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Assessing the capacity to govern flood risk in cities and the role of contextual factors

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Abstract
Sea level rise and increased storm events, urge cities to develop governance capacity. However, a cohesive conceptual and empirical-based understanding of what governance capacity implies, how to measure it, and what cities can learn, is largely lacking. Understanding the influence of context is critical to address this issue. Accordingly, we aim to identify crosscutting contextual factors and their influence in impeding, enhancing or prioritising different elements of governance capacity to address urban flood risk. By assessing governance capacity through nine conditions and 27 indicators in two Dutch and two cities in the UK, three crosscutting contextual factors are identified: 1) flood probability and impact, 2) national imposed institutional setting, and 3) level of authority to secure long-term financial support. We found that contextual factors explain differences in urban capacity-priorities within and between both countries. The institutional setting in the UK and recent political devolution emphasized the role of citizen awareness, stakeholder engagement, entrepreneurial agents, and the overall necessity for local capacity-development. The Dutch focus on flood safety through centralised public coordination reduces flood probability but also inhibits incentives to reduce flood impacts and reduced public awareness. In conclusion, the three identified contextual factors enable a better understanding of capacity-building priorities.

Keywords: Water Governance; Governance Capacity; Comparative Studies; Urban Flooding; contextual factors

1. Introduction

Water challenges are becoming ever more pending in a world of rapid population growth, depleting resources and increasing climate change impacts [1]. Even if all countries implement their intended contribution to reduce GHG-emissions, as agreed at the Paris climate agreement, warming is projected to reach 2.7°C above pre-industrial levels by 2100 [2]. Hence, it is generally recognised that it is impossible to live in a world without substantial climate adaptation. As a consequence, the sense of urgency to adapt to climate change has been highlighted both by academia and cities [e.g. 3,4]. One of the largest climate threats is flood risk. A large proportion of the human settlements are in river catchments, deltas and coastal areas. In fact, about 15% of the global population – including almost all megacities – are under threat as a consequence of combined impacts of sea-level rise, river flooding and human pressure, while storm events are expected to increase both in frequency and magnitude.

Flood challenges transcend administrative boundaries. Typically, multiple governance layers and a variety of stakeholders, sectors, and policies are involved, each with different responsibilities, interests and time horizons [5]. Because of the nature of these challenges, the governance capacity of public and private actors to collaborate is often much more

decisive than the role of single organizations or institutions. The literature on climate adaptation, water governance and adaptive capacity has identified a plethora of barriers, enablers and conditions that influence the problem-solving capability of the public and private sectors [e.g. 3,6,7]. However, despite the valuable insights provided by these studies, the body of literature has arguably not yet established sufficient conceptual coherence to empirically validate the large number of theoretical premises. First, many identified conditions are predominantly based on theoretical considerations that are not sufficiently supported by empirical findings [7,8,9]. Second, the definitions of these identified barriers, enablers and conditions are often neither made explicit, nor is it clear how they are operationalized, measured, and how they relate to one another [6,8]. Third, many barriers or enablers apply within the context of individual case studies often without considerable efforts to identify general patterns or transferable lessons [7,10].

Both impasses and opportunities result from many interconnected processes with often unforeseen effects which cannot be explained by a single barrier or event [11]. In order to understand dynamic governance mechanisms, it is therefore necessary to consider a broader range of conditions that together form the capacity to address water governance challenges. Moreover, governance processes consist of actors' interactions that are by definition complex, unpredictable, and susceptible to external social, economic and environmental developments. As a consequence, governance capacity in itself does not guarantee effective change, but rather is a precondition or enabler. Accordingly, we define water governance capacity as "the key set of conditions that should be developed to enable change that will be effective in finding dynamic solutions for flood governance challenges" [12].

Conceptual definitions generally establish themselves through repeated testing, evaluations and refinements. Accordingly, the notion of governance capacity can be considered as the product of a conceptual integration of empirical knowledge from many different case studies and theoretical debates. Therefore, the concept of governance capacity is, in an implicit manner, a rationale that has to be derived from comparative analyses. In order to do so, a coherent, empirical-based diagnostic framework is required that can be used to assess existing governance capacities in different urban contexts. In this way, a database can be developed that can be used to identify overarching patterns and transferable lessons across a range of case studies while, at the same time, facilitate our understanding of cause-effect relations in detail through individual cases. Such a mutual purpose requires a thorough understanding of how contextual factors influence the governance capacity. However, it is not well-understood in what way governance capacity is influenced by context and which contextual factors account for differences between city's flood risk governance [6,7,11].

In this paper we aim to contribute to a better understanding of the context-specific capacity development priorities of urban flood risk governance in the United Kingdom (UK) and the Netherlands. Second aim is to explore crosscutting contextual factors that may explain the observed differences. In order to fulfil this research aim, a comparative case-study approach will be applied in four cities in both countries. Section 2 provides the conceptual framework behind the analysis of governance capacity that will be applied in this paper. Section 3 first provides a rationale for the selection of the four case-study cities. Second, the data collection methods are provided. In section 4, the case study results are presented and crosscutting contextual factors that may impede, enhance or prioritise different elements of governance capacity are explored. Section 5 discusses other potential context factors and the implications of the identified contextual factors for interpreting governance capacity analyses in other cities. We end with the conclusions in section 6.

2. A framework to analyse context-specific governance capacities

Based on an extensive literature review, Koop et al. [12] developed a diagnostic framework in order to coherently assess the most important conditions that together determine the capacity of cities to govern water challenges. This empirical-based Water Governance Capacity Framework (GCF) consists of three dimensions: knowing, wanting, and enabling (Table 1). The "knowing" dimension refers to the need of involved actor's to be aware, understand, and learn about the risks and impacts of strategic choices and policy. In this dimension, the level of awareness (condition 1), existence of useful knowledge (condition 2) and the network's ability to continuously learn (condition 3) are being assessed. The "wanting" dimension relates to the necessity that actors commit, cooperate, act upon ambitions and use their skills to find solutions. More specifically, the stakeholder engagement process (condition 4), management ambition (condition 5) and the role of agents of change (condition 6) are being assessed. Finally, the "enabling" dimension analyses the network potential to address water challenges (condition 7), the financial viability (condition 8), and existing policy instruments that actors require to realise their ambitions (condition 9: implementing capacity).

The relative importance of these local governance conditions are influenced by more broader national and international social, environmental or economic factors beyond the city's sphere of influence. For example, international, national and regional policies may largely determine the city's means to act. Moreover, the extent and nature of flood risk challenges may differ considerably between urban areas. In addition, 2008's global financial crisis may have affected the availability of financial resources to address flood risk. Finally, cultural components such as public environmental risk perception may be an important contextual component as well that can rearrange priorities for capacity-development or pose important windows of opportunity [13,14].

3. Methods

3.1 Case study selection

In order to better understand the context-specific governance capacity development priorities of urban flood risk governance, two countries with 1) considerable flood vulnerability and 2) with a long track record in flood risk management, have been selected: the UK and the Netherlands. In both countries, two cities have been selected that resemble the flood risk challenges and exemplify the policy efforts of their country. In the UK, Milton Keynes (261,800 inhabitants) and Leicester (394,000 inhabitants) have been selected. Like most other flood prone cities in the UK, both cities are vulnerable for river flooding and inundation of urban areas due to rainfall runoff. In the Netherlands, Rotterdam (638,000 inhabitants) and Amsterdam (833,624 inhabitants) were selected. As for at least 25% of the Netherlands, both cities are situated below sea level and potentially exposed to sea flooding, river flooding and inundation due to rainfall runoff. In both countries an 'old' city and a 'new' city were selected to better represent the diversity within both countries. The 'old' cities of Leicester and Amsterdam both have an historic city centre and high population densities (respectively 4.494 people km^{-2} and 5,042 people km^{-2}) that complicate the implementation of physical flood risk measures. On the other hand, the 'new' cities of Milton Keynes and Rotterdam have lower population densities (respectively 2,584 people km^{-2} and 2,920 people km^{-2}) which result in greater flexibility to adapt urban infrastructure to cope with flood risks. As experiences with recent flood events is an important determinant for adaptation efforts [e.g. 15,16], all four selected cities did not experience any significant flood events in the last decades. The EU Water Framework Directive (WFD) applies to all four cities and the cities are more or less equally affected by the 2008 financial crisis. Furthermore, climate change mitigation and adaptation have become a central theme in the national policy [17].

3.2 Data collection

Each of the nine conditions that constitute the governance capacity analysis comprise of three indicators. Each indicator has a pre-defined question and with its own Likert scoring system that ranges from very encouraging (++) to very limiting (--) the overall governance capacity. The scoring system is publicly available [18]. By providing arguments and references, the indicator's scores and pre-defined questions were substantiated. A triangular approach has been applied in all four case studies in order to validate findings by different sources through three consecutive steps:

1. **Preparatory desk study**: A desk study of primary sources such as governmental reports, legal documents and secondary sources such as scientific literature, websites, newspapers, etcetera, resulted in a substantiated preliminary score for each indicator.
2. **Stakeholder selection & interviews**: Stakeholders were identified, categorized, and their responsibilities, relations and main interactions were mapped in order to select a range of stakeholders that include the largest variety of interests. At least one stakeholder that respectively represents the government, the market and civil society has been included as suggested by Lange et al. [20]. We also included at least one knowledge institute or university. In many cases, multiple persons from the identified key stakeholders were selected with different roles, areas of expertise, and responsibilities in order to minimize the risk of bias and unravel socially desirable responses. In total 30 in-depth interviews were conducted. The scores were determined based on the preparatory desk study, interviews and additional collection of reliable and accessible information that may ratify or provides nuance to the interview findings.
3. **Verifying findings**: The overall results have been checked by asking feedback from all interviewees. After incorporation of this feedback, the final scores were determined.

Based on the GCF analyses, the indicator scores that mostly differed between the four cities, were examined more closely in order to explore crosscutting contextual factors to explain these differences. In each of the previously mentioned interviews national contextual differences between the UK and the Netherlands have been explored as well. In addition, flood management related documentation in both countries has been studied (documents such as the Pitt review [19] in the UK and the Delta Programme [20] in the Netherlands) and a detailed analysis of local, regional, national and international policies related to flood risk management has been performed.

4. Results

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In section 4.3, crosscutting contextual factors are explored that may impede, enhance or prioritise different elements of governance capacity.

Table 1 shows the overall results of the GCF analyses. Section 4.1 will present the national flood risk management context in the UK, followed by the results of the city of Milton Keynes and Leicester. In section 4.2, the national flood risk management context of the Netherlands is provided, followed by the results of the cities of Rotterdam and Amsterdam. In section 4.3, crosscutting contextual factors are explored that may impede, enhance or prioritise different elements of governance capacity.

Table 1 Overview of the governance conditions and associated indicators in Milton Keynes, Leicester, Rotterdam and Amsterdam. The scores range from very encouraging (++) to very limiting (- -) the governance capacity to address the city's flood risk challenge.

Conditions	Indicators	England		The Netherlands	
		Milton Keynes	Leicester	Rotterdam	Amsterdam
1 Awareness	1.1 Community knowledge	-	0	0	0
	1.2 Local sense of urgency	-	+	+	++
	1.3 Behavioural internalization	0	+	0	++
2 Useful knowledge	2.1 Information availability	+	+	++	++
	2.2 Information transparency	++	+	+	0
	2.3 Knowledge cohesion	0	+	++	0
3 Continuous learning	3.1 Smart monitoring	0	+	0	++
	3.2 Evaluation	+	+	0	++
	3.3 Cross-stakeholder learning	0	+	0	++
4 Stakeholder engagement process	4.1 Stakeholder inclusiveness	+	0	++	++
	4.2 Protection of core values	0	0	+	++
	4.3 Progress and variety of options	0	0	+	++
5 Management ambition	5.1 Ambitious and realistic management	++	+	++	+
	5.2 Discourse embedding	0	0	++	+
	5.3 Management cohesion	0	0	+	+
6 Agents of change	6.1 Entrepreneurial agents	-	0	+	+
	6.2 Collaborative agents	0	0	0	+
	6.3 Visionary agents	0	+	+	++
7 Multi-level network potential	7.1 Room to manoeuvre	0	0	0	+
	7.2 Clear division of responsibilities	0	0	+	++
	7.3 Authority	-	0	++	++
8 Financial viability	8.1 Affordability	++	+	+	+
	8.2 Consumer willingness to pay	0	0	0	+
	8.3 Financial continuation	0	0	++	+
9 Implementing capacity	9.1 Policy instruments	0	0	++	+
	9.2 Statutory compliance	0	+	++	++
	9.3 Preparedness	0	+	+	+

4.1 Flood risk governance in the UK

The UK has a long history in flood events, mainly with respect to rivers bursting their banks, as well as local water nuisance due to unsustainable drainage systems. The UK has a risk-

based approach with a recognition that floods cannot be fully prevented [22]. In this context, citizens and property owners are considered to have a fundamental role. For example, the UK's private flood risk insurance system appeals to individuals being aware of their flood risk and taking action to protect their property [23,24]. The summer floods of 2007 proved to be a determining event. Between May and July, the highest rainfall intensity was recorded since records started in 1766 [25]. About 55,000 properties were inundated along the major rivers Severn, Don and Thames. The total damage amounted to £4 billion [26]. A review led by Sir Michael Pitt [19] identified that a lack of clarity over which organisations were responsible for surface flooding and emergency action led to contrasting and uncoordinated messages. Moreover, flood impact data was found to be fragmented and replicated. Consequently, the Pitt review called for a permanent centralised coordinating body. As a result, the Government's Department for Environment, Food and Rural Affairs (DEFRA) took coordinated action [27]. First, the Environment Agency (EA), responsible for the main rivers, coasts and reservoirs, got more authority to maintain a strategic overview [28]. Second, Regional Flood and Coastal Committees (RFCCs) were established. At the regional level the EA is required to consult RFCC and get approval for implementing and expending revenues raised [29]. Third, more power was directed to local authorities through the Lead Local Flood Authority (LLFA). The LLFAs are obliged to develop, maintain, apply and monitor a strategy for local flood risk management of surface runoff, groundwater, and ordinary watercourses within its area [28,29]. The LLFA is required to register flood risk assets, investigate flood incidents and promote Sustainable Drainage systems (SuDS) through close cooperation with the highway authority, local risk management authorities, the regional Internal Drainage Boards (IDBs) and through public consultation. The sewer system is management by private companies who fund their operations through water bills under supervision of Ofwat, the economic regulator for water and sewerage services in England and Wales.

Milton Keynes

Milton Keynes is a designed city and national frontrunner in sustainability and innovation. Of the 261,800 inhabitants, 1,753 properties in the older, lower areas have a high flood risk [30]. The citizens who have recently experienced water nuisance, apply mitigation measures such as walls and airbricks to protect their property (indicator 1.3 behavioural internalisation). However, most citizens have little knowledge or commitment with flood risk challenges (indicators 1.1 community knowledge and 1.2 local sense of urgency; [30]) and are not willing to pay more than they already do (indicator 8.2 consumer willingness to pay). Flood risk information is provided transparently through real-time river and sea levels and flood warnings: https://www.gov.uk/check-flood-risk. The EA flood risk maps are complemented with detailed assessments from the local authorities providing accurate information about current and future flood risks (indicator 2.1 information availability). Moreover, local flood risk prediction maps are available for periods of five days and further ahead and a free flood warning service for house owners and businesses is available: https://www.gov.uk/sign-up-for-flood-warnings (indicator 2.2 information transparency). Milton Keynes' City Council has a coordinative task as LLFA. In their local flood risk management strategy [30], the suggested agreements and goals are realistic and moderately ambitious, taking into account funding limitations. Each objective is translated into three measures, each with intermittent targets that have clear deadlines (indicator 5.1 ambitious and realistic management; [29]). All stakeholder are free to engage in projects and have the opportunity to express their concerns and provide feedback on draft plans through workshops and on paper (indicator 4.1 stakeholder inclusiveness). Different departments within the City Council, are responsible for narrowly defined flood-related tasks, each with different drivers and budget allocations. For example, interests for spatial development can contest flood risk management goals. The division of responsibilities (indicator 7.2) with respect to SuDS is somewhat complex. Highways departments are tasked with ensuring good traffic flow through, amongst others, SuDS. Other actors outside City Council also have an important. Anglian water is tasked with the sewer system. Parks Trust is a charity who takes care of Milton Keynes parks and green spaces and the Bedford Group of IDBs manages the regional drainage system. The

jurisdiction of the IDB is inconsistent with the river catchment, leading to difficulties in both upstream and downstream coordination. Despite many efforts, the fragmented organisational structure leads to limited knowledge cohesion (indicator 2.3) and suboptimal management cohesion (indicator 5.3). Due to recent devolution of political power and cuts in national funding [31], local authorities have to find new funding sources such as local investors. The City Council reviews the funding opportunities every six months. However, this system may reduce financial security for long-term more proactive measures (indicator 8.3 financial continuation). Likewise, the windows of opportunity for entrepreneurial agents (indicator 6.1) to innovate, is also financially limited. Hence, the national imposed institutional setting and financial constraints are considered important contextual factors that impact the local governance capacity.

Leicester

Leicester is situated in the wide flat River Soar valley and is particularly vulnerable to heavy downpours and prolonged periods of rain. From the East and West hills, a number of large watercourses flow quickly towards the River Soar through urban areas. Major developments projects are expected upstream, which could increase the surface water runoff and flood vulnerability. It is estimated that about 1,915 residential and commercial properties are at risk of a 1 in 75 years flood [32]. Leicester therefore recognises the importance that residents understand the causes, risk and impact of their properties being flooded, how to respond to emergencies, and how they can be involved in local decision-making. This is also reflected in the high availability, transparency and cohesion of flood risk information (condition 2 useful knowledge; [33]). In general, differences in culture and language form barriers for people's awareness, preparedness, and their ability to recover from flood events [34]. As one of the most culturally diverse cities in the UK, Leicester allocates much resources to effectively communicate with multicultural communities. For example, flood risk information is translated in multiple languages. It also poses extra challenges to include citizens in the stakeholder engagement process (condition 4). Consultation procedures are clear, adhere to national requirements, and all relevant stakeholders and responsible risk authorities are involved. For example, everyone could provide feedback on the draft local flood risk management strategy through consultation meetings and online platforms. However, citizen involvement heavily depends on a select group of well-informed, non-transient, and often highly educated citizens. Stakeholders can also raise issues themselves in council or ward meetings. However, the level of influence that stakeholders have on the end-result is somewhat limited. Engagement is mainly via consultation and not that frequently through focus groups that co-produce knowledge to explore optimal solutions. Leicester is open for this type of stakeholder engagement, but is also restricted by financial resources. As a result of diminished national funding, Leicester needs to fund flood-defence projects through their own resources, partnership funding or local developers. However, these funding mechanisms may limit the long-term financial security necessary to pro-actively adapt to challenges of climate change and land-use change. Consequently, the role of local individuals that provide a long-term vision, promote initiatives, bring actors together, and mobilize the required local resources, has become critical (indicator 6.1 entrepreneurial agents). The room to manoeuvre (indicator 7.1) that these agents of change need to effectively seize opportunities for new projects and innovations is somewhat limited. The division of responsibilities, interests and tasks are divided over many actors (indicator 7.2 clear division of responsibilities) and pose constraints for the coordination of different policies (indicator 5.3 management cohesion). The EA is responsible for the main river Soar, Leicester City Council (LCC) is the LLFA and is responsible for flood risk and spatial planning. The Leicestershire county and district councils carry out flood risk management works on minor watercourses surrounding the municipality. The water and sewerage company Severn Trent has the duty to maintain the sewer system and drain their area. Successful attempts have been made to integrate the development of green space with flood risk management [35]. However, the flood risk goals are much less synergetic with respect to national targets for housing development that the LCC has to comply with. In terms of contextual factors, the city's vulnerability to heavy downpours and

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prolonged periods of rain requires a high level of citizen awareness to adapt, anticipate and cope with 'unavoidable' flood events. Moreover, a limited national and local flood management authority leads to uncertainties with respect to local financial resources.

4.2 Flood risk governance in the Netherlands

About 55% of the Netherlands is flood prone and about 25% lies below sea level including the country's main economic district and largest cities. In 1953, the levees in the south-eastern delta region were unable to withstand a major storm surge. In total, 1,836 people died, over 2,000 square kilometres of land was flooded, and the damage was estimated at €5.2 billion [36]. In response to this disaster, the national Delta Plan was initiated which included the embankment of the estuaries in the south-eastern areas. The Delta works were designed to prevent such a large-scale disaster to ever happening again. The Delta Plan has a strong emphasis on engineering flood defence structures and is controlled by the national authority "Rijkswaterstaat". The Dutch government fully compensates flood damages. However, a number of river flood incidences in the 1990s changed this dominant discourse. In 1993, the river Meuse burst through its banks and flooded one-fifth of the southern province of Limburg. Moreover, the risk of river flooding led to the largest post-war evacuation of about 80,000 people in 1995. As a consequence the *Room for the Rivers* policy was developed which emphasized the role of spatial planning in dealing with climate change induced extreme weather events. Accordingly, the focus shifted from reducing flood probabilities to reducing flood impacts [37]. The national government's Delta Commission formulates the strategic goals and a financial structure for flood defence and freshwater provision within the Delta Programme. The provinces are responsible for the regional operationalization of these national strategies and to manage groundwater bodies. The Ministry of Infrastructure and Water Management is responsible for protection against the sea, main rivers and canals. The water boards manage the regional water systems. The water boards raise their own public taxes to recover their costs and have their own elected public representatives. Finally, the municipalities have a duty of care regarding the sewer system, rainwater and groundwater which is financed through a specific tax. Due to significant damages of recent storm events and new more extreme climate predictions, the Delta Programme [20] announced extra investments for urban areas. Municipalities are required to perform a '*water stress test'* in order to map their long-term resilience and to identify required action with respect to flooding, drought and heat stress [20].

Rotterdam

Rotterdam is home to 638,000 people and has Europe's biggest port. The city has large flood risk challenges as it is situated below sea level in the Delta of the river Rhine and Meuse, and its main canal 'de Nieuwe Waterweg' is openly connected to the North Sea. Rotterdam has a long tradition of flood risk management and the city's water safety is highly dependent on the national dikes and sea barriers (indicator 5.2 discourse embedding). Rotterdam is one of the safest delta cities in the world. The main responsibilities lie with the municipality, the water boards, and the Dutch government through the Delta Programme. Local policies strictly adhere to national flood risk policies and safety standards [39]. At the local level, the division of responsibility (indicator 7.2) between public and private actors is more determined on a case-by-case fashion. Regular inter-sectorial meetings, in particular between the city's three water boards, the municipality and main businesses in the harbour enable cohesive water management. Nevertheless, inter-sectorial exploration of synergies can be further enhanced (indicator 3.3 cross-stakeholder learning and 5.3 management cohesion). For example through smarter, more integrated monitoring and evaluation of the city's drainage system (indicator 3.1 smart monitoring and 3.2 evaluation). Overall, long-term goals are ambitious and implemented by intermittent targets embedded in various policies (indicator 5.1 ambitious and realistic management; [39,40]). Within Rotterdam's Climate Proof programme, climate adaptation is considered a means for creating employment, social cohesion and citizen engagement, which enhances economic growth. Delta technology and knowhow are referred to as the blue-green economy and are considered as export products.

Investments in a safe and vital infrastructure is expected to attract international investments and to ensure long-term growth and prosperity. There is much room for experimentation. Many small-scale pilots and experiments such as floating houses, farms, hotels and forests are supported by local authorities. Initiatives, such as collective city gardens, nature-based playgrounds and child friendly neighbourhoods, are combined with climate adaptation goals and improve the attractiveness and liveability of Rotterdam. Important climate adaptation projects are realised such as a water square that combines water storage with the improvement of the quality of urban public space and an underground parking lot that can also store excess stormwater. In some cases, more unconventional collaboration with the private sector has been established leading to for example the development of tidal parks along the main canals: the 'Nieuwe Maas' and the 'Nieuwe Waterweg' (indicator 6.2 collaborative agents). Visionary agents (indicator 6.3) who push for long-term, integrated and climate adaptive flood risk management at the political or strategic level are most active at the national scale. In Rotterdam entrepreneurial agents (indicator 6.1) who initiate new concepts, innovations and ideas, are most active. Whilst Rotterdam is not a rich city according to Dutch standards, the municipal and regional taxes are generally being considered affordable (indicator 8.1 affordability). The High Water Protection Programme, which is a part of the Delta fund, ensures funding for water safety measures. An additional benefit of this financial structure is that the municipality saves time and resources otherwise spend on acquisition (indicator 8.3 financial continuation). In the context of high potential flood impact and substantial future challenges, the city is forced to be proactive. In these efforts Rotterdam is strongly supported by the authority of national and regional policy and institutions, which is an important contextual factor that provides the necessary financial resources for Rotterdam to be innovative and proactive.

Amsterdam

Amsterdam is an old and densely populated city with a complex hydrological setting. The city is protected from the North sea, the Lek river, lake Markermeer, and regional water bodies through a complex system of dikes, dams and sluices. The city is connected to the North Sea via a canal running through the city centre. North and south of the canal the city is protected by dikes under national authority ensuring high safety standards (flood risk of once in 10,000 years). In some areas a lower safety standard of once every 1250 years is operational. Amsterdam has applied a flood safety approach. However, recently the national Delta Programme has initiated a *Multi-layer Safety* (MLS) approach which is being piloted in six voluntary cases, one of them is Amsterdam. MLS consists of three layers [20]:

1. Reducing flood probability through flood defence infrastructure
2. Reducing flood impact through adaptive spatial planning
3. Reducing flood impact by preparing flood response strategies

A thorough scanning according to the MLS revealed that suboptimal spatial planning, in particular with respect to vital infrastructure, largely increases the potential flood impact. In particular, the harbour area Westpoort is vulnerable. The Westpoort area is vital for supply of electricity for third of the city. Furthermore, flooding of its wastewater treatment plants, data centres and the chemical industry would lead to large scale damage. Despite a long-term preparedness to anticipate flood risks, the flood response strategy was found to be insufficiently equipped (indicator 9.3 preparedness; [41]). Cost-efficiency of spatial adaptation is low due to the low flood probability. However, the city is pioneering with a strategy that combines flood adaptation with projected infrastructural refurbishments and with measures to reduce heat stress, air pollution or water nuisance. For example, soil remediation can be combined with measures to increase the ground-level. This integral cost-efficient approach can slowly reduce the flood impact over the next decades. However, the implementation of this strategy is hampered by limited awareness and knowledge of flood risks beyond the water authorities (indicator 1.1 community knowledge; [41]). Amsterdam is served by one municipally owned utility for water called Waternet. Waternet manages the entire urban water cycle, including drinking water, water safety, surface water and wastewater transport, and

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treatment (indicator 7.2 clear division of responsibilities). This integrated approach and close ties with the municipality and regional water board is unique and provides sufficient authority (indicator 7.3 authority) and room to manoeuvre (indicator 7.1 room to manoeuvre) for individual agents to coordinate the long-term implementation of cost-efficient synergies (condition 7). By 2040, the city expects an additional 70,000 houses within its borders, resulting in further densification of sealed areas such as roofs, streets and parking spaces. A climate-induced increase in the frequency and intensity of storm events will further increase the city's vulnerability for water nuisance. The Amsterdam Rainproof programme was created to make Amsterdam resistant to the increasingly common downpours. Adaptive measures such as green roofs, urban gardening and the use of rainwater for toilet flushing are being mainstreamed into urban planning. However, it is challenging to do this in a city with limited awareness. Hence, there is not yet a fully shared ambition, rather low commitment, and a lack of an inter-sectorial policy and coordination. More understandable and cohesive knowledge provision (indicator 2.2 information transparency and 2.3 knowledge cohesion) may facilitate a better integration between urban planning, climate adaptation and flood impact reduction objectives. The new national imposed obligation to perform a water stress test may provide an opportunity for improvement [42]. The national imposed institutional setting leads to a clear division of responsibility but also limits the involvement of citizens and stakeholders beyond the water management authorities. Moreover, an overly focus on reducing flood probability complicates local efforts to reduce the impact of potential flooding.

4.3 Crosscutting contextual factors for cities

Reflecting on the indicator scores within the four case studies (Table 1), we can identify a few key differences (Table 2). The root cause of these differences may be explained by crosscutting contextual factors. Moreover, the relative importance of some indicators differed between cities in the two case-studies in the UK and the Netherlands. In particular, indicators 1.2 local sense of urgency, conditions 2 useful knowledge and 4 stakeholder engagement process, and indicator 6.1 entrepreneurial agents, were found to be relatively important within the UK context. Whereas for Rotterdam and Amsterdam condition 1 awareness, indicator 8.2 consumer willingness to pay and 9.3 preparedness, may require most attention in the Dutch context. The observed differences in relative importance and the key the differences in indicator scoring were examined in more detail through the in-depth interviews, document analyses and a multi-level policy analyses in order to find crosscutting contextual factors that can explain these differences. As a result of this explorative exercise, we have identified three crosscutting contextual factors: 1) flood probability and impact, 2) national imposed institutional setting, and 3) level of authority to secure long-term financial support.

Table 2 Overview of indicators that differed the most between on the one hand the Milton Keynes and Leicester on the one hand and Rotterdam and Amsterdam. For each indicator the predefined question is provided. The full methodological details for all 27 indicator is publicly available [18].

Indicator	City	Score	Pre-defined question
4.2 Protection of core values	**Milton Keynes**	**0**	To what extent 1) is commitment focused on the process instead of on early end-results? 2) do stakeholders have the opportunity to be actively involved? 3) are exit procedures clear and transparent? (All three ensure that stakeholders feel confident that their core values are not harmed)
	Leicester	**0**	
	Rotterdam	**+**	
	Amsterdam	**++**	
4.3 Progress and variety of options	**Milton Keynes**	**0**	To what extent are procedures clear and realistic, are a variety of alternatives co-created and thereafter selected from, and are decisions made at the end of the process in order to secure continued prospect of gain and thereby
	Leicester	**0**	
	Rotterdam	**+**	
	Amsterdam	**++**	

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			cooperative behaviour in the engagement process?
5.2 Discourse embedding	**Milton Keynes**	**0**	To what extent is sustainable policy interwoven in historical, cultural, normative and political context?
	Leicester	**0**	
	Rotterdam	**++**	
	Amsterdam	**+**	
6.1 Entrepreneurial agents	**Milton Keynes**	**-**	To what extent are the entrepreneurial agents of change enabled to gain access to resources, seek and seize opportunities, and have influence on decision-making?
	Leicester	**0**	
	Rotterdam	**+**	
	Amsterdam	**+**	
7.2 Clear division of responsibilities	**Milton Keynes**	**0**	To what extent are responsibilities clearly formulated and allocated, in order to effectively address the water challenge?
	Leicester	**0**	
	Rotterdam	**+**	
	Amsterdam	**++**	
7.3 Authority	**Milton Keynes**	**-**	To what extent are legitimate forms of power and authority present that enable long-term, integrated and sustainable solutions for the water challenge?
	Leicester	**0**	
	Rotterdam	**++**	
	Amsterdam	**++**	
8.3 Financial continuation	**Milton Keynes**	**0**	To what extent do financial arrangements secure long-term, robust policy implementation, continuation, and risk reduction?
	Leicester	**0**	
	Rotterdam	**++**	
	Amsterdam	**+**	
9.1 Policy instruments	**Milton Keynes**	**0**	To what extent are policy instruments effectively used (and evaluated), in order to stimulate desired behaviour and discourage undesired activities and choices?
	Leicester	**0**	
	Rotterdam	**++**	
	Amsterdam	**+**	

1. Flood probability and impact

The hydro-physical setting largely determines the probability and impact of flood events and pre-selects the viable solutions. The Netherlands faces flood challenges characterised by a low probability but high impacts and a short warning time [43]. As a consequence, high safety standards are required that are accomplished through structural flood prevention measures. Improving flood defences in vulnerable reclaimed areas - the 'Polders' - increases feelings of safety that stimulate investments and further economic development in these areas. It becomes an economic rational choice to invest in flood defence of increasingly valuable social and economic assets. Due to the large investments already made, each additional investment receives an increasing return creating a path-dependency. This self-reinforcing phenomenon has also been described as the 'levee effect' [44]. On the contrary, in the UK most flood risks tend to have a relatively lower impact but higher probability and it is possible to predict and prepare for floods well in advance. In this hydro-physical setting, not all floods can be prevented. These diverging processes related to flood probability and impact have important repercussions for the role and responsibility of individuals. In the Netherlands, the government monopoly on flood safety has greatly reduced the involvement of citizens and the private sector. Moreover, the government has compensated damages caused by major floods while flood insurances do not exist. Consequently, most people are rather disconnected from flood challenges and take their safety for granted. Measures to reduce the flood impact (indicator 9.3 preparedness) are typically not cost-efficient and difficult to implement due to limited awareness beyond the water sector. On the contrary, the UK does not apply a minimum safety standard. A cost-benefit analysis fully determines the optimal protection at the local scale. Individuals can therefore be exposed to a great variety of flood probability and impact. The UK private flood risk insurance system requires

individuals to be aware of their own flood probability and impact, and act accordingly by protecting and insuring their property [23,24]. In this context, the availability and transparency of local flood risk information for citizens becomes critical (indicator 2.1 information availability and 2.2 information transparency). Accordingly, these indicators score high for both Milton Keynes and Leicester. Citizen awareness also becomes critical, and in fact, an interesting difference was found between the analysed cities in the UK and in the Netherlands. Awareness of local authorities was found to be highest in the Netherlands whereas citizen awareness was low (indicator 1.1 community knowledge and 1.2 local sense of urgency). In the English cities this was rather different. Leicester has a higher citizen behavioural internalisation which can be explained as a necessity given the high flood probabilities. In fact, knowledge, awareness and behavioural internalisation of citizens can be considered as key indicators in the UK context of considerable food probability and appeal on individual responsibility. The flood probability and impact characteristics largely explains the different management pathways that both countries have taken. Overall, this contextual factor particularly lead to differences in condition 1 awareness, condition 2 useful knowledge and in particular to indicator 9.3 preparedness. These elements are particularly relevant for cities in the UK to help citizens to cope higher flood risks and particularly relevant for Dutch cities to reduce their flood impact in the long run.

2. National imposed institutional setting

The existing institutional context defines, to a large degree, which actors will be involved, how they act and which new initiatives emerge. In fact, new initiatives are likely to be discussed in already existing coordination bodies in order to avoid large transaction costs involved in setting up new bodies [45]. The institutional setting in both countries is rather different as a result of the 1953 Dutch catastrophe and the social-political reactions afterwards. The 1953 event has led to a strong discourse of flood safety coordinated by the central government through the Delta Programme. Flood risk is considered as a matter of public safety and national priority. Regional water management is controlled by the water boards. Water boards have separate elections and raise their own tax. In turn, municipalities are responsible for urban drainage, spatial planning and the sewer system. Urban flood risk management is strongly driven by national legislation and policy leading to cohesive knowledge production (indicator 2.3 knowledge cohesion) and largely integrated management practices (5.3). The water stress test mandated by the Delta Programme for all Dutch cities, is a clear illustration of this national coordination. Hence, the institutional setting is characterised by a national monopoly on flood safety and public institutions responsible for regional and urban flood safety. The dominance of a single public governance arrangement in the Netherlands seems to limit the scope, interaction and learning of other actors, in particular with respect to the reduction of flood impacts [indicator 1.2 local sense of urgency, 1.3 behavioural internalisation and 3.3 cross-stakeholder learning, 45]. Traditionally flood risk management in the UK was focussed on drainage of mainly agricultural land, organised through IDBs in the lowlands. From the 1970s onwards, priorities shifted from agriculture towards urban flood protection and ecological non-structural measures within a river basin approach [17]. The central government incrementally changed from almost completely decentralised towards more centralised decision-making and funding. However, a process of political devolution can be observed throughout the last decade. In particular, the Cameron administration's 'National Flood and Coastal Erosion Risk Management Strategy' [31] ushers for a shift in responsibility towards the LLFA while the central government continues to coordinate policy. Overall, the government has no statutory duty of care to protect land or property from flooding, but only permissive powers. Private insurance companies provide cover against floods for residential properties and the majority of commercial buildings since the 1950s. Due to technological progress that increases knowledge about flood risk exposure, the pricing system has become much more accurate revealing previously unknown cross-subsidy [46]. The risk-based approach led to a great variety in premiums including some 'uninsurable' properties where governmental rehousing programmes or higher safety standards are necessary. This national imposed institutional setting may

jeopardise stakeholders core values such as their house prices, insurance and liveability (indicator 4.2 protection of core values). Finally, the responsibilities for emergency planning, spatial planning, and emergency response may be allocated to different local risk management authorities. The flood response strategy therefore tends to be fragmentally organised whereas proactive flood mitigation is impeded due to a lack of a resourceful authorities that can address SuSD measures at the river basin scale (indicator 9.3 preparedness). In fact, flood risk management largely depends on SuDS measures, particularly in upstream areas which are managed by a variety of local organisation. At the city scale SuDS also involve the LLFA and water companies that are responsible for sewer drainage system. Therefore, the division of responsibilities, roles and tasks is rather dispersed and each actor is only accountable for their own often narrowly defined tasks (indicator 7.2 clear division of responsibilities) and suboptimal use of policy instruments (indicator 9.1 policy instruments). The differences in national imposed institutional setting between the UK and the Netherlands also emphasizes different governance conditions. In the Netherlands, city's need to pay extra attention with respect to condition 1 awareness and condition 3 continuous learning, particularly with respect to learning together with stakeholders outside the water sector. In the UK, condition 4 stakeholder engagement process is of particular important because many decisions that impact them are made locally. In addition, the city's multi-level network potential (condition 7) requires priority given the rather fragmented division of tasks and roles.

3. Level of authority to secure long-term financial support

The liberal governance style in the UK regards the task of the government as ensuring the most cost-effective outcome for taxpayers' money [47]. Accordingly, the allocation of funding to LLFAs is done on a case-by-case cost-benefit evaluation based on nine Outcome Measures [48]. Since, the general election in 2010, a process of political devolution also introduced significant cuts in national funding in response to the state budget deficits. In order to fill this funding gap, local projects that do not or only partially qualify for central funding, require a significant financial contribution from local communities, industries or governmental agencies; a process referred to as 'partnership funding' [31]. Different studies have indicated that these local investments are often initiated after recent flood events through active engagement of Flood Action Groups (FAGs) [e.g. 15,34]. In these cases, awareness, knowledge and learning (conditions 1, 2 and 3) have to be well-established in order to successfully apply for funding. In particular cross-stakeholder learning (indicator 3.3 cross-stakeholder learning) is key in these cases. However, in most cases such a financial structure tends to be erratic and may inhibit investments in more holistic and proactive measures [49]. In our four case-study cities we recognised a well-known pattern that shows that often the non-transient well-educated citizens tend to organise themselves and gain a significant influence on local decision-making through various forms of co-management and knowledge co-production [e.g. 50,51]. Therefore the partnership funding system tends to work appropriately in well-educated middle class communities but not so well in more deprived areas [15,34]. Hence, flood protection levels are diverging in the UK and the local agents of change (condition 6), the stakeholder engagement process (condition 4) and overall capacity-building have become critical for ensuring adequate flood safety standards throughout the country. This is particularly challenging in cities with more deprived communities that lack significant recent floods-experiences [e.g. 15,34,52], such as the city of Leicester. In the Netherlands, differences in flood safety between cities is rather limited. The Delta Programme ensures long-term funding of flood defence through the Delta Fund. In period 2017-2031, about €17 billion is reserved, for which 66% is to ensure water safety measures. Every year, the funding programme is extended with one year [20]. Regional flood risk is managed by the water boards. Water boards have elected representatives and have the authority to raise tax for regional flood risk management. Likewise, the municipality raises public taxes to finance the sewer system. In this way, long-term financial security is largely ensured, irrespective of political turns and to some extent financial crisis. Hence, the level of authority to ensure financial support is largely related to condition 6 *agents of change*. In the

Netherlands, visionary agents have secured long-term financial support. In the UK, local entrepreneurial and collaborative agents are essential to gain access to resources, seek and seize opportunities, and to have a significant impact on local decision-making.

5. Discussion

In different contexts, organisational structures can vary substantially and municipalities therefore can provide a useful spatial unit and institutional scope to compare, learn and improve existing flood risk management. Like other consensus concepts – such as adaptive capacity, resilience or sustainability – governance capacity has hardly been defined with respect to cities or flood risk specifically. There is little agreement on which indicators or proxies are valid to assess governance capacity. Consequently, the researchers normative assumptions of what governance capacity entails leads to implicit accenting of certain issues over others. In order to be fully transparent and consistent in our approach we have applied the Governance Capacity Analysis ([12], Table 1). At large, single-n case studies can provide a deep contextual understanding of the policy process at the cost of generalizability [53]. On the other hand, comparative studies parallel several case studies across contexts in order to explain variation, but at the cost of contextual understanding [54]. The identified contextual factors may serve both purposes. It helps to understand the variation between cities and countries and provides guidelines for individual cities to understand their capacity-development priorities. However, this type of assessment is a snapshot and merely an indication of what might be expected in the long-term urban transformation process. In order to identify overarching lessons and provide applicable and effective knowledge to individual cities, the consistent empirically-based analysis of governance capacity in combination with the identification of influential contextual factors are required. In this paper we found three crosscutting contextual factors that may explain the root cause of the observed differences (Table 2) between the analysed cities: 1) flood probability and impact, 2) national imposed institutional setting, and 3) level of authority to secure long-term financial support. These contextual factors emphasize different elements of governance capacity in both countries. The higher flood probability, decentralised institutional setting and recent political devolution in the UK emphasizes the responsibility of individuals to pursue their own interests. National budget cuts requires local public and private stakeholders to financially contribute to flood management measures. Within this context, condition 1 awareness, 2 useful knowledge and 4 stakeholder engagement process appear to be essential to empower citizens and local actors and create the right conditions for them to fulfil the responsibility that is given to them. In particular, the role of individuals that gain access to resources, seek and seize opportunities, and influence decision-making becomes critical (indicator 6.1 entrepreneurial agents). In the Netherlands, the low flood probabilities, national monopoly on flood safety and long-term financial continuation of flood safety programmes results in low awareness beyond the water authorities (condition 1). However, sea level rise, increased river discharges, storm events and ground subsidence necessitate alternative approaches focussed on flood preparedness and the reduction of flood impact (indicator 9.3 preparedness). This will be challenging because these measures are often not cost-efficient due to low flood probabilities and prioritises condition 1 awareness. In both countries the role of local digital social platforms may provide interesting opportunities to engage citizens and local stakeholders in decision-making and improve awareness and behavioural change [].

The three crosscutting contextual factors provide a useful narrative to interpret the impeding and enhancing element of governance capacity and help cities in the UK and the Netherlands to identify priorities for flood risk management. Moreover, these contextual factors may enable a better interpretation and prioritisation of activities to increase the capacity to govern flood risk in European cities because they also adhere to the EU WFD, have comparable levels of wealth and demographics, and all apply democratic principles. Further research may help us understand whether these contextual factors also apply to other world regions or that other contextual factors need to be considered as well to

understand the most important impeding and enhancing elements that determine the urban capacity to govern flood risk. Such crosscutting contextual factors may include social-cultural factors. For example, the way different cultures experience time and accordingly frame problems and conceive solutions [55] or the perception to environmental risk [13,14] that may influence the capacity-building process [57]. Moreover, urban feedback loops may be different in other world regions. For example Rahmasary et al. [58] found that insufficient solid waste collection and treatment led to sewer clogging and urban flooding in Bandung, Indonesia. Such urban flooding also poses the risk of malaria outbreaks and substantial traffic congestion [59]. Moreover, ground subsidence as a consequence of groundwater over-abstraction aggravates urban flooding. Hence, in order to address flood risks in such urban context may require an improved provision of basic services such as drinking water, sanitation and solid waste collection. The three contextual factors may apply to other water or environmental issues in cities such as water scarcity, water pollution, urban heat islands or air pollution. The identification of contextual factors for these issues and in other world regions forms a key challenge for analysing and comparing governance capacity in order to identify transferable lessons for cities to transform in the face of unprecedented challenges of water, waste and climate change in a rapidly urbanizing world.

6. Conclusions

Urbanization, sea level rise and extreme rainfall urge cities to further develop their capacity to govern their flood risks. A cohesive conceptual understanding of what governance capacity implies, how it can be measured, and what cities can learn from existing practices, is largely lacking. Empirical studies may be key to better understand capacity-development opportunities with respect to the various contextual factors at play. Accordingly, we aimed to contribute to a better understanding of the context-specific capacity development priorities of urban flood risk governance in the UK and the Netherlands, and explore crosscutting contextual factors that may explain the observed differences in both countries. We found that the institutional setting in the UK and recent political devolution and national austerity measures enlarged differences in flood safety standards. In this context, the role of citizen awareness, useful knowledge, stakeholder engagement process, and entrepreneurial agents become critical components of governance capacity. On the contrary, the Dutch focus on flood safety through centralised public coordination with long-term financial continuity results in high flood safety standards. However, this approach also inhibits incentives to reduce flood impacts and low awareness, as most citizens take flood protection for granted. The three crosscutting contextual factors we have identified provide a useful narrative for cities in the UK and the Netherlands to improve their capacity to govern flood risk. These contextual factors may also apply in other European cities. More research is necessary to gain a deeper understanding of governance capacity development in other world regions and for other urban environmental challenges. We found that urban governance capacity is to a large extend a product of multi-level governance processes and therefore cities have to respond to broader national or international contextual factors in order to identify and seize available opportunities to improve their capacity to govern flood risk. A thorough understanding of the different elements of governance capacity and how broader national and international contextual factors influence them is therefore indispensable.

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