scored according to three consecutive steps:

1. *Policy review:* For all 27 indicators, data (documents, reports, policy) were gathered. By performing this desk study of grey literature and other relevant sources, prior knowledge on all indicators has been obtained. This policy review provided a substantiated preliminary score for each indicator.
2. *Interviews:* To refine the preliminary scores, more in-depth and case specific information was collected. Nine face-to-face interviews were conducted with a wide variety of stakeholders. To select the interviewees, the importance/influence matrix has been used. *Importance* can be defined as a measure for a stakeholder's (first) concern and interests with a certain activity; whereas *Influence* alludes to the power and opportunity a stakeholder has to negatively or positively change the accomplishment of that activity [46]. The importance/influence matrix consists of four classes: 1) *Subjects* (high importance, low influence), 2) *Key players* (high importance, high influence), 3) *Crowd* (low importance, low influence) and 4) *Context setters* (low importance, high influence). For an in-depth understanding of the local urban context, this study focussed on key players and subjects for the interview selection. The nine interviews lasted approximately one hour and were recorded after permission was given. This ensured accuracy and enabled to easily compare specific indicators.
3. *Score determination:* Finally, the preliminary score of the policy review and the results of interviews were compared and led to a final score per indicator.

A coding system is applied in this paper to refer to guarantee anonymity, where [SR01], [SR02], [SR03] and so on refer to the conducted interviews. The interviewees include stakeholders that participate in collaborative regional networks and can be classified in the groups 'key players' and 'subjects'. As *key players*, we selected two policy advisors on urban water and public green spaces (Municipality of Utrecht), a spatial adaptation expert (Province of Utrecht) and representatives of the regional water authority (HDSR; in Dutch: Hoogheemraadschap De Stichtse Rijnlanden). For flood risk management in the city of Utrecht, the regional partnerships Winnet (in Dutch: Water Innovatie Netwerk), Coalition Spatial Adaptation (CSA; in Dutch: Coalitie Ruimtelijke Adaptatie) and Nature and Environment Federation Utrecht (NEFU; in Dutch: Natuur en Milieu Federatie Utrecht) form the *subjects*. Winnet is a regional cooperation in Utrecht, consisting of 14 municipalities and the regional water authority HDSR, and aims at a sustainable and efficient waste water cycle. Similarly, CSA is a regional platform facilitated by the engineering consultancy Sweco that addresses drought, heat stress and flooding by joining forces with the Province of Utrecht, six municipalities, HDSR and Safety Region Utrecht (in Dutch: Veiligheidsregio Utrecht). Finally, NEFU unites various

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stakeholders (e.g. citizens, local authorities, businesses, housing corporations) to achieve a sustainable province and to tackle climate adaptation, including pluvial flooding.

### *2.3 Case study: Utrecht (The Netherlands)*

In July 2014, the city of Utrecht was hit by the most severe rainfall ever recorded with measurements ranging from 75 to over 100 millimetres in 24 hours [47]. Utrecht has limited capacities to store such downpours as only 21.8% of the city centre is green (vegetation) or blue (water) [4]. Besides, the city is characterized by an ageing sewer system and has only 384 km of stormwater sewers and 630 km of combined sewers (both rainwater and sanitary water) [48]. The combined sewer system is common in many Dutch cities and as risks of pluvial flooding increase [6], the exposure to combined sewer overflows (CSOs) increases as well. This may result in urban surface water pollution that may negatively affect both environmental and human health [14,43].

The municipality of Utrecht has approximately 352,941 inhabitants (1st of January 2019) and prognoses are that it will reach over 400,000 citizens by the year 2025 [49]. When comparing the four largest Dutch municipalities, Utrecht grew most rapidly from 2010 – 2018 (13,16%) and it is expected to continue growing at this rate [50]. Urbanization, in combination with extreme rainfall and the aforementioned limitations regarding the sewerage and water storage capacities, calls for more understanding of how to adequately govern these challenges. Knowledge will help local policymakers and other stakeholders to implement climate adaptive policies. As many other Western-European cities face the challenge of pluvial flooding and share the same characteristics as Utrecht (e.g. ageing water infrastructures, urbanization and sealed urban surfaces), our lessons may also benefit other cities.

## 3. Results

Figure 1 shows the capacity profile that indicates how well stakeholders work together to govern pluvial flood risk in Utrecht. Overall, the governance capacity is well developed. However, note that all neutral (0) or encouraging (+) scores can still improve substantially. Section 3.1 provides the key results of the governance capacity analyses which is structured according to the framework's three dimensions *knowing, wanting* and *enabling*. Section 3.2 focusses on the role of citizen engagement which turned out to be a priority for future efforts to mitigate pluvial flood risk in Utrecht (Figure 1).

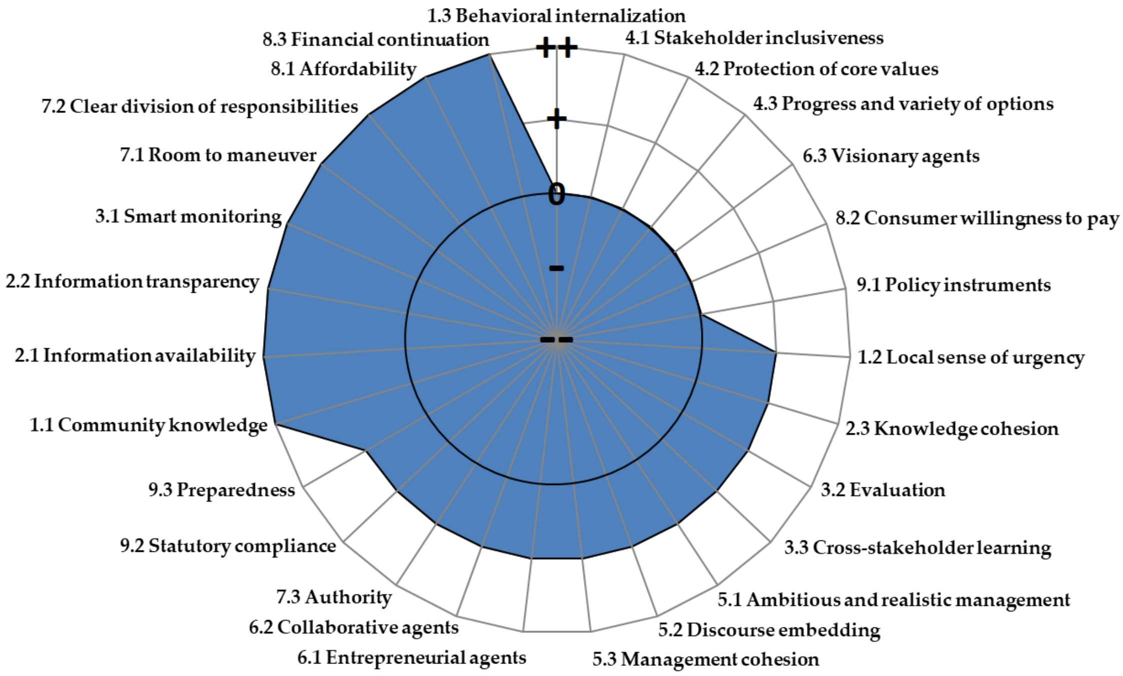


**Figure 1.** Results of the Governance Capacity in Utrecht. The indicators are arranged clockwise from very limiting (--) to very encouraging (++); the bluer, the better.

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*3.1. Utrecht's capacity to govern pluvial flood risk*

**Dimension 1: Knowing**

The city of Utrecht performed a mandatory 'climatic stress test' in 2018. This test [51] contributed to identifying locations that are vulnerable to floods, heat stress and water scarcity issues [SH02,SH09]. Moreover, sewer systems are adequately monitored, and precipitation and prediction models are upgraded by a collaboration of the municipality of Utrecht, cooperation Winnet and the regional water authority (indicator 3.1-[SH02,SH03,SH07]). Utrecht's current strategy is, however, not aimed at sewer pipe dimensioning to store excess water in case of a heavy rain event. Sewer pipes will only be enlarged when standard precipitation norms are exceeded [SH05]. This emphasises the need for alternative solutions. In addition, cross-stakeholder learning (indicator 3.3) is well-embedded in Utrecht, for instance in the form of knowledge sharing between many networks and cooperations [SH06]. Knowledge sharing with a broader audience than specialist networks is somewhat limited, especially the citizens of Utrecht are largely overlooked.

Despite awareness campaigns such as '*Waterproof030*' and '*Water-friendly Garden*', a widespread sense of urgency about pluvial flood risk (indicator 1.2) has not been established yet. However, a sense of urgency does exist in flood-prone neighbourhoods: Lombok and Zeeheldenbuurt [SH01]. It seems that a more profound sense of urgency requires a downpour, as SH07 describes: '*What we actually need, is another heavy cloudburst as a kind of wake-up call to raise the urgency of the water issue.*'

Citizens seem to be informed about the impacts and probabilities of pluvial floods (indicator 1.1). In addition, some communities are starting to engage in flood alleviation initiatives. For example, by placing rain barrels in their street (indicator 1.3-[52]). However, in general, people do not feel an urgency to change their behaviour by taking pre-cautionary measures (indicator 1.3). In fact, most people do not act because they perceive such adaptation measures as a primary responsibility of local authorities (i.e. the regional water authority and municipality) [SH01,SH02,SH06]. These results are in line with the OECD study [31] that observes a water awareness gap amongst Dutch citizens who take water services for granted. Contrary to this awareness gap, the availability of transparent and intelligible information about pluvial flood risk is well-organised through various channels such as websites, newspapers, television or in policy documents (indicator 2.1 and 2.2-[SH01,SH03,SH05,SH07]). For example, the municipality published an online manual for citizens on how to make dwellings and gardens waterproof [53]. In short, citizens in Utrecht know about the risk of pluvial flooding, yet do not consider this issue as a priority and do not seek for information until they experience 'wet feet' themselves.

**Dimension 2: Wanting**

Stakeholder engagement (condition 4) is important for joint problem framing, gaining access to resources and creating support for successful implementation of measures and policies. Although stakeholder engagement is an integrated part of governing pluvial flood risk related-issues in Utrecht, its current application is rather limited. In fact, for pluvial flooding specifically, stakeholder engagement is hardly considered [SH07]. More generally, stakeholder engagement in Utrecht consists merely of consultation sessions where people can ask for amendments to proposed policy plans. In a number of cases, these consultations occur at the end-stage of the decision-making process (indicator 4.1-[SH07]), resulting in a low influence of stakeholders on the end-result and arguably low stakeholder engagement in the implementation phase [34]. In addition, only public parties and one consultancy company are represented in the main regional partnerships CSA and Winnet, whereas citizens and housing corporations have yet to be included.

Moreover, Utrecht's sustainability ambition (condition 5) is found to be well-embedded and goals for water policy and green policy on the municipal level are more or less aligned, and are thus enhancing cohesion (indicator 5.3-[SH07,SH08]). Besides, Utrecht has adopted the seven ambitions of the national Delta Programme [54], which aim at making the Netherlands water-resilient and climate-proof. However, the pathways to reach this goal are yet to be formulated by local authorities [SH09]. The role of local citizens who promote initiatives, bring actors together, and mobilise the

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required local resources, can be improved (condition 6). In Utrecht, such agents of change are rather limited to small-scale neighbourhood initiatives such as individual initiatives to install rain barrels [52]. Though limited in scale, these types of initiatives may spur neighbours to do the same [SH05, SH07]. As SH05 argues: '*It is crucial to have examples in practice. If your neighbours take measures, this may encourage other residents to take action as well.*'

At the municipal level, the city's mayor for instance can be considered a visionary agent of change regarding sustainability initiatives, but he does not (yet) perceive pluvial flooding as a priority. By contrast, municipal representatives of the nearby smaller city of Houten are more engaged with pluvial flood risk adaptation [SH07]. The city of Utrecht cannot fully rely on local agents of change, but could facilitate more initiatives when the municipality recognises pluvial flooding as a priority.

**Dimension 3: Enabling**

The results show that stakeholders who participate in collaborative regional networks (e.g. CSA and Winnet) have sufficient room to manoeuvre and find solutions to pluvial flood risks (indicator 7.1). However, these cooperations and local authorities are not the only stakeholders who bear responsibility, as multiple interviewees acknowledge that citizens have to make an effort as well [SH06,SH07,SH09]. To enable actors to implement their ambitions and ideas concerning flood resilience, sufficient financial resources are crucial. For citizens in Utrecht, taking climate adaptation measures to cope with pluvial flooding is financially supported by the regional water authority and the municipality through multiple subsidy schemes [SH02,SH04,SH06,SH08]. This financial support enhances the affordability of various adaptation measures (indicator 8.1) such as the replacement of pavements by greenery in private gardens. According to SH04, there is, in general, a willingness to pay among citizens for taxes levied by the regional water authority. However, the willingness to invest in pluvial flooding solutions is found to be moderate among citizens in the flood-prone neighbourhood Lombok (indicator 8.2). The municipality realised a separate drainage of rainwater in this low-lying part of Utrecht and connected 68 semi-based dwellings to this system [SH07]. As these houses are private entities, homeowners bear responsibility as well. However, not every household was willing to invest, as SH07 explains: '*About half of the 68 homeowners in Lombok signed an agreement with the municipality to contribute in implementing pluvial flooding measures on their property.*'

In fact, this limited willingness to pay is a recurring pattern for Dutch municipalities. For example, a survey conducted by the Dutch Broadcast Foundation among 1,700 Dutch citizens that experienced serious pluvial flooding issues, showed that the community would like to see the municipality invest more in the sewer system while only 25% of them is willing to pay more municipal sewer tax [55]. A study on Dutch water governance recommends to strengthen the financing system, for instance, by implementing polluter-pays-principles, such as abstraction charges [31]. Following this report, a special commission appointed by the Dutch Water Authorities investigated the possibilities to optimise the regional water authority's tax system [SH04]. Currently, rainwater accounts for approximately a third of the water treatment costs [56]. To minimise this share, the commission suggests to increase incentives to decouple rainwater pipes from the drain to relieve the sewer system and reduce treatment costs [56]. The commission's proposal is hitherto not implemented in Utrecht or elsewhere in the Netherlands.

Nonetheless, monetary aid or financial incentives are no guarantee for successful adaptation by citizens. For instance, the municipal subsidy for green roofs has had, up to now, minimal effect because many people do not yet fully understand the added value of having a vegetated roof [SH07,SH08]. To date, stimulating rather than implementing sustainable behaviour through binding guidelines has been preferred by local authorities [SH07]. To summarize, citizens are financially supported through various subsidy schemes to take climate adaptive measures (e.g. removing pavements, installing green roofs or building climate-proof playgrounds), yet do not take advantage of this. This may be explained by the low sense of urgency and limited awareness that has been observed.

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Overall, Utrecht can considerably improve its capacity to govern pluvial flood risk. In particular, the following indicators and conditions showed the most room for improvement, and therefore should form the core focus for future action. First of all, there is a relative low willingness to pay (indicator 8.2) for climate adaptive solutions such as infrastructure augmentations (i.e. separate rainfall runoff from the sewer system). Accordingly, local communities and the private sector show limited efforts to understand, react and anticipate risks of pluvial flooding through for example applying green roofs (indicator 1.3). Limitations in awareness among citizens and private stakeholders (condition 1) and a suboptimal use of policy instruments (indicator 9.1) both require additional effort to better address the increasing downpours that Utrecht is projected to have. Governmental bodies, such as the municipality and the regional water authority, are aware and are actively initiating action through multi-level collaborative networks (condition 7). However, with respect to private actors and citizen engagement, considerable progress is required to effectively address pluvial flood risk (condition 4). To achieve this, Utrecht may need to formulate an action plan in close collaboration with its citizens and local enterprises (indicator 9.3). In this way, stakeholder engagement (condition 4) can be improved to better serve both the policy development and implementation phase.

### *3.2. Citizen engagement*

Despite serious efforts made by the municipality and regional water authority (e.g. through campaigns and provision of information and advice), the level of awareness among citizens on pluvial flooding in Utrecht is limited. In general, they lack a sense of urgency to take action as they hold local authorities responsible for taking climate adaptation measures to alleviate the risk of urban floods. And if they do feel accountable, citizens show reactive behaviour (i.e. taking measures after pluvial floods occurred) rather than proactive. This reactive behaviour is mainly visible among citizens who are exposed to the negative effects of extreme rainfall in their garden or inside their dwelling, as SH05 explains: '*A sense of urgency among citizens does not occur until they are confronted with pluvial floods themselves. They purely react upon pluvial flooding issues*.'

To change this reactive behaviour into (pro)active behaviour regarding pluvial adaptation, both the municipality and regional water authority in Utrecht make an effort to support its inhabitants by providing various grant schemes. In spite of this, citizens' willingness to pay still appears to be low. Taken together, the combination of information provision (e.g. through policy documents, campaigns, manuals, guest lectures at schools) and financial aid (e.g. grant schemes) provided by local authorities does not yield the desired result, namely, citizens taking climate adaptive measures to minimise the adverse effects of pluvial flooding.

What is largely missing, is an active involvement of citizens in (municipal) decision-making. Citizens are expected to be actively engaged in addressing pluvial flooding, yet they have little influence on municipal flood-related policies. At present, the municipality is only obliged to ask for consultation from the regional water authority and province [SH07].

To stimulate citizens to adapt to pluvial flooding, an important incentive is to actively engage them in the development and implementation of flood adaptation policy plans. To do so, their level of influence should go beyond being informed or consulted. The opportunity to be actively engaged and coproduce policy plans may be essential in motivating citizens to take part. Active engagement usually takes much more time than more unilateral decision-making. However, many authors argue that this is generally more than offset by time gains in the implementation phase, not the least because citizens become more aware of the relevance and their role in flood mitigation [34,57,58]. Our results indicate that in particular the stakeholder engagement process (condition 4; Table 1) of Utrecht can be improved for flood decision-making. More often, stakeholders should be given the opportunity to be actively engaged and the municipality can structurally stimulate their active engagement. More precisely, additional effort may be required to engage all relevant stakeholders in an early stage of policy coproduction processes. In these processes it is crucial that stakeholders (e.g. citizens and local experts) develop a range of different alternatives and, when all alternatives are considered, commit themselves to a final decision. In addition, clear and realistic procedures, with clear exit moments may ensure sufficient progress for stakeholders to continue their initial engagement and ensure that

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they feel confident that their core values are not being harmed (i.e. creating trust).

On another note, the policy instruments which are currently applied in Utrecht, have a suboptimal effect. The municipal subsidy which is supposed to stimulate citizens to implement green roofs, for instance, has been adopted by citizens on a rather limited scale [SH08]. In addition, the municipal sewer levies, which are mandatory for all citizens, are currently not related to the discharge quantity of wastewater into the sewer system. This indicates that the 'polluter-pays principle' is not implemented, and therefore, producing less wastewater is not rewarded by tax reductions. This demonstrates that Utrecht is rather implementing soft policies (e.g. providing information and subsidies) than hard policies (e.g. binding rules or punishment, such as charging citizens if over 70% of their garden consists of impermeable pavements). Although the latter strategy requires considerable paperwork (and thus resources), it is likely to have a substantially better result than the current package of non-binding soft policies. These stricter baseline instruments are an important contribution to spur active citizen engagement and may simultaneously contribute to improved water quality and drought alleviation.

## 4. Discussion

The adverse effects of extreme rainfall on urban areas demand for adequate water governance to prevent pluvial flooding. We used the GCF [38] to assess the water governance capacity of all water-related stakeholders within the city of Utrecht to govern (the effects of) pluvial flooding. Our results demonstrate that the overall capacity of Utrecht to govern pluvial flooding is relatively well-developed.

### *4.1 Method validity and limitations*

The GCF method integrates a wide range of governance gaps to assess a city's capacity to adequately manage water challenges [38]. This plethora of divergent aspects of water governance offers the opportunity to identify barriers and enablers and thus reveals a city's current position on governing a specific water challenge. The applied methodology is comprehensive, and to enhance reproducibility, it includes both a policy review of local authorities and organisations, as well as in-depth interviews with various local stakeholders. The results provide relevant insights for city planners and policy makers at the local level and can thus help the urban network in place to implement sound climate adaptation strategies and water management policies to alleviate the risk of pluvial flooding.

However, this study has also revealed limitations. The outcomes of the governance capacity analyses emphasised the role of citizen engagement in addressing pluvial flood risk. Since this study is based on a literature review and expert interviews, an assessment of how citizens consider their role in addressing flood risk is not fully accounted for. As such, a suggestion for future research is an in-depth study that explicitly includes citizens, for example through surveys. This will be relevant to further substantiate our findings related to citizen engagement in urban flood risk management.

The applied governance capacity analysis is a methodology based on Likert scale descriptions of indicators that together are argued to form the capacity to govern water challenges. Although this method is well-embedded in existing literature on adaptive management, co-management and water governance [32], it is important to note there is a plethora of frameworks developed to assess the key conditions that together constitute governance capacity (e.g. [22,59,60]). The GCF is selected because it is arguably one of the most standardized approaches in terms of definitions, operationalisation, research approach and geographical scope, which enables high levels of scientific reproducibility and falsifiability of the empirical results. A second reason for selecting the GCF relates to its (graphical) design which aims to be intelligible for a variety of non-experts such as policy makers, operators and citizens.

### *4.2 Promising multi-sectorial linking opportunities*

The study revealed barriers (e.g. limited citizen engagement) and opportunities (e.g. many local partnerships working on the issue of heavy rainfall) that require action by the entire network of

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stakeholders in Utrecht. Although the city is generally adopting sustainable pathways, it hitherto insufficiently recognises the broad potential benefits of implementing integrated climate adaptation plans. Improving soil permeability, adding green spaces, adapting underground water infrastructures, installing green roofs and even relocating buildings may reduce pluvial flooding and urban heat island effects. Such measures have additional benefits such as better air quality, urban surface water quality, biodiversity, human health and the overall attractiveness of the city [4,13,22]. For instance, green roofs offer multiple environmental benefits, such as efficient temperature control of buildings (using less energy), retaining rainwater (reducing pluvial flood risk), restoring biodiversity and enhancing air and stormwater runoff quality [61]. The benefits of these 'linking opportunities' [54], may outweigh their costs and may ultimately improve the attractivity and liveability of the city of Utrecht.

### *4.3 The role of citizen engagement in municipal water management and climate adaptation*

The importance of the involvement of both public and private actors in climate adaptation and flood risk management has been stressed frequently (e.g. [1,21,22,24,26]). Through our case study of Utrecht, we found that citizens are hardly involved in the local decision-making process on pluvial flooding. Similarly, recent studies on the engagement of local stakeholders (e.g. citizens and/or other private actors) in climate adaptation and flood risk management show that involvement of local (private) stakeholders tends to be limited (e.g. [25,27,62]). Moreover, city-citizen collaborations on climate adaptation are scarce [29,30]. We found that Utrecht's public actors' (i.e. municipality and regional water authority) current strategy is primarily focussed on supplying information about climate adaptation to spur civic action. Through an extensive study of 402 urban areas, Klein et al. [27] found similar results as they argue that local authorities steer citizens through solely information provision. These residents are, in turn, expected to use this information to implement adaptation measures [27]. In addition to solely providing information in a one-way direction (i.e. from government to citizens), local authorities may consider citizen's capability to collect data or information themselves. With respect to this, the concept of 'citizen science' is repeatedly referred to. Citizen science is defined as a practice in which individuals voluntarily participate in data collection or observations for scientific purposes and can be seen as a form of collaborative research [63,64]. Sy et al. [65] emphasise that citizens play a crucial role in flood hazard assessment through various techniques, such as monitoring rainfall or analysing messages on rainfall on social media. Moreover, citizen science contributes to an increased understanding of the investigated subject by all involved actors [64]. In turn, a better understanding results in a higher level of awareness [66]. Five recent citizen science projects in the Dutch surface and drinking water sector show promising results on the effects of citizen participation. 70% of these projects' participants indicated that their level of awareness regarding water had increased and even 87% of them described participation in the project as a 'learning experience' [66]. Thus, citizen science can be seen as a valuable form of citizen engagement (condition 4) through which awareness, knowledge and transparency (condition 1 and 2) on pluvial flooding can be obtained.

It has been suggested that involving citizens in the decision-making process is time-consuming and involves higher costs for the government [30,67]. However, the costs do not outweigh the positive effects of citizen participation, such as gaining legitimacy of decisions, trust-building and learning from citizens [67]. Moreover, Mees et al. [17] argue that 'coproduction' (i.e. interaction between citizen and public authorities during decision-making processes and in practice) can be seen as a way to reduce additional governmental investment in flood risk management. If citizen engagement becomes *business as usual* in governing pluvial flood risk, this may have a positive impact on the financial viability (condition 8) of dealing with the specific risk.

Furthermore, we found that citizens' willingness to pay (indicator 8.2) for flood protection measures in Utrecht is limited. This may be related to the observed limited risk perception (sense of urgency; indicator 1.2). In addition to this, Owusu et al. [68] conclude that the scale of flood events and their impacts also relate to the extent which people are open to adaptation measures. In other words, a large-scale flood event results in more citizens who might consider implementing

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adaptation measures on their property. Furthermore, Torgersen and Navrud [69] stress that citizens in high-risk flood areas have a greater willingness to pay for adaptation measures. Besides, Henstra et al. [70] found that willingness to pay for property-level flood protection measures has a positive relationship with age, housing type and level of education. However, the present study shows that living in a flood-prone neighbourhood does not automatically lead to investments (i.e. adaptation measures) to reduce pluvial flood risk. This might relate to the perception citizens of Utrecht have regarding the flood risk they face. This is in line with Bubeck et al. [33] who argue that the supposed positive relation between flood risk perceptions and taking private adaptation measures is found to be limited in current empirical studies.

The available financial aid (e.g. subsidies) provided by Utrecht is currently suboptimal (indicator 9.1). The results of this study indicate that solely the dissemination of information in combination with financial incentives, i.e. 'soft policies', does not yield the desired effect of taking adaptive action. With respect to this, Dai et al. [6] suggest that more binding rules instead of soft policies may be a valuable contribution. These regulations may contribute to the engagement of citizens in the implementation of climate adaptation measures. For example, if local authorities decide to levy taxes on heavily paved gardens (for example when >70% of a private garden is paved), citizens have a stronger incentive to take action. Likewise, Mees et al. [71] conducted a comparative study on the installation of green roofs and also conclude that hierarchical arrangements (steering through regulations) are most effective. However, local governments should play a facilitating role in supporting citizens [72]. Hence, a well-balanced use of both soft and hard policy instruments seems key. For instance, Kamperman and Biesbroek [73] advocate for a combination of 'hard' and 'soft' modes, because the existing Dutch regional water authorities' strategy of soft policy measures seems to be insufficient to spur climate change adaptation.

This research may support this finding. A first way to achieve an improved governance capacity includes regulations such as levies or taxes on heavily paved gardens or large wastewater discharges (according to the 'polluter-pays' principle). Another way to enhance the overall governing capacity to address pluvial flooding is through an increased engagement of citizens in local decision-making processes. Providing sufficient examples of good local practice (i.e. adaptation measures of fellow citizens) may contribute to getting citizen engagement off the ground in practice.

Raising awareness is often perceived as crucial to realise more citizen engagement. However, a more nuanced balance between effective policy instruments, stakeholder engagement processes and the development of local private initiatives is needed to effectively engage citizens to adapt to urban flood risk. To obtain a better insight into how to engage different citizen groups, further empirical research is needed to examine citizen engagement in urban flood risk management in practice.

## 5. Conclusions

The aim of this study in Utrecht (the Netherlands) is to obtain a deeper understanding of how the capacity to govern pluvial flood risk can be developed through citizen engagement. We applied citizen engagement as an umbrella term for the participation of citizens in the local decision-making process and for an active involvement in the implementation phase by taking climate adaptive measures. The results of this study indicate that solely providing information and subsidies, i.e. 'soft policy instruments' does not yield the desired effect of citizens taking climate adaptive measures to protect themselves from pluvial flooding. Residents in Utrecht are currently insufficiently engaged in the local decision-making process, which may explain the limited flood risk awareness among citizens. Their limited awareness in combination with a low willingness to pay may explain why they barely take climate adaptation measures to alleviate the risk of pluvial flooding. The city of Utrecht might consider to 1) include citizens more explicitly in the decision-making process regarding (pluvial) flood risk management and 2) broaden the scope of its policy instruments by implementing more binding rules, such as taxes on heavily paved gardens. In doing so, residents are expected to become more aware of and more engaged with pluvial flooding. Improved citizen engagement can also be enhanced through citizen science projects. By realising such initiatives to establish more meaningful citizen engagement, Utrecht's capacity to govern pluvial flood risk can be strengthened

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substantially. Because other cities in the Netherlands and Europe face similar challenges of increasing downpours, aging infrastructure and inexperience with citizen engagement, these lessons may of value for them as well.

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