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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 flooding from downpours because of their large share of impervious surfaces. Minimising pluvial flood risk requires all involved stakeholders to collaborate and overcome various barriers. Although an increase in citizen engagement in climate adaptation is generally preferred, experiences with inclusive decision-making are often 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 the key 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 few 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 near future [3,4], demanding sound flood risk management. Urban areas are particularly vulnerable to 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 damage and traffic congestion. It may also induce irregularities in the provision of electricity [6–8]. In 2011, for instance, the city of Copenhagen (Denmark) was hit by a downpour of 150 millimetres in less than three hours. The concomitant damage was estimated at around one 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 lead 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 surface water flooding [4,14]. Thus, growing precipitation extremes together with a large percentage of impermeable urban surfaces and an increasingly obsolete drainage system, call for more advanced urban flood adaptation.

In many countries in Europe, governmental institutions have been solely 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, 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 to private actors [21]. This trend towards governance is widely adopted in, for instance, the European Union's (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]. 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. Intergovernmental Panel on Climate Chance [1] and Organisation for Economic Co-operation and Development (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 citizens and authorities and the impact of citizen engagement on decision-making [23]. In the Netherlands, citizens are held responsible by the law 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 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 on their sense of self-efficacy and the financial means made available to genuinely let citizens influence the end-result of decision-making processes [34]. Thus, active citizen engagement in urban flood adaptation seems to be challenging in practice, although 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, 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.

In our study we apply the governance capacity analysis. This methodology is 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. [22,38,39]). The Governance Capacity Framework (GCF) is selected because it is one of the most standardised approaches in terms of definitions, operationalisation, research approach, and geographical scope, which enables high levels of scientific reproducibility and falsifiability of the empirical results. An overview of the operational indicators and key references to literature can be found here [40]. 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 policymakers, operators, and citizens. Thirdly, although other governance assessment frameworks have been developed for institutions at various scales such as social-ecological systems, bioregions, countries, river basins, or organisations (e.g. [22,39,41,42]), there are not that many frameworks focussing on the urban context, particularly with respect to governance capacity. However, cities are important and well-established institutional entities where integration of water with different sectors, objectives, and interests is perhaps most prevalent and concrete. In fact, the direct interaction between citizens, governments, and smaller and larger private stakeholders may be most widespread in cities [43,44].

The GCF consists of nine key conditions for good governance such as 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. Accordingly, the aim of this paper is to obtain a deeper understanding of how the capacity to govern pluvial flood risk can be developed and further improved 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. Additionally, 'Utrecht' will be used to 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.

Section 2 provides the conceptual framework, research methodology, and case study description. Section 3 presents the results of the governance capacity assessment of Utrecht and specifically addresses the role of citizen engagement. Finally, Sections 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. [45]. The framework consists of three dimensions and nine conditions and is supported by 27 indicators (Table 1). The dimension *knowing* refers to the need to be aware (e.g. [46]), understand (e.g. [47]), and learn (e.g. [48]) about the risks and impacts of environmental challenges and policy. *Wanting* alludes to the willingness and motivation of various actors to cooperate (e.g. [34]), act upon ambitions (e.g. [49]), and devote oneself to finding solutions (e.g. [50]). *Enabling* refers to the network's ability to collaborate (e.g. [51]), coordinate, and implement action plans through various policy instruments and available resources (e.g. [38,52]). The selected nine conditions are based on a literature review in the field of water governance, environmental governance, and adaptive management [45], and are well aligned with the much-accredited

principles for water governance proposed by the Organisation for Economic Co-operation and Development [22]. For detailed references to key literature for each of the framework's 27 indicators, we refer to [40]. The GCF provides a diagnosis of urban water challenges. These challenges generally require different organisations to collaborate and align their activities. The framework's indicators are consistently scored according to an indicator-specific Likert scale ranging from very limiting (− −) to very encouraging (+ +) to the governance capacity. The GCF has been applied to assess 41 water-related challenges in 15 cities across the globe [32,45,53–58].

Table 1. Overview of the Governance Capacity Framework (GCF) adopted from Koop et al. [45].

Dimensions	Conditions	Indicators
Knowing	1 Awareness	1.1 Community knowledge
		1.2 Local sense of urgency
		1.3 Behavioural internalisation
	2 Useful knowledge	2.1 Information availability
		2.2 Information transparency
		2.3 Knowledge cohesion
	3 Continuous learning	3.1 Smart monitoring
		3.2 Evaluation
		3.3 Cross-stakeholder learning
Wanting	4 Stakeholder engagement process	4.1 Stakeholder inclusiveness
		4.2 Protection of core values
		4.3 Progress and variety of options
	5 Management ambition	5.1 Ambitious and realistic management
		5.2 Discourse embedding
		5.3 Management cohesion
	6 Agents of change	6.1 Entrepreneurial agents
		6.2 Collaborative agents
		6.3 Visionary agents
Enabling	7 Multi-level network potential	7.1 Room to manoeuvre
		7.2 Clear division of responsibilities
		7.3 Authority
	8 Financial viability	8.1 Affordability
		8.2 Consumer willingness-to-pay
		8.3 Financial continuation
	9 Implementing capacity	9.1 Policy instruments
		9.2 Statutory compliance
		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. Through this extensive and comprehensive analysis on existing data, a valuable insight into each indicator was acquired. The obtained information formed the core of the analysis. The interviews conducted in step 2 provided further improvements in accuracy, comprehensiveness, awareness and support for the study's results.
2. *Interviews:* To refine the preliminary scores, more in-depth and case-specific information was collected through nine face-to-face interviews with a wide variety of stakeholders. To select the interviewees, the importance/influence matrix was used. *Importance* can be defined as a measure for a stakeholder's (first) concern and interest with a certain activity; whereas *Influence* alludes to the power and opportunity of a stakeholder to negatively or positively change the accomplishment of that activity [59]. 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 easy comparisons of 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 interviewees while guaranteeing their anonymity. Accordingly, codes such as [SR01], [SR02], [SR03] refer to the individual interviews respectively. The interviewees included 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 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 heaviest rainfall ever recorded, with measurements ranging from 75 to over 100 millimetres in 24 hours [60]. Utrecht has limited capacity to store such downpours as only 21.8% of the city centre is green (vegetation) or blue (water) [4]. Besides, the city is characterised by an ageing sewer system, and has only 384 kilometres of stormwater sewers and 630 kilometres of combined sewers (both rainwater and sanitary water) [61]. 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 the environment and human health [14,57].

The municipality of Utrecht has approximately 352,941 inhabitants (1 January 2019) and prognoses are that it will reach over 400,000 citizens by the year 2025 [62]. 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 [63]. The involvement of citizens in addressing pluvial flooding is important, as they own, together with businesses, approximately 60% of Utrecht's land surface [64]. Citizens can thus make a large contribution, for instance by installing green roofs on their property or removing pavements in their gardens, to respectively store and infiltrate rainwater. This clearly shows the potential of citizens' actions to help address downpours. In 2018, 3716 square metres of green roofs were installed in Utrecht, financially stimulated through a municipal subsidy programme [65]. Although this coverage has more than tripled compared to 2017, the installation of green roofs in Utrecht by citizens is still in its infancy.

Urbanisation, in combination with extreme rainfall and the aforementioned limitations regarding 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, urbanisation, 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 (Figure 1). 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, and ends with a synthesis of these results. 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.

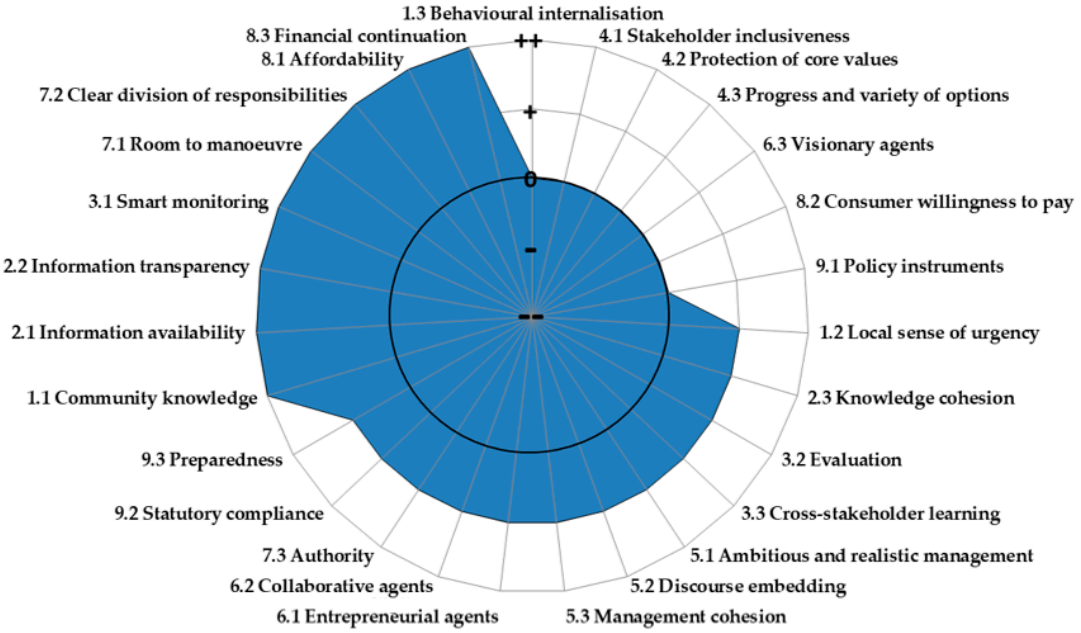

Figure 1. Results of the Governance Capacity of Utrecht to address pluvial flood risk. The indicators are arranged clockwise from very limiting (—) to very encouraging (++). Key message is "the bluer, the better".

3.1. Utrecht's Capacity to Govern Pluvial Flood Risk

3.1.1. Dimension 1: Knowing

The city of Utrecht performed a mandatory 'climatic stress test' in 2018. This test [66] 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 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, specifically 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 cloudburst as a kind of wake-up call to raise the urgency of the water issue." Citizens of Utrecht 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 such as placing rain barrels in the street (indicator 1.3 [67]). However, in general, people do not feel an urgency to change their behaviour by taking precautionary 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 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 [68]. 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.

3.1.2. 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.

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 [69], 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 required local resources, can be improved (condition 6). In Utrecht, such agents of change are rather limited to small-scale neighbourhood initiatives as individual initiatives to install rain barrels [67]. 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 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 neighbouring smaller city of Houten are more engaged with pluvial flood risk adaptation [SH07]. Utrecht cannot fully rely on local agents of change but could facilitate more initiatives when the municipality recognises pluvial flooding as a priority.

3.1.3. 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, these limitations in the willingness to pay are 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 are willing to pay more municipal sewer taxes [70]. A study on Dutch water governance recommends strengthening the finance system by implementing polluter-pays principles, such as abstraction charges [31]. Following this report, a special commission appointed by all Dutch water authorities investigated optimising the regional water authority's tax system [SH04]. At present, rainwater accounts for approximately a third of the water treatment costs [71]. To minimise this share, the commission suggests increasing incentives to decouple rainwater pipes from the drain to relieve the sewer system and reduce treatment costs [71]. 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 minimal effect because many people do not yet fully grasp 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]. 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.

3.1.4. Synthesis

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, there is a relatively low willingness to pay (indicator 8.2) for climate adaptive solutions such as infrastructure augmentations (i.e. separate rainfall runoff from the sewer systems). Accordingly, local communities and the private sector show limited efforts to understand, react, and anticipate risks of pluvial flooding such as 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 act as they hold local authorities responsible for taking climate adaptation measures to alleviate the risk of urban floods. 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. Despite this, citizens' willingness to pay still appears to be low. Taken together, the combination of information provisions (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 [34,72,73]. Our results indicate that the stakeholder engagement process (condition 4; Table 1) of Utrecht can be improved for flood decision-making. Stakeholders should be given the opportunity to be actively engaged so that 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 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 implementing soft policies (e.g. providing information and subsidies) over 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 [45] 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. However, there is also room for improvement. In particular, the engagement and

behavioural change of citizens seems to be essential for addressing pluvial flood risk. This result seems to be well-aligned with other studies of Utrecht and the main municipalities in the Netherlands (e.g. [6,31,74]).

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 [45]. 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, enables reproducible results and 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 policymakers at the local level and can thus help the urban network in place to implement sound strategies and 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 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.

There are also other frameworks that assess the governance capacity of environmental challenges, most notably, the adaptive capacity wheel [39] and the framework proposed by Mees and Driessen [75] to assess the governance capacity for green urban areas. Like the GCF, these frameworks rely on similar literature related to adaptive capacity, environmental governance, and water governance. Hence, elements such as social learning, division of responsibilities, resources, leadership, or accounting for uncertainty, are included. Moreover, the starting point of these frameworks is the comprehension of different values, viewpoints and alternatives in problem framing, decision-making, and implementation. Gupta, et al. [39] identify six dimensions: Variety, learning capacity, room for autonomous change, leadership, availability of resources, and fair governance. These dimensions and their 22 criteria assess the adaptive capacity of institutions (including their ideological values and norms), predominantly at the national level. This approach differs from the GCF's focus on how well different stakeholders collaborate and jointly address urban environmental challenges. In this respect, Mees and Driessen [75] have a similar approach as the GCF but focus specifically on green urban areas. They identify five key capacities: Learning, legal, managerial, political, and resources. Their framework also includes legal capacity and stakeholder engagement. Likewise, the GCF specifically includes indicators such as policy ambition, institutional compliance, smart monitoring, implementing capacity, and stakeholder engagement. The adaptive capacity wheel is, however, less focussed on the stakeholders and legal or policy aspects. When considering the scoring system, Gupta, et al. [39] apply a generic Likert scoring, which implies that there is more room for a researcher's interpretation when compared to the GCF's indicator specific Likert descriptions and standardised data gathering procedure. Moreover, Mees and Driessen [75] apply a more descriptive analysis of each component of their framework. Since this paper aimed to provide insights that may apply beyond the case study itself, a more standardised method has been selected that enables a better reproducibility and comparability of different cases. Given the similarities between the scope of this paper and that of Mees and Driessen [75], the frameworks can be considered complementary and may be combined in future research about the capacity of cities to govern pluvial flood risk. In particular, the indicators of Mees and Driessen that specifically address urban green areas may strengthen the more generic scope of the GCF and thus enable a more accurate analysis of pluvial flood risk.

4.2. Promising Multi-Sectorial Linking Opportunities

This 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

stakeholders in Utrecht. Although the city is generally adopting sustainable pathways, it hitherto insufficiently recognises the multifaceted benefits of implementing integrated climate adaptation plans. For example, 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 [76]. The benefits of these 'linking opportunities' [70] may outweigh their costs and may ultimately improve the attractiveness 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 frequently stressed (e.g. [1,21,22,24,26]). For example, leading concepts such as integrated water resources management and adaptive management include principles of engagement of a variety of stakeholders. Influential organisations include International Water Management Institute, the Food and Agriculture Organization, the World Bank, and various regional authorities. In addition, the United Nations Sustainable Development Goals and the European River Basin Approach also emphasise the authentic participation of a variety of public and private stakeholders [77–79]. However, how to engage stakeholders and citizens is a key challenge in many contexts. 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. [25,27,80]). 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 solely through 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 citizens' 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 viewed as a form of collaborative research [81,82]. Sy et al. [83] 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 [82]. In turn, a better understanding results in a higher level of awareness [84]. 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' [84]. Thus, citizen science can be seen as a valuable form of citizen engagement (condition 4) through which awareness, knowledge, and transparency (conditions 1 and 2) on pluvial flooding can be enhanced.

In addition to citizen science, citizens may be further engaged in addressing pluvial flooding by taking measures on their private properties. These initiatives include, for example, the decoupling of rainwater from the sewer system, placing rain barrels, removing pavements, or installing a green roof (e.g. [25,27,85]). As our study shows, the implementation of these property-level protection measures (i.e. 'coproduction') often takes place after the occurrence of pluvial floods or solely in flood-prone areas. To address pluvial flooding more effectively, it is crucial to shift towards proactive actions, instead of reactive behaviour.

It has been suggested that involving citizens in decision-making processes is time-consuming and involves higher costs for the government [30,86]. However, the costs do not outweigh the positive effects of citizen participation, such as gaining legitimacy of decisions, trust-building, and learning from citizens [86]. 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. [87] conclude that the scale of flood events and their impacts also relate to the extent to which people are open to adaptation measures. In other words, a large-scale flood event results in more citizens who might consider implementing adaptation measures on their property. Furthermore, Torgersen and Navrud [88] stress that citizens in high-risk flood areas have a greater willingness to pay for adaptation measures. Besides, Henstra, et al. [89] 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 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. [90] conducted a comparative study on the installation of green roofs and concluded that hierarchical arrangements (steering through regulations) are the most effective. However, local governments should play a facilitating role in supporting citizens [85]. Hence, a well-balanced use of both soft and hard policy instruments seems key. For instance, Kamperman and Biesbroek [91] advocate for a combination of 'hard' and 'soft' modes, because the existing Dutch regional water authorities' strategy of soft policies seems to be insufficient to spur climate change adaptation.

This research may support this finding. One 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 practices (i.e. adaptation measures of fellow citizens) may contribute to getting citizen engagement off the ground in practice. Further research may be required through various neighbourhood experiments where different combinations of 'soft' and 'hard' measures are applied. In such an experimental setting, behaviour influencing tactics, other than just information transfer, should be tested to develop an optimal package that triggers citizen engagement in climate adaptation measures both in home and within their city. In such an experimental approach, different citizen groups could be identified based on their socio-economic characteristics, behaviours, and attitudes with respect to climate adaptation. Engagement of each of these groups could be effectively triggered by a different approach. Such experimental knowledge seems promising for obtaining valuable knowledge to effectively engage citizens and trigger climate adaptive behaviour.

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 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 against pluvial flooding. Residents in Utrecht are currently insufficiently engaged in the local decision-making processes, 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 rarely take climate adaptation measures to alleviate the risk of pluvial flooding. The city of Utrecht might consider: (1) Including citizens more explicitly in the decision-making process regarding (pluvial) flood risk management; and (2) broadening 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 creating such initiatives to establish more meaningful citizen engagement, Utrecht's capacity to govern pluvial flood risk can be strengthened 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 be of value for them as well.

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References

1. Intergovernmental Panel on Climate Change. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; IPCC: Geneva, Switserland, 2014; p. 151.
2. Kreibich, H.; Seifert, I.; Thieken, A.H.; Lindquist, E.; Wagner, K.; Merz, B. Recent changes in flood preparedness of private households and businesses in Germany. *Reg. Environ. Chang.* **2011**, *11*, 59–71, doi:10.1007/s10113-010-0119-3.
3. Hartmann, T. *Clumsy Floodplains—Responsive Land Policy for Extreme Floods*; Ashgate: Farnham Surrey, UK, 2011.

4. EEA. *Urban Adaptation to Climate Change in Europe: Challenges and Opportunities for Cities Together with Supportive National and European Policies*; EEA Report No 2/2012; EEA: Copenhagen, Denmark, 2012.
5. Zhou, Q. A Review of Sustainable Urban Drainage Systems Considering the Climate Change and Urbanization Impacts. *Water* **2014**, *6*, 976–992.
6. Dai, L.; Wörner, R.; van Rijswick, H.F.M.W. Rainproof cities in the Netherlands: Approaches in Dutch water governance to climate-adaptive urban planning. *Int. J. Water Resour. Dev.* **2018**, *34*, 652–674, doi:10.1080/07900627.2017.1372273.
7. Gaitan, S.; van de Giesen, N.C.; Ten Veldhuis, J.A.E. Can urban pluvial flooding be predicted by open spatial data and weather data? *Environ. Model. Softw.* **2016**, *85*, 156–171, doi:10.1016/j.envsoft.2016.08.007.
8. Runhaar, H.A.C.; Uittenbroek, C.J.; van Rijswick, H.F.M.W.; Mees, H.L.P.; Driessen, P.P.J.; Gilissen, H.K. Prepared for climate change? A method for the ex-ante assessment of formal responsibilities for climate adaptation in specific sectors. *Reg. Environ. Chang.* **2016**, *16*, 1389–1400, doi:10.1007/s10113-015-0866-2.
9. Liu, L.; Jensen, M.B. Climate resilience strategies of Beijing and Copenhagen and their links to sustainability. *Water Policy* **2017**, *19*, 997–1013, doi:10.2166/wp.2017.165.
10. Mikovits, C.; Rauch, W.; Kleidorfer, M. Dynamics in Urban Development, Population Growth and their Influences on Urban Water Infrastructure. *Procedia Eng.* **2014**, *70*, 1147–1156, doi:10.1016/j.proeng.2014.02.127.
11. EEA. *Climate Change, Impacts and Vulnerability in Europe 2016: An Indicator-Based Report*; EEA Report No 1/2017; EEA: Copenhagen, Denmark, 2017.
12. Tscheikner-Gratl, F.; Hammerer, M.; Rauch, W.; Kleidorfer, M. Integrated Rehabilitation management for different infrastructure sectors. In *Coecor. Ceocor, Florence*; DIV Deutscher Industrieverlag GmbH: München, Germany, 2013; pp. 1–18.
13. Koop, S.H.A.; van Leeuwen, C.J. The challenges of water, waste and climate change in cities. *Environ. Dev. Sustain.* **2017**, *19*, 385–418, doi:10.1007/s10668-016-9760-4.
14. Koop, S.H.A.; van Leeuwen, C.J. Application of the Improved City Blueprint Framework in 45 Municipalities and Regions. *Water Resour. Manag.* **2015**, *29*, 4629–4647, doi:10.1007/s11269-015-1079-7.
15. Johnson, C.L.; Priest, S.J. Flood Risk Management in England: A Changing Landscape of Risk Responsibility? *Int. J. Water Resour. Dev.* **2008**, *24*, 513–525, doi:10.1080/07900620801923146.
16. Wiering, M.; Green, C.; van Rijswick, M.; Priest, S.; Keessen, A. The rationales of resilience in English and Dutch flood risk policies. *J. Water Clim. Chang.* **2014**, *6*, 38–54, doi:10.2166/wcc.2014.017.
17. Mees, H.; Crabbé, A.; Alexander, M.; Kaufmann, M.; Bruzzone, S.; Lévy, L.; Lewandowski, J. Coproducing flood risk management through citizen involvement: Insights from cross-country comparison in Europe. *Ecol. Soc.* **2016**, *21*, doi:10.5751/ES-08500-210307.
18. Penning-Rowsell, E.; Johnson, C.; Tunstall, S. 'Signals' from pre-crisis discourse: Lessons from UK flooding for global environmental policy change? *Glob. Environ. Chang.* **2006**, *16*, 323–339, doi:10.1016/j.gloenvcha.2006.01.006.
19. Meijerink, S.; Dicke, W. Shifts in the Public–Private Divide in Flood Management. *Int. J. Water Resour. Dev.* **2008**, *24*, 499–512, doi:10.1080/07900620801921363.
20. Forrest, S.; Trell, E.-M.; Woltjer, J. Civil society contributions to local level flood resilience: Before, during and after the 2015 Boxing Day floods in the Upper Calder Valley. *Trans. Inst. Br. Geogr.* **2019**, *44*, 422–436, doi:10.1111/tran.12279.
21. Mees, H. Local governments in the driving seat? A comparative analysis of public and private responsibilities for adaptation to climate change in European and North-American cities. *J. Environ. Policy Plan.* **2017**, *19*, 374–390, doi:10.1080/1523908X.2016.1223540.
22. OECD. *Stakeholder Engagement for Inclusive Water Governance*; OECD Publishing: Paris, France, 2015.
23. Wehn, U.; Rusca, M.; Evers, J.; Lanfranchi, V. Participation in flood risk management and the potential of citizen observatories: A governance analysis. *Environ. Sci. Policy* **2015**, *48*, 225–236, doi:10.1016/j.envsci.2014.12.017.
24. Driessen, P.P.J.; Hegger, D.L.T.; Kundzewicz, Z.W.; Van Rijswick, H.F.M.W.; Crabbé, A.; Larrue, C.; Matczak, P.; Pettersson, M.; Priest, S.; Suykens, C.; et al. Governance strategies for improving flood resilience in the face of climate change. *Water* **2018**, *10*, 1595.
25. Hegger, D.L.T.; Mees, H.L.P.; Driessen, P.P.J.; Runhaar, H.A.C. The Roles of Residents in Climate Adaptation: A systematic review in the case of the Netherlands. *Environ. Policy Gov.* **2017**, *27*, 336–350, doi:10.1002/eet.1766.

26. Brink, E.; Wamsler, C. Citizen engagement in climate adaptation surveyed: The role of values, worldviews, gender and place. *J. Clean. Prod.* **2019**, *209*, 1342–1353, doi:10.1016/j.jclepro.2018.10.164.
27. Klein, J.; Araos, M.; Karimo, A.; Heikkinen, M.; Ylä-Anttila, T.; Juhola, S. The role of the private sector and citizens in urban climate change adaptation: Evidence from a global assessment of large cities. *Glob. Environ. Chang.* **2018**, *53*, 127–136, doi:10.1016/j.gloenvcha.2018.09.012.
28. Wamsler, C.; Pauleit, S. Making headway in climate policy mainstreaming and ecosystem-based adaptation: Two pioneering countries, different pathways, one goal. *Clim. Chang.* **2016**, *137*, 71–87, doi:10.1007/s10584-016-1660-y.
29. Wamsler, C. From Risk Governance to City–Citizen Collaboration: Capitalizing on individual adaptation to climate change. *Environ. Policy Gov.* **2016**, *26*, 184–204, doi:10.1002/eet.1707.
30. Brink, E.; Wamsler, C. Collaborative Governance for Climate Change Adaptation: Mapping citizen–municipality interactions. *Environ. Policy Gov.* **2018**, *28*, 82–97, doi:10.1002/eet.1795.
31. OECD. *Water Governance in the Netherlands: Fit for the Future?* OECD Publishing: Paris, France, 2014.
32. Koop, S.; Monteiro Gomes, F.; Schoot, L.; Dieperink, C.; Driessen, P.; Van Leeuwen, K. Assessing the Capacity to Govern Flood Risk in Cities and the Role of Contextual Factors. *Sustainability* **2018**, *10*, 2869.
33. Bubeck, P.; Botzen, W.J.W.; Aerts, J.C.J.H. A Review of Risk Perceptions and Other Factors that Influence Flood Mitigation Behavior. *Risk Anal.* **2012**, *32*, 1481–1495, doi:10.1111/j.1539-6924.2011.01783.x.
34. Cernesson, F.; Echavarren, J.M.; Enserink, B.; Kranz, N.; Maestu, J.; Maurel, P.; Mostert, E.; Otter, H.; Patel, M.; Ridder, D.; et al. *Learning Together to Manage Together. Improving Participation in Water Management*; Harmonising Collaborative Planning (HarmoniCOP): Onasbrück, Germany, 2005; p. 99.
35. Plummer, R.; Crona, B.; Armitage, D.R.; Olsson, P.; Tengö, M.; Yudina, O. Adaptive Comanagement: A Systematic Review and Analysis. *Ecol. Soc.* **2012**, *17*, doi:10.5751/ES-04952-170311.
36. Emerson, K.; Nabatchi, T.; Balogh, S. An Integrative Framework for Collaborative Governance. *J. Public Adm. Res. Theory* **2011**, *22*, 1–29, doi:10.1093/jopart/mur011.
37. Patterson, J.J.; Smith, C.; Bellamy, J. Understanding enabling capacities for managing the 'wicked problem' of nonpoint source water pollution in catchments: A conceptual framework. *J. Environ. Manag.* **2013**, *128*, 441–452, doi:10.1016/j.jenvman.2013.05.033.
38. Moser, S.C.; Ekstrom, J.A. A framework to diagnose barriers to climate change adaptation. *Proc. Natl. Acad. Sci. USA* **2010**, *107*, 22026–22031, doi:10.1073/pnas.1007887107.
39. Gupta, J.; Termeer, C.; Klostermann, J.; Meijerink, S.; van den Brink, M.; Jong, P.; Nooteboom, S.; Bergsma, E. The Adaptive Capacity Wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environ. Sci. Policy* **2010**, *13*, 459–471, doi:10.1016/j.envsci.2010.05.006.
40. European Commission. European Innovation Partnership on Water. Indicators of the Governance Capacity Framework. Availabe online: https://www.eip-water.eu/sites/default/files/Indicators%20of%20the%20Water%20Governance%20Capacity%20Framework_0.pdf (accessed on 20 May 2019).
41. Alexander Ballard Ltd. *Adaptive Capacity Benchmarking: A Handbook and Toolkit*; Alexander Ballard Ltd.: Berkshire, UK, 2008.
42. Engle, N.L.; Lemos, M.C. Unpacking governance: Building adaptive capacity to climate change of river basins in Brazil. *Glob. Environ. Chang.* **2010**, *20*, 4–13, doi:10.1016/j.gloenvcha.2009.07.001.
43. Haus, M.; Heinelt, H.; Stewart, M. *Urban Governance and Democracy: Leadership and Community Involvement*; Routledge: London, UK, 2004; doi:10.4324/9780203340950.
44. Yang, K.; Callahan, K. Assessing citizen involvement efforts by local governments. *Public Perform. Manag. Rev.* **2005**, *29*, 191–216.
45. Koop, S.H.A.; Koetsier, L.; Doornhof, A.; Reinstra, O.; Van Leeuwen, C.J.; Brouwer, S.; Dieperink, C.; Driessen, P.P.J. Assessing the Governance Capacity of Cities to Address Challenges of Water, Waste, and Climate Change. *Water Resour. Manag.* **2017**, *31*, 3427–3443, doi:10.1007/s11269-017-1677-7.
46. Raaijmakers, R.; Krywkow, J.; van der Veen, A. Flood risk perceptions and spatial multi-criteria analysis: An exploratory research for hazard mitigation. *Nat. Hazards* **2008**, *46*, 307–322, doi:10.1007/s11069-007-9189-z.
47. Rowley, J. The wisdom hierarchy: Representations of the DIKW hierarchy. *J. Inf. Sci.* **2007**, *33*, 163–180, doi:10.1177/0165551506070706.

48. Pahl-Wostl, C. A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Glob. Environ. Chang.* **2009**, *19*, 354–365, doi:10.1016/j.gloenvcha.2009.06.001.
49. Brown, R.R.; Farrelly, M.A. Delivering sustainable urban water management: A review of the hurdles we face. *Water Sci. Technol.* **2009**, *59*, 839–846, doi:10.2166/wst.2009.028.
50. Brouwer, S.; Biermann, F. Towards adaptive management: Examining the strategies of policy entrepreneurs in Dutch water management. *Ecol. Soc.* **2011**, *16*, doi:10.5751/ES-04315-160405.
51. Folke, C.; Hahn, T.; Olsson, P.; Norberg, J. Adaptive governance of social-ecological systems. *Annu. Rev. Environ. Resour.* **2005**, *30*, 441–473, doi:10.1146/annurev.energy.30.050504.144511.
52. Mees, H.L.; Dijk, J.; van Soest, D.; Driessen, P.P.; van Rijswick, M.H.; Runhaar, H. A method for the deliberate and deliberative selection of policy instrument mixes for climate change adaptation. *Ecol. Soc.* **2014**, *19*, 58.
53. Schreurs, E.; Koop, S.; van Leeuwen, K. Application of the City Blueprint Approach to assess the challenges of water management and governance in Quito (Ecuador). *Environ. Dev. Sustain.* **2018**, *20*, 509–525, doi:10.1007/s10668-017-9916-x.
54. Šteflová, M.; Koop, S.; Elelman, R.; Vinyoles, J.; Van Leeuwen, K. Governing Non-Potable Water-Reuse to Alleviate Water Stress: The Case of Sabadell, Spain. *Water* **2018**, *10*, 739.
55. Aartsen, M.; Koop, S.; Hegger, D.; Goswami, B.; Oost, J.; Van Leeuwen, K. Connecting water science and policy in India: Lessons from a systematic water governance assessment in the city of Ahmedabad. *Reg. Environ. Chang.* **2018**, *18*, 2445–2457, doi:10.1007/s10113-018-1363-1.
56. Kim, H.; Son, J.; Lee, S.; Koop, S.; Van Leeuwen, K.; Choi, Y.J.; Park, J. Assessing Urban Water Management Sustainability of a Megacity: Case Study of Seoul, South Korea. *Water* **2018**, *10*, 682.
57. Feingold, D.; Koop, S.; van Leeuwen, K. The City Blueprint Approach: Urban water management and governance in cities in the U.S. *Environ. Manag.* **2018**, *61*, 9–23, doi:10.1007/s00267-017-0952-y.
58. Madonsela, B.; Koop, S.; van Leeuwen, K.; Carden, K. Evaluation of Water Governance Processes Required to Transition towards Water Sensitive Urban Design—An Indicator Assessment Approach for the City of Cape Town. *Water* **2019**, *11*, 292.
59. DFID. *Tools for Development: A Handbook for Those Engaged in Development Activities*; DFID: London, UK, 2003.
60. Van Schaik, M.; Boelhouwer, G.; Harms, M. *Plan van Aanpak Ruimtelijke Adaptatie*; Coalitie Regio Utrecht: Utrecht, The Netherlands, 2016.
61. Brockhoff, R.C. *Pluvial Flooding in Utrecht: On Its Way to a Water-Wise City*; Utrecht University: Utrecht, The Netherlands, 2018.
62. WistUdata Utrecht. Municipal Database. Availabe online: https://wistudata.nl/ (accessed on 2 May 2019).
63. Statistics Netherlands. StatLine Database. Availabe online: www.cbs.nl (accessed on 6 May 2019).
64. Wateroverlast Voorkomen: Waterproof030. Availabe online: https://www.utrecht.nl/wonen-en-leven/duurzame-stad/wateroverlast-voorkomen/ (accessed on 10 July 2019).
65. Janssen, I.; van Lochem, J.B. *Sustainability Report 2018. Duurzaamheidsverslag 2018*; Municipality of Utrecht: Utrecht, The Netherlands, 2019.
66. Climatic Stress Test Utrecht. Availabe online: https://livinglabutrecht.maps.arcgis.com/apps/MapSeries/index.html?appid=3242b2dbca544f99a714abc1f63aeefe&entry=2 (accessed on 20 May 2019).
67. Willemsen, C. Utrechtse Bankstraat aan de Regenton, Dankzij Ellen. Availabe online: https://www.ad.nl/utrecht/utrechtse-bankstraat-aan-de-regenton-dankzij-ellen~af4570d1/ (accessed on 2 May 2019).
68. Online Manual Waterproof Dwellings. *Waterproof: Handleiding Maatregelen aan de Woning en Tuin Tegen Wateroverlast*; Municipality of Utrecht: Utrecht, The Netherlands, 2016.
69. *Delta Programme 2019. Continuing the Work on the Delta: Adapting the Netherlands to Climate Change in Time*; Ministry of Infrastructure and Water Management, the Ministry of Agriculture, Nature, and Food Quality, and the Ministry of the Interior and Kingdom Relations: The Hague, The Netherlands, 2018; p. 119.
70. Meindertsma, B.; van der Parre, H. Burgers Met Natte Voeten kijken Naar Overheid, Maar Willen Niet Meer Betalen. Availabe online: https://nos.nl/artikel/2230728-burgers-met-natte-voeten-kijken-naar-overheid-maar-willen-niet-meer-betalen.html (accessed on 29 April 2019).

71. Commission Adjustment Tax System (Commissie Aanpassing Belastingstelsel). Een Stevige Basis Voor de Toekomst: De Nieuwe Waterschapsbelastingen. Availabe online: https://www.uvw.nl/wp-content/uploads/2018/06/Eindrapport-Commissie-Aanpassing-Belastingstelsel.pdf (accessed on 19 May 2019).
72. Glucker, A.N.; Driessen, P.P.J.; Kolhoff, A.; Runhaar, H.A.C. Public participation in environmental impact assessment: Why, who and how? *Environ. Impact Assess. Rev.* **2013**, *43*, 104–111, doi:10.1016/j.eiar.2013.06.003.
73. Pahl-Wostl, C.; Nilsson, C.; Gupta, J.; Tockner, K. Societal learning needed to face the water challenge. *Ambio* **2011**, *40*, 549–553, doi:10.1007/s13280-011-0149-1.
74. Ernst, L.; de Graaf-Van Dinther, R.; Peek, G.-J.; Loorbach, D. Sustainable urban transformation and sustainability transitions; conceptual framework and case study. *J. Clean. Prod.* **2016**, *112*, 2988–2999.
75. Mees, H.-L.P.; Driessen, P.P. Adaptation to climate change in urban areas: Climate-greening London, Rotterdam, and Toronto. *Clim. Law* **2011**, *2*, 251–280.
76. Vijayaraghavan, K. Green roofs: A critical review on the role of components, benefits, limitations and trends. *Renew. Sustain. Energy Rev.* **2016**, *57*, 740–752, doi:10.1016/j.rser.2015.12.119.
77. UN-Water. Coordinating the UN's Work on Water and Sanitation. Availabe online: www.unwater.org/about-unwater/ (accessed on 6 June 2019).
78. Medema, W.; McIntosh, B.; Jeffrey, P. From premise to practice: A critical assessment of integrated water resources management and adaptive management approaches in the water sector. *Ecol. Soc.* **2008**, *13*, 29.
79. Rahaman, M.M.; Varis, O. Integrated water resources management: Evolution, prospects and future challenges. *Sustain. Sci. Pract. Policy* **2005**, *1*, 15–21.
80. Begg, C.; Callsen, I.; Kuhlicke, C.; Kelman, I. The role of local stakeholder participation in flood defence decisions in the United Kingdom and Germany. *J. Flood Risk Manag.* **2018**, *11*, 180–190, doi:10.1111/jfr3.12305.
81. Kullenberg, C.; Kasperowski, D. What Is Citizen Science?—A Scientometric Meta-Analysis. *PLoS ONE* **2016**, *11*, e0147152, doi:10.1371/journal.pone.0147152.
82. Bonney, R.; Phillips, T.B.; Ballard, H.L.; Enck, J.W. Can citizen science enhance public understanding of science? *Public Underst. Sci.* **2016**, *25*, 2–16, doi:10.1177/0963662515607406.
83. Sy, B.; Frischknecht, C.; Dao, H.; Consuegra, D.; Giuliani, G. Flood hazard assessment and the role of citizen science. *J. Flood Risk Manag.* **2018**, e12519, doi:10.1111/jfr3.12519.
84. Brouwer, S.; Hessels, L.K. Increasing research impact with citizen science: The influence of recruitment strategies on sample diversity. *Public Underst. Sci.* **2019**, *28*, 606–621, doi:10.1177/0963662519840934.
85. Mees, H.L.P.; Uittenbroek, C.J.; Hegger, D.L.T.; Driessen, P.P.J. From citizen participation to government participation: An exploration of the roles of local governments in community initiatives for climate change adaptation in the Netherlands. *Environ. Policy Gov.* **2019**, *29*, 198–208, doi:10.1002/eet.1847.
86. Irvin, R.A.; Stansbury, J. Citizen Participation in Decision Making: Is It Worth the Effort? *Public Adm. Rev.* **2004**, *64*, 55–65, doi:10.1111/j.1540-6210.2004.00346.x.
87. Owusu, S.; Wright, G.; Arthur, S. Public attitudes towards flooding and property-level flood protection measures. *Nat. Hazards* **2015**, *77*, 1963–1978, doi:10.1007/s11069-015-1686-x.
88. Torgersen, G.; Navrud, S. Singing in the rain: Valuing the economic benefits of avoiding insecurity from urban flooding. *J. Flood Risk Manag.* **2018**, *11*, e12338, doi:10.1111/jfr3.12338.
89. Henstra, D.; Thistlethwaite, J.; Brown, C.; Scott, D. Flood risk management and shared responsibility: Exploring Canadian public attitudes and expectations. *J. Flood Risk Manag.* **2019**, *12*, e12346, doi:10.1111/jfr3.12346.
90. Mees, H.L.P.; Driessen, P.P.J.; Runhaar, H.A.C.; Stamatelos, J. Who governs climate adaptation? Getting green roofs for stormwater retention off the ground. *J. Environ. Plan. Manag.* **2013**, *56*, 802–825, doi:10.1080/09640568.2012.706600.
91. Kamperman, H.; Biesbroek, R. Measuring Progress on Climate Change Adaptation Policy by Dutch Water Boards. *Water Resour. Manag.* **2017**, *31*, 4557–4570, doi:10.1007/s11269-017-1765-8.