1. Introduction. Local organisation to address flood risks: possibilities for adaptation to climate change?

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'Climate change adaptation and disaster risk management (especially disaster risk reduction) are critical elements of long-term sustainability for economies, societies, and environments at all scales.'

(IPCC 2012: 444)

INTRODUCTION AND AIM

Adaptation to climate change has recently arisen as a major issue for local planning and organisation. While mitigation – the reduction of greenhouse gas emissions – is necessary to limit risks, present assessments suggest that even at existing emission levels we need to develop adaptations or ways of managing the effects of climate change. Water resources are among the components of the environment most seriously affected by climate change, and water-related hazards make up 90 per cent of all natural hazards (Sadoff and Muller 2009; Connor and Stoddard 2012; cf. IPCC 2012). In the European Union (EU), over 40 billion euros per year are currently spent on flood mitigation, and recovery and compensation for flood damage, most of this sum in urban areas. Between 2000 and 2009, Europe 'witnessed some of the largest flooding events in its history' (van Ree et al. 2011: 874). While much of the rise in losses from natural disasters is a result of increased assets in risk areas, it signals higher potential risk in the context of climate change (Connor and Stoddard 2012). Built environments, which are prevalent in flood risk areas due to the concentration of population in coastal and river areas, affect and are affected by floods, and make the costs of infrastructure damage particularly large (Wheather and Evans 2009; EEA 2012). Some of the potential consequences of climate change include increased costs for the infrastructure of inhabited areas, including roads,

storm water drainage and flood protection (Muller 2009).[1] In addition, critical urban infrastructure, such as water, electricity and transport, are today often interdependent, resulting in substantial risks in the case of extreme events (van Ree et al. 2011).

This situation makes it relevant to not only cope with the relatively high incidence of extreme events – evidenced during the last few years – but also to adapt to the increased risk of floods in the future, anticipated rises in sea level and the predicted higher frequency of extreme weather events (Sadoff and Muller 2009; Birkmann and von Teichman 2010; Quevauvillier 2011). These consequences will impact both small and large population centres, which may have very different strategies for dealing with flooding. Even systems that work well today will need to reassess responses, as they may face flow regimes that vary beyond recorded limits due to the effects of climate change. The development of policy to adapt to climate change at the local, regional, state or even higher levels may support the extension of disaster management to extreme events and long-term trends, provided that the policy frameworks are integrated. Relevant frameworks include those for existent emergency and disaster management, flood management and more recently developed adaptation policies (Krysanova et al. 2010: 4122).

The chapters in this book focus on possibilities to integrate emergency preparedness, flood response and recovery measures with adaptation to climate change; the principal interest is in planning in order to improve responses to events. With a focus mainly on the local level, the chapters concentrate on institutional factors more so than the technical availability of resources, modelling methods or construction techniques. Broader governance and more specialised sectoral management or operational procedures (cf. Reed and Bruyneel 2010) are seen as constituting part of the framework that needs to be understood in order to conceive of the multiple contexts that affect responses to water-related risk. However, in reviewing how current systems deal with challenges that are among those likely to increase with climate change, in particular the risk of floods, we are not assuming that any events viewed so far are necessarily the result of climate change. Rather, we note that an understanding of the measures and capacities developed to deal with these is likely to help understand potential coping and adaptation during future events and may furnish a basis from which increased adaptive capacity may need to progress.

This book thus also asks to what extent adaptation to climate change is actually developed in practice to support long-term flood response strategies, and to what extent it is being mainstreamed, that is, integrated with existing approaches. With adaptation to climate change only recently recognised as a relevant long-term issue, how can it be identified

in flood management in different cases? Indeed, is a focus on adaptation necessary for current activities in flood management in order to support adaptation or longer-term adaptive capacity? In examining these issues, the book seeks to problematise adaptation and place the focus on the multiple forces and contexts that may determine how flood management is developed in a future-oriented context.

The book draws attention to a number of different cases. They have been selected within federal states (Canada and Germany) and unitary states (the Netherlands, Sweden and Finland), which exhibit very different flood preparedness, incidences of extreme events, adaptation policies and forms of local organisation. The cases have also been chosen to include both rural and urban population centres in order to elucidate the differing capacities among municipalities to deal with flood risks. The rural areas studied feature winter snow and snowmelt floods, supplementing the focus on flash floods often seen in Continental Europe. The federal states Canada and Germany have both experienced major flood events – in the case of Saxony, Germany, one that even contributed to the final shape of the EU Floods Directive – but have developed adaptation polices to very different extents and with very different orientations. There is a risk that the federal system in both countries results in highly varied responses among different states and local communities. In the unitary states – the Netherlands, Sweden and Finland – flood response systems also vary considerably. The Netherlands, much of which lies below sea level, has had to learn to live with water management risks and has, to a large extent, naturalised flood response in administration and by encouraging local networks, among other means. Sweden and Finland, while comparatively less focused on water management, grant local government relatively extensive opportunities for self-determination in planning, whereby there may be extensive variation responses locally. However, in both countries, the risk of floods has thus far been comparatively less pronounced and involved comparatively few societal actors. Taken together, these varying cases may – rather than providing a unified picture – illustrate the diversity in how different rural and urban contexts experiencing varying events and working under different governance structures are able to deal with floods today and may respond to them in the future.

Serving as an introduction and broad theoretical context to the book, this chapter reviews adaptation as an issue for the local level within different state structures and how this problem is addressed in different contexts. The chapter discusses planning for present and future circumstances with reference to integration between emergency management, water management and adaptation frameworks, as well as the responses on the local, regional, national and international levels. The concluding section provides an overview of the component contributions to the volume.

DEFINITIONS AND SETTING THE STAGE

In line with the IPCC (2012), for instance, this book treats events in terms of hazardous physical events. The cases discussed include extreme events, defined as those where measurements rise above threshold values near the upper end of observed values of the variable, and less severe cases of flooding, that is, overflowing of the normal channel of a river (cf. IPCC 2012). The concepts of disaster, emergency and hazard are used largely in line with the literature and seen as related to local and other preconditions. The risk associated with events may include both perceptions of risk that may affect responses and more calculable facets of the risk of a disaster. Risk ultimately depends on the likelihood of severe alterations 'determined by examining the probability of occurrence of the event, along with measuring asset inventory and liable resources' (Haque and Burton 2005: 344). A hazard is defined as being 'generated and determined by the potential for damage, both tangible and intangible', by an extreme environmental event. Thus, it is preconditioned by the 'presence of the human domain' (Haque and Burton 2005: 343). Similarly, a disaster is defined as 'severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions' (IPCC 2012: 31).

Events are thus not always associated with disasters or hazards; whether they are may depend to a large extent on available response frameworks and adaptive capacity and, more broadly, the institutional context. Accordingly, a well-managed flood may not result in a disaster, whereas even small floods, if poorly managed, may have significant impacts. As the book primarily concerns itself with response and broader adaptation frameworks, the focus is on institutional rather than natural conditions. This also makes discussions of responses to non-extreme events and to gradual change relevant, as these may be used to indicate preparedness. From an institutional viewpoint, events are important here mainly as drivers of policy and responses to flood; they may also serve to indicate a level of capacity for dealing with future events. Terms such as 'flood management' are used to cover a number of available frameworks that may support responses – in the areas of water and disaster management as well as in potential adaptation contexts – in order to cover the breadth of actions in different fields that have an influence on water disaster-related risks.[2] While insurance plays a substantial role in the management of catastrophic events, it falls outside the scope of the present research, as the focus is mainly on the public sector and public-sector responses (but see, for example, Keskitalo et al., 2012b).

With regard to potential changes in risks in the future, uncertainty on a very specific level, as well as variation down to individual localities, in how climate change may affect flood regimes makes exact assessments difficult. However, agreement exists that climate change may increase the variability and intensity of precipitation; this, in turn, may increase the risk of rain-generated floods, for instance, in many areas (Sadoff and Muller 2009; see also IPCC 2012). In addition, the melting of the polar ice due to climate change and thermal expansion causes a rise in sea levels that affects coastal areas and cities. In areas with snow cover during winter, glacial lake outburst floods and impacts related to precipitation stored in snow, such as snowmelt and meltwater floods, will impact flood regimes (van Ree et al. 2011; IPCC 2012). Such changes will place requirements on planning not only for present levels of risk, but also for how risk may increase or decrease in relation to certain events or during specific seasons as a result of climate change (IPCC 2012) (see Box 1.1).

These differential impacts, as well as numerous flood risk patterns in different countries, result in varying types of flood risks in the present and the future where infrastructure development and changes in natural conditions are concerned. In Continental Europe, flash floods were responsible for 40 per cent of the flood-related casualties between 1950 and 2006 (EEA 2012), and may become more frequent with an increase in high precipitation events, in particular as denser infrastructure development may hinder percolation. Well-known examples of flash floods include the event in Saxony in 2002 (EEA 2012) examined in this volume (Chapter 2). In areas with snow cover during winter, floods are closely connected to the snowmelt period and may increase with higher precipitation during winter or quicker snowmelt. Today, about 40 per cent of flood disasters in Canada occur during the spring thaw in southern Canada (April–May) (Shrubsole et al. 2003).

BOX 1.1 EXAMPLES OF FACTORS CONTRIBUTING TO FLOOD RISKS

The European Environment Agency (EEA) lists the types of flooding affecting cities as river floods, flash floods, coastal floods, urban drainage flooding and groundwater flooding. River floods can be triggered by heavy rainfall, upstream snowmelt or downstream tidal influence that saturates the ground and results in overflow. Flash floods result from events causing rapid release of water – often upstream from higher elevations.

Events causing this range from extreme rainfall to landslides or dyke/flood protection failure. Coastal floods result from storm surges, but may take a long time to drain from the affected area. Urban drainage flooding may occur if the capacity of drainage systems cannot accommodate rainfall. Groundwater flooding may raise the water table, for example, as a result of excessive rainfall over long periods (EEA 2012).

Causes of flooding in northern areas include snowmelt runoff floods, rain-on-snow floods and ice jam floods (Shrubsole et al. 2003). Snowmelt runoff floods may have considerable impacts, especially where a thick snow cover melts rapidly when temperatures rise above freezing. Rain-on-snow floods combine the features of high rainfall with those of snowmelt runoff floods, resulting in very rapid increases in runoff. Ice jam floods can occur from ice build-up in river channels that blocks upstream water; this can take place both during freeze-up and break-up periods. Once the ice jam breaks up, the resulting water surge may cause flooding downstream. Ice jams can develop during snowmelt and the two forms of flooding may occur simultaneously, worsening impacts (Shrubsole et al. 2003).

Table 1.1 List of factors contributing to flooding

Meteorological factors	Hydrological factors	Human factors aggravating natural flood hazards
Rainfall Storm surges Temperature Snowfall and snowmelt	Soil moisture level Groundwater level prior to storm Presence of impervious cover Channel cross-sectional shape and irregularity Topography, slope, basin geometry Presence or absence of over bank flow, channel network Synchronisation of runoff from various parts of watershed High tide impeding drainage	Land-use changes (for example, surface sealing due to urbanisation, deforestation) increase runoff and may cause sedimentation Inefficiency or non-maintenance of sewage system and clearing of river banks Excessively efficient drainage of upstream areas increases flood peaks Climate change affects magnitude and frequency of precipitation and floods Urban microclimate may exacerbate precipitation events Building in flood-prone areas Reducing/cutting off flood plains

Source: modified from EEA 2012 (44).

ORGANISING IN RESPONSE TO FLOOD RISKS

Organising in response to flood risks is necessarily related to policies and practices among a range of actors at the local, national and supranational levels. To understand response structures in relation to events such as disasters, it is thus crucial to understand existing water, disaster and emergency management frameworks and any developing adaptation policies designed to accommodate future risks in responses. One relevant framework is emergency or disaster management at large, which is regularly organised through a number of local and national actors and is designed to cover a number of different emergencies. A second important context consists of the water and flood management frameworks that govern regular water management – not that for extraordinary or crisis situations – and that may include a number of water management actors, such as water authorities or other parties who regularly influence the planning system. A third framework, the most recent to start taking shape, is the adaptation framework, which is often determined at national as well as regional and local levels but at present differs in development and implementation (see, for example, Keskitalo 2010) (see Figure 1.1). Key strategies across all of these contexts may encompass combinations of a number of different structural and non-structural strategies, such as flood warnings and awareness raising, land-use control and management to limit risky development, homeowner adaptation and improved emergency management (Johnson et al. 2007).

Of these, adaptation constitutes a future-oriented as well as conceptually broad framework that can be used to contextualize water and emergency management. Policy development on adaptation to climate change in advanced industrial states has received relatively limited attention in literature to date (Gagnon-Lebrun and Agrawala 2008; Keskitalo 2010a; Ford and Berrang-Ford 2011).[3] This may be a result of the novelty of adaptation as a subject area and its necessary linkage to other issue areas as well as the complexity of the issues. Adaptation is generally defined as actions to respond to the impacts of climate change (Smit and Wandel 2006). The concept can be subdivided into planned adaptations – managed responses explicitly conditioned through policy and management systems – and autonomous or reactive adaptations, which are undertaken as events occur as an extension to or in the absence of formal management frameworks. It is today an accepted perspective in social vulnerability research that climate change, as a stress, needs to be understood in the broader perspective of how people develop and prioritise adaptations in relation to the full scope of stresses to which

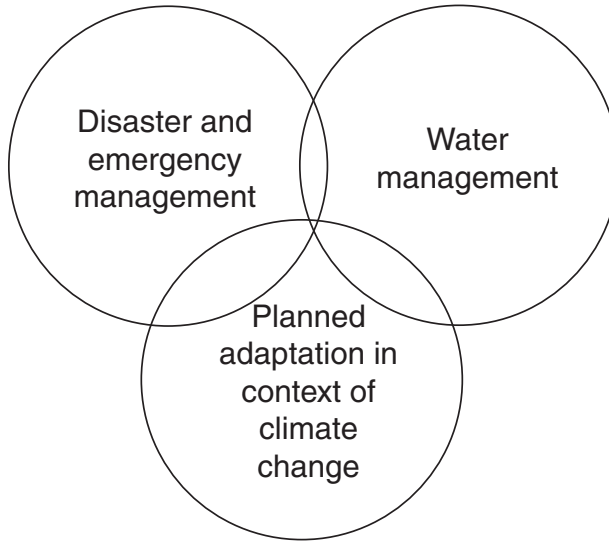

Figure 1.1 The intersecting management requirements for flood risks including the impacts of climate change

they need to respond, with these including economic and political changes (for example: O'Brien and Leichenko 2000; Dixit 2003; Haque and Burton 2010). While the term 'adaptation' is generally designed to cover specific responses to climate change stress, it is recognised that these will often draw upon and develop from coping responses, which are defined as more short-term responses to a stress, such as increased flooding, that are developed based on present behavioural patterns (cf. Keskitalo 2010b). The dividing line between adaptation and coping responses may thus not be clear-cut: indeed, it may be expected that rather than developing entirely new responses to extreme events – flooding, for example – in order to deal with future climate change, society will highlight and extend present coping responses (cf. IPCC 2012). Further limitations to adaptation also lie in the fact that not all adaptations are necessarily beneficial. While they may be undertaken to respond to a specific stress, adaptations may result in maladaptation if they are developed without adequately analysing the effects on different actors or, for instance, on sectors other than the one for they which were designed. This makes it necessary to examine 'who is adapting to what' (Smit et al. 2000).

Factors that may determine even longer-term, strategic actions on flood response to a rather large extent may thus not necessarily relate explicitly to climate change adaptation as such even though they may influence responses to climate change; rather, the possibility to efficiently adapt to future stress is fundamentally dependent on present organisational systems and assumptions. This extensive context dependence has led to an increasing focus in the literature on adaptive capacity (Smit and Wandel 2006).[4] Adaptive capacity is defined as the capacity of a societal, organisational or other unit to adapt to any impact (such as flooding or climate change at large) and is determined by institutional, economic and technological factors (among others) as well as by infrastructure, knowledge/information access and structures (Smit and Pilifosova 2001; Keskitalo et al. 2012a).[5] A focus on adaptive capacity thus underlines the social vulnerability perspective whereby one should start with understanding the societal preconditions that form the basis for any development of adaptation. However, among other sources, the IPCC (2012: 74) points out that 'capacity to respond is not sufficient to reduce risk', as not all capacities may be tapped in interventions or as interventions may be targeted incorrectly. Van Ree et al. note that major bottlenecks that hamper adaptation may include '(i) lack of understanding of current and future risks, (ii) lack of long-term planning, poorly integrated and comprehensive planning, (iii) lack of understanding of the effectiveness of these technologies, and (iv) inadequate controlling guides of local and regional authorities, and lack of formal guidance and policies for adaptation' (van Ree et al. 2011: 875).

The adaptation and adaptive capacities literature thus to a large extent highlights the capacities and potential actions for responding to climate change. However, although the literature on adaptation is mainly centred on adaptation to climate change (see, for example, Smit and Wandel 2006 for an overview), it is recognised that adaptations can be reactive or may to a large extent be developed from existing coping responses. As a result, even if adaptations are conceived of more as longer-term actions designed specifically in relation to climate change, the specific actions involved may not in all cases operationally differ from existing ones other than in their being suitable also in the context of climate change stress. For this book, this prompts a focus on problematising adaptation as well as on exploring the potential for development or inclusion of adaptation concerns in existing management systems. Even if adaptations to climate change specifically are not yet developed in a particular case, resources such as developed long-term plans or existing administration and long-term approaches to flood management may make it more likely that strategic, planned adaptations – which relate to future risks and not

only present circumstances – could be developed. Considerations of context thus figure significantly, prompting questions such as how varying cases treat climate issues, and which interests are involved in defining those issues. This makes it relevant to review the role of adaptation in relation to existing systems, for example, those for emergency and disaster management.

Existing emergency management models are designed for planning and management in response to disasters and are often described in terms of four steps: mitigation (actions that prevent, reduce risk of or lessen effects of disaster); preparedness (actions taken before disaster, such as development of specific plans); response (actions taken during disaster); and recovery (actions after impact, often to facilitate returning to more stable situations). These steps are known as the RPPR (response, preparedness, prevention, remediation) chain (for example, Kapucu 2008) (see Table 1.2). The term 'flood mitigation' can cause confusion viewed from the context of the literature on adaptation to climate change. However, adaptation to increased flood risks in the context of climate change and mitigation of flood risks at large may suggest the same options. The terms mainly originate in different literatures: 'in the context of climate change, disaster risk management is considered as an adaptation option' (Prabhakar et al. 2009: 8).[6]

Different actors may have different responsibilities in relation to hazards management. For instance, mitigation of disaster has often meant the provision of engineering and structural flood management, while planners have been more involved in preparedness; fire, health and police services focus on response; and local authority services (such as housing management) concern themselves primarily with recovery (Kapucu 2008). Comprehensive emergency management is needed to move more towards integrating these different responsibilities in order to decrease fragmentation and improve management. This has been described as the coordination within one actor of the four phases of the RPPR chain. Integrated emergency management has been described as one actor coordinating all of these with other entities (Col 2007; cf. Drabek and Hoetmer 1991).

While flood risk management throughout the RPPR chain has thus traditionally been seen as differentiated into structural (highly engineered) and non-structural measures, with an emphasis on the former, this view is changing today 'to the wider focus of pro-active management of risk' (van Ree et al. 2011: 875; cf. Bruk 2002; Drobot and Parker 2007; Harries and Penning-Rowsell 2011).[7] As a result, it has been noted that the role of spatial planning, such as imposing requirements on area development and the use of specific building codes, should be further

Table 1.2 Potential elements of a programme for disaster management

Timing	Ex ante		Ex post	
Type	Prevention/ Mitigation	Preparedness	Response (and risk financing)	Recovery (managing the impacts)
Effect	Reduces risk	Reduces risk	Transfers risk (reduces variability)	Reduces impacts (relief) and repairs the losses (reconstruction)
Key options	Physical and structural mitigation works (for example, irrigation, embankments) Land-use planning and building codes Economic incentives for proactive risk management Mitigation plan Warning system Public education Dangerous goods routing by-law Risk-based land-use planning	Early warning systems, communication systems Contingency planning, networks for emergency response shelter facilities, evacuation plans Emergency manager program committee Hazard identification and risk assessment Emergency response plan Plan review Emergency management by-law Training exercises Mutual aid agreement Critical infrastructure protection Planning for people with special needs Engagement with business community	Emergency operations centre Incident management system Evacuation plan Emergency shelter arrangements Volunteer management Community emergency response teams Search and rescue Emergency public information Risk transfer (by means of [re-] insurance) for public infrastructure and private assets, microinsurance Alternative risk transfer National and local reserve funds	Recovery plan Continuity of operations planning Damage assessment Debris management Rehabilitation Providing relief to the affected and compensating losses Supporting recovery Rebuilding housing and infrastructure

Notes: Variations of these divisions into factors exist. See, for example, Bourget (2002), cf. Krysanova et al. (2010) and Kundzewicz (2002).

Source: Modified from Henstra (2010a: 241) and Aakre et al. (2010: 726).

emphasised, as 'spatial planning in general (including land-use planning) is involved directly or indirectly in all versions of hazard/event and vulnerability modification' (Sapountzaki et al. 2011: 1446; see also Henstra 2010a).

Emergency and disaster management also needs to relate to broader, sector-specific systems – in the case of flooding, water management – and water-related adaptation. Much of the complexity may thus lie in integration between these systems. Sadoff and Muller (2009: 74) note that:

> a special case of the institutional challenge is the integration of disaster management systems with the broader institutions of water management. Much knowledge about managing extremes already resides in specialized disaster management institutions. Based on the assumption that once rare events will occur more frequently, this knowledge will have wider and more general applications.

Changes in occurrence and approaches to flooding have in some cases drawn further attention to a realisation that structural measures such as dykes and other physical arrangements cannot stop flooding everywhere; this is something that in both the Netherlands and the UK has led to a stronger emphasis on allowing or 'living with' floods; for instance, by creating overflow areas. This has been described as 'a strong "return to nature" theme […] in recognition that flooding has to be accommodated […] floods cannot be prevented […] and that we cannot engineer our way out of this problem' (Penning-Rowsell et al. 2006: 335).[8]

These developments and insights have given rise to strategies offering more integrated risk management in larger watercourses. McFadden et al. (2009) discuss integrated coastal zone management, co-adaptive management, integrated flood risk management, and strategic planning as relevant concepts for coastal flood risk. Other processes emphasised include integrated water resources management, which is aimed at coordinated water management that includes all different uses of water and is often linked with adaptive approaches that aim to learn from outcomes of existing strategies in order to improve management (for example, Sadoff and Muller 2009 and Connor et al. 2012). These approaches vary in process, in having a place-based approach and in scope; for instance, co-adaptive management focuses on partnership in the process, while strategic planning often concentrates on the physical environment. Similarities can be found, however, such as a focus on management of areas in terms of systems and on cross-boundary links to identify common problems. Defining these commonalities as relating to

integrated systems, McFadden et al. note (2009: 637) 'benchmarks of an integrated strategy' as 'engagement across individuals, communities or organisations that have some claim to involvement in the decision-making processes […] combining different types of knowledge [and] linking management across the range of spatial and temporal perturbations within the system'.

At a more local level, such strategic planning measures (for example, in cities or urban areas) may, in relation to all of these frameworks, have to be extended in response to the rather comprehensive requirements that adaptation may necessitate; one such measure would be the management of the higher variation in water flows that climate change is likely to cause. The design of waterworks – ranging from canals to pipelines, wastewater disposal, drainage systems, dams and other facilities – includes 'formal quantitative assumptions about climate since it takes into account likely variations in rainfall and stream flow as well as likely storm intensities and maximum flood sizes' (Muller 2009: 294). As such intensities change, risks of urban flooding may increase, with implications for the siting of developments, requirements regarding water infrastructure, and emergency management.

A number of the measures that already exist within emergency/disaster and water management frameworks may thus be tapped to extend flood management as part of adaptation to climate change to address the projected increased risks of extremes and changes in flows. In relation to climate change risks, van Ree et al. (2011) note as important responses river and coastal defences, improved land use planning and flood-proofing of buildings, as well as the setting aside of land to accommodate increasing overflow in urban areas (cf. Evans et al. 2008). Urban flood defences (soil embankments, hard structures) may need to be targeted at weak links in flood defence (transition areas between different zones, where soil erosion may set in) (Myatt et al. 2003). The EEA has noted that cities and towns have a large potential range of measures at their disposal, most among those discussed above, as regards adaptation to flood risk in the context of climate change. Cities and towns can adapt to flooding through, among other means, strategic planning for flood risk management, one example being to avoid development in areas at risk. Cities and towns may also utilise grey infrastructure approaches, such as integrated water management at river basin level (for example, overflow areas), urban storm water disposal to decrease pressure on drainage systems, and temporary water storage areas. Another option is innovative infrastructure design, or green infrastructure approaches, such as land-use

modification to promote soil protection and river restoration. Soft measures include forecasting and early warning systems that enhance preparedness; awareness raising and capacity building, including flood mapping and training; the integration of climate change concerns in spatial planning and building codes; regulations and fiscal initiatives to promote water treatment plants; and insurance options to protect assets at risk (EEA 2012; cf. Myatt et al. 2003).

FRAMEWORKS FOR RESPONDING TO FLOODS AT DIFFERENT SCALES

A large number of different potential responses as well as actors undertaking these are thus made relevant by a focus on adaptation, emergency and water management in concert. This makes scale of response an important question with regard to flood risks. While the adaptation literature often argues that responses should be undertaken at the local level as this is where impacts occur (Næss et al. 2005), an understanding nevertheless exists that adaptation and other actions at local level are nested within and determined by decision-making frameworks at higher levels in what may be viewed as a multi-level governance system (for example, Keskitalo 2008, 2010b). The term 'multi-level governance' underscores the role of both public and private actors at different levels in decision making (Marks and Hooghe 2004). Thus, it highlights the role of the state at different levels, of supra-scale actors such as the EU, of international conventions, and also of private-sector actors, comprising corporations and interest groups, including non-governmental organisations (NGOs). This focus emphasises the need to understand actions on a particular level, such as the local, as influenced by governing frameworks on higher levels and to discern the ways in which complex multi-scalar networks may influence possibilities for local action in different states and contexts.

Local Level (City, Municipality or Local Government)

The local level is that often most acutely impacted by floods (IPCC 2012). Cities, municipalities or local governments are often the first responders to flood risk, and many flood risk and emergency management measures, such as local planning, infrastructure and emergency management, are the responsibility of local government. Given the extensive requirements in terms of responses outlined above, efficient organisation to address flood risks at the local as well as higher levels is

imperative. However, studies have pointed out that while some recent approaches have aimed to re-scale water governance more to a local level, re-scaling has not necessarily increased local institutional capacity or limited the power of the state at the local level. Instead, re-scaling may have increased the number of actors (Norman and Bakker 2009; Reed and Bruyneel 2010) and thereby the complexity of management. With regard to resources, small authorities may also lack the technical and financial resources to develop sufficient emergency management plans (Beucher 2009). Management may thus be hampered by a number of factors. As Beucher (2009: 101) notes in a comparison between the UK and France, complications with developing and implementing measures may include that 'there are often tensions and even conflicts between national and local levels as far as flood management is concerned'. Public managers may have limited awareness and training in their emergency management roles, and limited perceptions of risks as a result (Somers and Svara 2009). Flood or emergency management may also in some cases be fragmented between different localities, which may make coordination difficult where localities are located along a common watercourse or an emergency affects several municipalities.

Given these potential limitations, constraints may also exist in how well existing frameworks are integrated with more novel adaptation frameworks. While some limitations in flood responsibility may be politically motivated, others may be logical consequences of conflicts between priorities, for instance in the absence of organised or public pressure (Henstra 2010b). Somers and Svara (2009: 181–2) note the pressures at local and other levels to weigh new stresses against existing priorities, where 'often, there are tensions between responding to the aspirations and pressing needs of the moment and addressing important potential problems and long-term needs'. However, such priorities need to be weighed against the costs of an event occurring and the need to include considerations of a potential increase in risk due to climate change (Corfee-Morlot et al. 2011; cf. Bulkeley and Betsill 2005; Bulkeley and Moser 2007).

While these kinds of limitations may hinder the development of flood response in an adaptation context at the local and national level, studies have indicated that local municipalities may also 'jump scale' to gain additional resources in cases where developed priorities, networks and organisational context allow this. For instance studies have highlighted the possibilities within the EU system, where additional funding on adaptation beyond the state context has in some cases enabled adaptation development beyond that funded or mandated by the state framework (Keskitalo 2010e). Even where adaptation may not be a priority of

a particular state, EU or regional development funding obtained through joint applications with other municipalities in other countries have in some cases provided seed money for developing capacity.

Such possibilities also apply to cases of more generalised water management and multiple other issues within the municipal framework, in particular in light of the general role of the EU in water and flood management. However, substantial differences in obtaining specialised EU funding for cooperation can also be observed between municipalities that are well resourced and have articulated flood risks as a priority and municipalities that may be equally vulnerable but have fewer economic and administrative resources to deal with such risks (Juhola 2010; Keskitalo 2010d). Other risks are that smaller municipalities lack resources to develop linkages or take part in applications with other municipalities. While risks to the particular municipality need to be known and assessed against the costs of potential events, such analyses require considerable resources for risk monitoring, assessment and other support to the municipality within state and other frameworks.

Regional and National-Level Influence

Different state and organisational structures play a considerable role in how different countries treat adaptation to climate change (Keskitalo 2010; Keskitalo et al. 2012a) as well as in the distribution of authority that exists for emergency management, for example, national emergency preparedness, prevention and management systems and water management in general (cf. IPCC 2012). The national framework naturally sets the context for the delegation of authority, with the legal framework constituting the baseline for the extent to which adaptation actions can be developed:

> Emergency management laws, for example, provide the legal framework within which government responses to extreme events take place. Road closures, prohibitions on entry into or evacuation from flooded or fire-damaged areas, declarations of state of emergency, and the associated entitlement to disaster relief payments are all determined under the statutory authority of emergency relief services legislation.
>
> (McDonald 2011: 287).[9]

Frameworks at the national level thus fundamentally affect regional and lower level agency (Sapountzaki et al. 2011). Whereas water management has in many cases traditionally been a responsibility delegated to the local or federal state levels (Connelly 2011), large differences exist,

ranging from federal flood management agencies for indigenous communities in northern Canada (Shrubsole et al. 2003) to largely municipal and county responsibility in Sweden and Finland, both examples now also influenced by EU regulations (Keskitalo 2010d).

For federal states, one assumption has been that possibilities for local as well as regional diversity may be greater than in unitary states (e.g. Keskitalo 2010b). In relation to this, particular concerns regarding the distribution of authority and coordination between levels may exist in the case of federal states – examples being Canada and Germany, whose systems are taken up in this volume – as regards complex arrangements with distinct administrative and implementation systems under independently elected bodies (Connelly 2011). The difficulties of creating a clear and functional distribution of authority – for instance, in Canada between federal, provincial and territorial, and municipal government – may thus be greater in a federal state, with any problems of integration further impacted by fiscal pressures. For instance, Hwacha (2005: 519) states that:

> Provincial and territorial emergency management organizations (EMOs) [in Canada] have the legislative authority to support a range of emergency management efforts, but current laws do not necessarily position EMOs to influence action on pre-event […] measures. For example, the enforcement of building codes or land-use regulations are delegated to municipal authorities or viewed by provincial ministries as non-emergency management responsibilities.

Differences in legal and administrative structure may further affect the way in which adaptation is developed in different countries. It has, for instance, been shown that the centralised nature of administration in England may have contributed to the fact that adaptation policy has been developed relatively early in a coherent, multi-level fashion across local, regional and national levels in the country. These factors have, however, acted in concert with substantial media attention, a framing of the issue in relation to the well-established priority on flooding in many of the English regions and a more recent considerable local level focus on adaptation as an issue (Keskitalo 2010c). In comparison, in Sweden and Finland the relatively decentralised capacities of local government – despite their being unitary states – have made it possible for municipalities to act on adaptation with regard to flood risk to some extent, notwithstanding what has been an even more limited national focus on local level adaptation (Keskitalo 2010d; Juhola 2010). However, in both countries this has also resulted in rather large differences between

municipalities in the extent to which they incorporate adaptation concerns (ibid.).

Large complexities thus exist in response patterns in different states, necessitating a contextualized understanding. In all cases, however, policy making at the national level may have a responsibility to respond or support responses to emerging risks that are larger than can be dealt with through existing arrangements at lower levels. This could take place through policy development and legislation or through economic incentives, depending on system. Haque and Burton (2005) note that states have been able to take into account such policy opportunities to differing extents – for instance, to learn from flood events and allow these experiences to provide a basis for amendments to legislation that limit risks, such as changes in building codes. It has been noted in some examples that although the structures and distribution of authority to develop incentives – for instance, subsidy systems – differ:

> Policy-makers could consider more creative ways of incentivising flood risk adaptation at the local level, by tapping into motivations not related to flood risks. For example, financial incentives for households, similar to solar panel rebates, could be offered for socio-technological innovations such as rain gardens (a type of bioretention system) or other on-site detention systems. (Godden and Kung 2011: 4064)

Supranational Regulation and Changes in Management Frameworks

Supranational regulation is having an increasing effect on flood management both nationally and directly on lower levels. Supranational regulation originating in the EU plays a considerable role, as directives must be implemented in member states, but international conventions and statements such as the Hyogo Framework for Disaster Management may also play a role. Both of these sources of regulation involve rather complex issues, however: adaptation is only presently emerging as a major concern on the EU (and global) level, and disaster management has often been seen more as a requirement for developing countries. Efficient responses to risk for extreme events such as flooding may to some extent require linking such separately developed frameworks. So far, on the EU level, major documents on adaptation include the Green and White Papers; however, Aakre et al. (2010: 734) have noted that 'the current EU extreme event interventions are clearly not sufficient to cope with future extreme events projected to increase in size and intensity as a result of climate change'.[10] However, a number of water-management instruments exist beyond the presently limited regulation dealing directly

with adaptation: for instance the Water Framework Directive (2000/60/EC), the Floods Directive (2007/60/EC) and the Water Scarcity and Drought Communication (Quevauvillier 2011).

The Water Framework Directive (WFD) is based largely on what has become known as the 'integrated [water management] approach […] as the preferred form of knowledge acquisition and strategy building for environmental management' (McFadden et al. 2009: 636). It has been seen as a way of developing integrated catchment management, which aims to include the variety of impacts on the hydrological cycle across a catchment, with integration of the various interests within it (Holzkämper et al. 2012; cf. Krysanova et al. 2010). Accordingly, the WFD requires implementation of good ecological status in river basin districts, potentially cutting across earlier management boundaries, for example, those of regional or local government. The Water Authority agencies established to manage the districts need to apply prescribed water quality criteria ('good ecological status') and to develop river basin management plans and programmes of measures aimed to increase ecological status in the watercourses. In addition, the WFD requires stakeholder cooperation and consultation within the districts, in particular through the local Water Councils that the directive establishes (Moss 2008).

As a result of the wide scope of the WFD, it has been highlighted that climate change will have effects on WFD implementation and its status objectives. Although water-related disasters such as floods, which may increase with climate change, are not specifically addressed in the WFD, for instance:

> [The] requirement of the directive to collect information on the type and magnitude of 'significant pressures' affecting surface waters [can] be considered as including climate change with the consensus that it is at least to a certain extent caused by human activities [and] would also impact on the achievement of the 'good status' objective of the WFD. (Quevauvillier 2011: 723)

Potential impacts on the WFD due to climate change are also discussed in a guidance document (European Commission 2009) that relates to the White Paper on adaptation: 'One feature of this document is the identification of adaptation strategies […] including by improving the management of water resources and ecosystems' (Quevauvillier 2011: 724).

A more recent addition to the WFD is the Floods Directive, which has been seen as driving progress on flood-risk management in EU member states (Dodds et al. 2010). It is coordinated with the implementation of

the WFD through river management plans, for example, and 'requires EU Member States to assess and manage flood risks, with the aim to reduce adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in Europe' (Quevauvillier 2011: 724). It also explicitly includes climate change, as member states are expected to take into account how climate change affects the occurrence of floods. Assessments are that the Floods Directive, as well as its common implementation with the WFD, could be used to incorporate 'adaptation to climate-related water disasters through risk assessment, monitoring, environmental objective setting, economic analysis and action programmes to achieve well defined environmental objectives' (Quevauvillier 2011: 724; cf. Dodds et al. 2010).

In addition, the EU has also expressed the need for 'linking actors and policies throughout the disaster management cycle' (Sapountzaki et al. 2011: 1448; cf. European Commission 2009). The EU has developed the Community Civil Protection Mechanism (CCPM) to deal with major, mainly transnational, catastrophes (natural, industrial and man-made). The CCPM was established by Council Decision (2001/792/EC) in 2001 and is managed by the European Commission Directorate-General for Environment (DG ENV). In 2005, the EU adopted the Emergency and Crisis Coordination Arrangements (CCA), which can be activated in case of impacts on EU interests, both inside and outside the EU (Wendling 2010).

On the international level, a relevant instrument is the Hyogo Framework for Action under the United Nations International Strategy for Disaster Reduction (UN-ISDR) (Quevauvillier 2011). Focused on resilient communities, the Hyogo Framework identified 'disaster risk management planning as one of the key points of entry to tackle the identified climate change threats' (Prabhakar et al. 2009: 8). While disaster management has historically largely been seen as a focus for developing nations, for example, in national committees developed during the 1990s as part of the UN International Decade for Natural Disaster Relief (cf. Dlugolecki 2000), Birkmann and von Teichman (2010) note that it should now also be linked to climate change adaptation at large. With regard to linking adaptation and disaster management, Prabhakar et al. (2009: 15) note that 'one of the best ways to mainstream climate change concerns in disaster risk management planning is to understand current and future possible impacts and address them in developmental and risk reduction planning'. However, this would require that local-level actors are aware of national and regional climate change risks and thus require capacity building (development of adaptive capacity) across these systems (Prabhakar et al. 2009; cf. Mileti and Gailus 2005).[11] With regard to

advanced industrialised states (such as those treated in this volume), the adaptation focus in the United Nations Framework Convention on Climate Change (UNFCCC) and, for example, the Bali Action Plan is less developed and targets mainly developing countries (IPCC 2012, with the general national reporting requirement being the largest exception). Mention is made, however, in the UNFCCC (Cancun Agreements) of the Hyogo Framework for Action, establishing a general linkage between climate and disaster response (IPCC 2012).

UNDERSTANDING DIFFERENTIAL RESPONSES: THE ROLE OF EVENTS IN DIFFERENT THEORETICAL CONTEXTS

The sections above have discussed the changes in flood policy, from what has been described as an engineering approach focused on structural measures, to a more integrated and also non-structural approach, which should include and integrate different types of actors and frameworks related to water management. However, authors also note that the integrated and stakeholder-oriented focus of integrated water or coastal zone management may not necessarily in itself guarantee that ultimate developments are more integrated. Rather, integration in practice remains a challenge. For instance, McFadden et al. (2009: 644) note that 'the specific success factors that can facilitate process patterns of integrated strategic flood risk are still relatively unknown' (also see Harries and Penning-Rowsell 2011). Similarly, 'calls for watershed-based governance often contain an implicit assumption about the positive benefits of downscaling governance to the local level […] problematic insofar that it implies that the inclusion of stakeholders on an equitable basis across the watershed is possible' (Norman and Bakker 2009: 103). While concerns have been noted in particular with attempts to integrate actors across water management, these could potentially also extend to difficulties in integrating a number of different frameworks. McFadden et al. (2009: 644) note that barriers in the case that they reviewed included 'a lack of clarity regarding the reasons for engaging stakeholders, a lack of goal setting for the integration process, the nature of knowledge bridges and weak cross-scale interactions among decision-makers'.

In this book, a number of different theoretical frameworks are drawn upon in the chapters to understand the factors that may enable or restrict integration among frameworks, including adaptation. Studies of the development of adaptation in flood management in several European

countries have indicated that a number of factors may influence the extent to which adaptation policies and practice are developed. These factors include the importance of administrative cultures, the role of government in different structures, as well as the media, events, public attention and policy entrepreneurs (Keskitalo et al. 2010; Juhola et al. 2011; Keskitalo et al. 2011; Westerhoff et al. 2011). Harries and Penning-Rowsell (2011) propose that development of action on flood risk needs to take into account both the influence of the prevailing institutional system and the influence of exogenous shocks that serve to create shifts in that system. They note that (2011: 188) 'cultures and rationalities have become embedded within these organisations [working with flood management] as a result of previous, more narrowly defined, policies [… This] can present a significant barrier to adaptation and limit the ability of society to respond flexibly and with fairness to climate change' (cf. McCarthy 2007).

Many authors point to the role of events in creating political will to deal with flood risks and potentially with future risks. Extreme events or other exogenous shocks may here play a significant role in including stresses that are less emphasised at present, such as an increasing focus on adaptation to future risks in terms of climate, which has not previously existed as a policy priority. As Harries and Penning-Rowsell note in this regard: 'the resistance resulting from policy feedback can be overcome by what Krasner (1988) calls *exogenous shocks*: events that shake the legitimacy of the assumptive worlds within the architecture of social identities and thereby facilitate change' (Harries and Penning-Rowsell 2011: 191, emphasis in original).[12] In particular has the literature on environmental policy development highlighted the role of extreme events as a type of 'focusing event' for setting the agenda on an issue and potentially opening a window for changing existing policy (cf. Birkland 1998; Farley et al. 2007). Other authors have described extreme events as creating critical moments in discourse or framing (Olsson 2009; Handmer and Dovers 2012). For example, Henstra (2010b: 248) notes that 'emergencies and disasters are the quintessential focusing events. The level of public interest in emergency management can shift dramatically following a major emergency, because an emergency (temporarily) alters peoples' perceived vulnerability to hazards'. In this respect, events may be seen as 'creating a policy window that can be exploited by those seeking policy change' (ibid.).

A focus has thus in some cases been placed in the literature on events, also emphasising those able to exploit events to develop policy. In the agenda-setting literature, for instance, these types of actors are referred to as policy entrepreneurs, defined as persons connected to administration

(ranging from city managers, elected officials, interorganisational and regional planning committees to consultants and interest groups) who are able to drive issues of emergency management – for example, those relating to flood risks – to 'offset' factors limiting development on the issues and deal with the expected issue resistance (Somers and Svara 2009: 183; cf., for example, Kingdon 1995). Henstra points out that these policy entrepreneurs perform a framing role, 'defining problems, mobilizing public opinion, and formulating policy solutions' (2010b: 245–6), and thereby creating a venue and proposed solutions for responding to risks. Potential ways of framing solutions in policy may range from more limited, incremental change based mainly on existing values, through reforms that also include changes in principles and, at the extreme, to 'paradigm shifts' that change policy orientation, values and organisation (Olsson 2009; cf. Boin et al. 2008). Different actors can here be seen as owning different storylines or narrative designs, which are used in framing contests where different storylines, depending on their weight, become used for understanding other actors' framings (Olsson 2009). In such a view, participation by multiple actors may not necessarily result in all views being heard and consensus decisions being reached; rather, coordination and framing conflicts could be expected in light of existing power distribution.

Beyond these kinds of approaches, some authors have tried to comprehend the organisational uses of information in crisis situations by using organisational learning theories which assume that emergency management adjusts and learns in response to changing conditions. Also in this context, a crisis is seen as potentially triggering high uncertainty, prompting new interpretations and supporting organisational learning (Kapucu 2008). Utilising a learning perspective within a focus on agenda-setting, Penning-Rowsell et al. (2006) note that both incremental and large-scale policy changes can be seen as part of continuous learning, influenced by both behavioural and contextual factors but without these as such determining change; rather, they constitute part of the primeval 'policy soup' from which ideas are drawn (Penning-Rowsell et al. 2006; cf. Huntjens et al. 2011). Some authors note, however, that collaborative learning-focused approaches such as adaptive management may be limited by a number of problems that hamper learning and response, including disconnects and problems of transferring learning between different participants and groups (Allan and Curtis 2004).[13] Views of learning that emphasise collaborative elements in a relatively non-conflictual setting may thus contradict the view adopted in certain framing and discourse approaches that include a focus on established

interests or discourses and a resistance to change (see, for example, Flyvbjerg and Richardson 2002).

Literature thus reveals a tension between incremental and 'catalytic' change as well as a problematisation of the possibilities and factors that may affect moving beyond the status quo. While different approaches – some of which are applied in this volume, such as historically contextualised, learning, and adaptive capacity approaches – highlight varying levels of conflict and processes of change, using differing approaches may serve to better help us understand the multifaceted ways in which flood responses are developed at present and will be developed in the future. Drawing upon reasoning based on a focus on agenda-setting on flood policy, Penning-Rowsell et al. (2006: 324) propose a likely general development with regard to adaptation to increased flood risk:

> First, that policy adaptation to increased flooding will be a continuation of the mix of incremental change over long periods of time and catalytic change at times of flood 'crisis' that we have seen in the past half-century […] and that the catalytic process is, in general, the more readily observable and dramatic agent of policy change.

They suggest, additionally, that new policy will be 'not based on the development of new ideas but on bringing forward existing ideas that are already the subject of widespread professional or public discourse within the incremental evolution of policy ideas in the precrisis period' (Penning-Rowsell et al. 2006: 324).

This provides the basis for an assumption similar to that applied in this work – that present developments and coping may be seen as indicators of future adaptive capacity and adaptation. Penning-Rowsell et al. (2006: 324) observe: 'We may therefore be able to detect now, as "signals" within current policy discourse, the embryos of the policy shifts that are likely to come about as part of any crisis-response adaptation to future climate change in so far as this affects the frequency and severity of future flooding.' Thus, 'if this is the case those with policy responsibilities may be able to begin carefully and proactively to prepare the ground for such policy changes ahead of the crisis events that alone will provide the necessary "window of opportunity" to trigger their acceleration and adoption' (ibid.). Possibilities to draw lessons between countries may thus be based not on the premise that specific adaptations may be directly transferable between potentially largely differing national contexts, but on the premise that actions can be modified or used to inspire specific actions targeted to different contexts (Keskitalo 2010b).

VOLUME OVERVIEW

This book includes a number of chapters that in different ways draw upon approaches for understanding flood policy development in relation to adaptation to climate change. The focus adopted is placed on the municipal (local) level but in the context of higher levels.

Chapter 2 reviews the policy responses, viewed in relation to adaptive capacity, of the 2002 major flood in Saxony, Germany. The study examines the extent to which adaptations to flood risk events – policy responses as well as physical measures – have been put in place, particularly in response to the risk of flood increase with climate change. Drawing upon the broad framework of adaptive capacity determinants, the study reviews the extent to which institutional, informational, economic, technological and infrastructural, and equity-based arrangements have supported or limited flood response. It confirms the considerable importance of nested institutional arrangements and the communication between these levels and notes the key role of comprehensive climate data in supporting adaptation.

Chapter 3 reviews the development of flood management measures on Torne River, which runs along the border between Sweden and Finland, measures that have been extended considerably with the implementation of the EU Floods Directive. The study reviews responses to particular events in the area from an adaptive capacity viewpoint with a focus on cooperation between Sweden and Finland in flood response as well as cooperation in Haparanda-Tornio and selected other municipalities. Illustrating the ways in which work on the EU WFD and Floods Directive has galvanised responses in the area, the chapter discusses differences in flood emergency management regimes and the role of existing institutional and knowledge capacities in the two countries.

Chapter 4 reviews the system of flood response in Canada, thereby highlighting the complexity of developing integrated flood and adaptation responses in a federal system outside the EU. The chapter illustrates the way in which flood management has developed over time in Canada and the way a larger role is attributed to the local level in the present phase of flood management. On this basis, the ways in which flood management in Canada can incorporate adaptation at the local level are discussed.

Chapter 5 further reviews changes in flood policy in Saxony, Germany, and the EU in the aftermath of the extensive 2002 flood event that affected more than 600 000 people across Europe. Drawing upon the broader case study described in Chapter 2, this chapter applies the advocacy coalition framework and the theory of focusing events to assess

policy changes and policy learning in the case. The study highlights interaction across levels in this federal case and how learning within as well as competition and collaboration between different groupings can lead to better flood policies.

Chapter 6 reviews a case of flooding in northern Canada in the largest inland delta in North America. It uses a narrative methodology to capture the impact of policy and procedures developed to anticipate, respond to and control floods (both structural and non-structural measures) in regions of the Canadian provinces of Manitoba and Saskatchewan. Comparing two floods in 2005 and 2011, respectively, the chapter argues that effective flood memory in a northern indigenous community can be a source of adaptive capacity that can contribute to a community's resilience.

Chapter 7 reviews the development of flood protection and prevention in northernmost Finland, an area increasingly impacted by floods in the 2000s, in terms of change over time in flood protection regimes. The study discusses changes in the flood protection frameworks in the region from the 1960s onwards, and points out the different framings flood response has been given, with a focus on the local level. The study also reviews the changing power relations in flood response between stakeholders, including the municipality, environmental and indigenous interests, highlighting the role of different framings of flood events.

Utilising a narrative methodology, Chapter 8 describes and analyses how Canadian watershed management played out in a local case in Carrot River, Saskatchewan. The research describes the ways in which arguments were put forward by different groups in relation to local water management, illustrating this as both a conflicted issue and an issue that to some extent contributed to local community-building processes.

Chapter 9 discusses how the risk of floods is viewed in the Netherlands, which due to its natural environmental features has a long tradition of water management and has naturalised these approaches in planning to a high extent, as well as to some extent integrated adaptation planning into water management frameworks. The study reviews the practical development on flood-risk response within network cooperation on flood risk, illustrating the historical as well as present role of cooperative as well as governmental planning in relation to the role of leadership at different levels in the municipality.

The final chapter revisits the major issues investigated in the book regarding the water and emergency management and present coping responses in relation to planned adaptation to future risk. It addresses the question of the extent to which different cases in the book utilise or develop adaptation tools, or relate to future risks in their planning. The

chapter further discusses the possibilities to draw conclusions from floods in low-lying areas or more severe events for adaptation planning and responses in general as well as for areas with differential resources and interest groups to deal with flood response and adaptation. In this, the chapter in particular highlights the different types of contributions possible through different theoretical frameworks and studies at different levels, in order to illuminate the development and context of adaptation responses.

NOTES

1. However, the boundary between 'normal' and 'new' variability is not obvious (Muller 2009: 298), a fact that makes it even more important to plan for a wide variety of potential impacts.
2. The current study mainly limits itself to responses to floods as one of the manifestations of impacts on water resources and the society at large; it does not focus on water security in a broader sense. Sadoff and Muller (2009) define water security in terms of reliable availability, and quality and quantity of water. Impacts on the water system will occur in manifold instances (for instance, as effects on water availability for industries such as hydropower) and manifest as droughts (Sadoff and Muller 2009). General hydrological issues related to other events such as drought thus fall outside the scope of the research.
3. Hunt and Watkiss (2011) also surveyed studies of adaptation to climate change at city level (however, using a somewhat restricted sample focusing on studies of large-scale cities including quantitative elements). They noted (2011: 20) that the 'majority of studies are single-issue, with sea level rise the most common focus, reflecting the fact that many major cities, and, indeed, over 50% of the world's population, are located in low lying areas and so potentially vulnerable to sea level rise'.
4. Vulnerability to climate change has often been conceived of as a result of exposure-sensitivity minus adaptive capacity (Smit et al. 2000; Smit and Wandel 2006). Exposure-sensitivity is defined as the sum of the exposure to climate change and sensitivity to this exposure (that is, the total impact).
5. For instance, Bourget (2002: 59–60) notes a number of requirements with regard to institutional, technical, infrastructural and cultural factors in relation to water management. He notes, for instance, that these may include the policy framework, such as the existence of basin-wide management plans, effective regulatory policies addressing flood plain residence, some local autonomy to adapt to risks, coordinated information management facilities within the basin, balance between structural and non-structural measures, and an 'open[ness to] […] innovative ideas regarding flood risk reduction on the regional level'.
6. For instance: 'In the natural hazards community, mitigation is defined as the wide array of actions that can be taken to reduce vulnerability. In the language of the United Nations Framework Convention on Climate Change (UNFCCC), the reduction of carbon dioxide and other GHGs and carbon sequestration in soils and biomass is referred to as 'mitigation'. Also, in the climate change world, the idea of vulnerability reduction is called 'adaptation'. Such varied usage of terms makes communications between the natural hazards and climate change communities difficult' (Haque and Burton 2005: 341).

7. 'Brown and Farrelly (2009) identify twelve barriers to delivering sustainable urban water management, none of which is lack of technical innovation. Critical constraints from this research, pertinent to adapting to flood risk include: uncoordinated institutional frameworks; ineffective regulatory frameworks; limited community engagement, empowerment and participation; unclear, fragmented roles and responsibilities; technocratic path dependencies; and little or no monitoring and evaluation' (Godden and Kung 2011: 4061).
8. In relation to such schemes, 'managed realignment [whereby the actively maintained line of flood defence is repositioned landwards] is the preferred option for sustainable coastal defences in the UK' (Myatt et al. 2003: 173); however, this may provoke local conflict with communities which are not content with surrendering existing land to the sea or disallowing development in certain areas (Myatt et al. 2003).
9. Differences in legal terms exist, of course, in these frameworks, but also in the system by which laws are interpreted: if no statute has been enacted by the legislative branch of government, Common Law countries can distil relevant law from key principles in court decisions. In Civil Law systems, law is assumed to be codified, leaving it to courts to only interpret and apply the laws on the books (McDonald 2011: 284). 'The limitations of substantive adaptation laws suggest that energy may be better directed at improving the adaptiveness of existing laws' (McDonald 2011: 291).
10. For instance, Aakre et al. (2010: 722) note that this is because 'no specific rationale for adaptation intervention is given in these official documents [the Green and White Papers on Adaptation to Climate Change]'.
11. A number of distinctions also exist with regard to classifications of types of extremes into natural and non-natural; this matter will not be taken up here (cf. Haque and Burton 2005).
12. Harries and Penning-Rowsell (2011) propose that action on flood risk include both the influence of the prevailing institutional system and the influence of exogenous shocks that serve to create shifts in this. These views largely correspond with the 'punctuated equilibrium' assumptions of authors like Baumgartner and Jones (1993), who view policy development on any given issue as long periods of stagnation punctuated by periods of rapid change (Penning-Rowsell et al. 2006).
13. Somewhat similarly, Connelly (2011: 4003) notes: 'Given that there has been rather limited success with the implementation of reforms attempting to integrate and coordinate management systems, it is worth asking whether more can be done by requiring less cooperation. It may well be that a river rehabilitation program based on an institution […] will be more in keeping with the messy realities that characterize complex pluralist federal political systems with their competing jurisdictions and many competing stakeholders.'

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