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From theory to practice

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Planning for Climate Change in Urban Areas: From Theory to Practice

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Abstract

Climate change poses a serious threat to sustainable urban development, placing many cities at risk. Consequently, city authorities face the challenge of finding ways to include adaptation strategies into their work, although related knowledge and competence is still scarce and fragmented. With the aim of contributing to knowledge development and organizational learning, the objective of this paper is to critically review and compare current theoretical and practical approaches to adaptation planning in cities. First the conceptual characteristics and features of a climate-resilient city are identified. Second, the reciprocal linkages between climate-related disasters, urban form and city planning processes are analysed – by taking into account the life cycle of disasters from causes, to short- and long-term impacts, and post-disaster response and recovery. Finally, urban adaptation measures proposed for both developed and so-called developing countries are assessed. On the basis of the differences, gaps and synergies identified between theoretical and practical approaches to adaptation planning, the implications for improving sustainable urban transformation are discussed.

Keywords

Adaptation, climate change, disaster, risk reduction, urban planning, urban resilience, urban transformation

1. INTRODUCTION

Climate change poses a serious threat to sustainable urban development, placing many cities at risk. The worldwide rate of so-called natural disasters has almost quadrupled in the last 30 years, resulting in escalating human and economic losses (UNISDR, 2012a). Despite many uncertainties concerning the magnitude and frequency of hazards, and their specific impacts, climate change will inevitably increase the susceptibility of urban societies if no effective adaptation takes place (IPCC, 2007; UNHABITAT, 2011). Historically, cities have been − and often still are − perceived as providing refuge from disasters and as buffers against environmental change. Today, however, they are better described as risk and disaster hotspots (Pelling, 2003; UNDP, 2004). The environmental changes humanity faces are deeply intertwined with complex urbanization processes and happen at a previously unseen rate and magnitude (EEA, 2012; O'Brien and Leichenko, 2008).

Consequently, city authorities face the challenge of finding ways to include adaptation strategies in their work. However, as climate change adaptation is a relatively new field of activity, related knowledge and competence is still scarce and fragmented (UNISDR, 2010a). While urban planners are generally regarded as responsible and capable of adapting to disasters and climate risk (Stern, 2006; IPCC, 2007) their role, the actions to be taken, and the responsibilities of city authorities are often unclear (Greiving and Fleischhauer, 2012).

With the aim of contributing to knowledge development and organizational learning for local adaptation planning, the objective of this paper is to critically review and compare current theoretical and practical approaches to adaptation planning in cities, and discuss their implications for achieving sustainable urban transformation. First, the research methodology is described (Chapter 2) and the conceptual characteristics of a disaster-resilient city are identified (Chapter 3). Next, the reciprocal links between climate disasters, urban form and city planning processes are analysed – by taking into account the life cycle of disasters: from causes, to short- and long-term impacts, and post-disaster response and recovery (Chapter 4). Chapter 5 assesses the most popular urban adaptation measures and strategies in both high- and low-income nations.[1] Differences, gaps and synergies between theoretical and practical approaches to adaptation planning are identified, and the implications for sustainable urban transformation are discussed (Chapter 6).

2. METHODOLOGY

This paper provides a critical review and comparison of current theoretical and practical approaches to adaptation planning in cities, and discusses their implications for sustainable urban transformation. The two main research questions are:

1. Is current urban adaptation practice based on a solid theoretical understanding of risk, mainstreaming, and adaptation (as described in Chapter 3)?
2. Is current urban adaptation practice based on a solid theoretical understanding of the city-disasters nexus (as presented in Chapter 4)?

The paper is based on the following two hypotheses: First, current adaptation practice does, as yet, not tap into its full potential to reduce and adapt to increasing urban risk. Second, the integration of theoretical and practical state-of-the-art understanding and approaches may provide more comprehensive and appropriate models. More specifically, it is assumed that a clearer understanding

[1] This paper examines adaptation practices in low-, middle-, and high-income nations. The categorization of nations is supported by e.g. The World Bank, which classifies countries each year based on the previous year's gross national income (GNI) per capita (The World Bank, 2012). In this context, low- and middle-income nations are sometimes referred to as "developing countries" or the "Global South", although definitions, and consequently the countries that fall into the category, differ slightly. Similarly, high-income nations are sometimes referred to as "developed countries" or the "Global North". Where possible, the terms "more developed community" and "less developed community" (or settlement) are used in this paper for a more nuanced discussion, and to acknowledge differences that exist within the same hemisphere, country or even city.

of the differences, gaps and synergies between theoretical and practical approaches will yield important insights into ways to improve local adaptation planning.[2]

The research consisted of four methodological steps.

- In the first step, the characteristics of disaster- and climate-resilient cities were identified through a review of theory and concepts related to disaster and climate risk.
- In the second step both recent and the decades-old literature on urbanization, city ecology, and urban climate comfort was reviewed to analyse the links between urban form, climate and their relation to risk (e.g. Adam, 1988; Bosher, 2008; Brenner and Keil, 2006; Emmanuel, 2005; Givoni, 1998; Hall and Pfiffer, 2000; Kay et al., 1982; Koch-Nielsen, 2002; Konya and Swanepoel, 1980; Legates and Stout, 2000; Mumford, 1968; Olgay, 1963; Roaf et al., 2005; Salmon, 1999; Simmel, 1960; UNHABITAT, 2007, 2010, 2011; Weber, 1966; Wirth, 1938; Worldwatch Institute, 2007).
- Next, current adaptation practice was assessed through a meta-evaluation of recent cross-country studies that included high-, middle- and low-income nations (e.g. Carmin et al., 2012; Brooks et al., 2009; Davoudi et al., 2010; EEA, 2012; European Commission, 2009; Fujikura and Kawanishi, 2010; Gagnon-Lebrun and Agrawala, 2006; Greiving and Fleischhauer, 2012; Kazmierczak and Carter, 2010; Lourenço et al., 2009; Massey and Bergsma, 2008; Meister et al., 2009; Mickwitz et al., 2009; Ribeiro et al., 2009; Roggema 2009; Schuster, 2008; Swart et al., 2010; UNISDR, 2004, 2010a, 2010b, 2011, 2012b, 2012c). The meta-evaluation was complemented by an analysis of a selection of information-rich country- and city-specific studies (e.g. Alam and Rabbani, 2007; German Stadtklimalotse, 2012; Greater London Authority, 2010; Jabeen et al., 2010: UKCIP, 2011).
- Finally, the last step was to contrast theoretical understandings of climate and disaster risk and the links between urban form, climate and risk with current adaptation planning.

This study is part of a broader research project on *Cities, Disaster Risk and Adaptation* carried out in 2011–12 for a Routledge book of the same title (Wamsler, 2013). The project was partially supported by Training Regions (Training Regions, 2011), a public–private partnership that promotes safety, security and sustainability in cities and regions.

3. LINKING DISASTER RISK, ADAPTATION AND RESILIENCE: A CONCEPTUAL FRAMEWORK

"Disaster risk" refers to risk related to climatic and non-climatic hazards, while "climate risk" only refers to risk related to climatic hazards. Climatic hazards include floods, windstorms, droughts, fires, heat and cold waves, sea level rise (water surges) and landslides (IPCC, 2007, 2012). Non-climatic hazards include earthquakes and volcanic eruptions. As this study is based on a comprehensive understanding of risk, the term "disaster risk" is used throughout the text. UNISDR (2009: 25) defines disaster risk as, "the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period." This definition reflects the disaster concept as the outcome of continuously present risk conditions, and is often expressed as a product of hazard (*H*) and vulnerability (*V*) ($R = H \times V$) (UNISDR, 2009).

Disasters are thus commonly understood as the result of an interaction between so-called "natural" hazards (*H*) and vulnerable conditions (*V*) (UNISDR, 2009; Wisner et al., 2004). Consequently, hazards alone do not cause disasters. Unlike hazards, the concept of vulnerability is more complex and multifaceted.

In simple terms, disaster vulnerability is the degree to which communities or societies are "susceptible to the damaging effects of a hazard" (UNISDR, 2009:30). It describes the existing conditions, characteristics and circumstances of an area exposed to one or several hazards, where a highly vulnerable area is understood as being incapable of resisting their impacts (UNISDR, 2009).

[2] Note that this does not assume that decision-makers automatically implement any "right" measures and strategies that may be prescribed by the theory.

Vulnerability and risk are therefore different concepts, although in the literature they are often used as synonyms.[3]

Based on the described understanding of disasters and risk, UNISDR defines disaster risk reduction as, "the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events" (UNISDR, 2009:10).

Identifying how risk can be reduced is crucial in order to better understand its complexity and meaning, which city authorities and planners need to sustainably adapt to increasing risk. The definition of risk given above makes reference to assessing risks, reducing hazard exposure, lessening vulnerability, and improving preparedness. It can be translated into an operational understanding expressed by the following risk reduction measures:

1. Measures to reduce or avoid hazards (i.e. hazard reduction or avoidance; sometimes also called prevention);
2. Measures to reduce the susceptibility of the affected location to withstand hazards (i.e. vulnerability reduction; sometimes also called disaster mitigation);
3. Measures to improve post-disaster response mechanisms and structures (also called preparedness for response); and
4. Measures to improve post-disaster recovery mechanisms and structures (also called preparedness for recovery). (cf. Wamsler, 2009).

Risk assessment is not itself a risk reduction measure; it is inherent in the risk reduction measures listed above (Coppola, 2011).

The first measure listed above addresses the first risk component (i.e. hazard *H*) while the other three address the second risk component (i.e. vulnerability *V*). Consequently, whether a specific area is vulnerable (or not) to a hazard, depends not only on location-specific conditions (e.g. the built environment; construction materials and the orientation of structures in space; population density; people's livelihoods, savings, physical capital, health and wellbeing; natural resources; resource degradation; and the existence of equality, peace and security) but also the ability of the population and institutions to react, both in the form of disaster response and recovery.

Disaster risk reduction, disaster response and disaster recovery are the three main phases of (urban) disaster risk management (Coppola, 2011). However, risk reduction is very different from disaster response and recovery in the sense that it is a cross-cutting (or mainstreaming) issue that is important throughout the disaster cycle (UNISDR, 2005).

While disaster risk reduction and climate change adaptation have in the main developed independently, they share the aim of reducing the occurrence and impacts of climate-related disasters and associated risk (IPCC, 2007, 2012; UN-IATF/DR, 2006; UNISDR, 2008) and must both be integrated into all kinds of sector work (including urban planning). Therefore, in the context of this study the terms risk reduction and adaptation are used as synonyms.

With risk reduction and adaptation being a cross-cutting topic, city authorities and planners do not only have to be familiar with how risk can be reduced. They also need to know how adaptation can be integrated or mainstreamed into urban planning practice (Greiving and Fleischhauer, 2012).

The term "mainstreaming" generally means the modification of core work in order to incorporate a new aspect or topic and indirectly act upon it (Holden, 2004). It does not mean a complete change in an organization's core functions and responsibilities; instead it means looking at them from a different

[3] This is also related to the fact that the fields of disaster risk reduction and climate change adaptation have in the main developed independently, and concepts such as vulnerability, capacity and mitigation are used in both fields with slightly different connotations (UN-IATF/DR, 2006; UNISDR, 2008). In contrast to risk literature, adaptation literature sees vulnerability as a function of exposure, sensitivity and adaptive capacity, which is similar to the concept of risk described here. Exposure is here conceptualized under the term hazard, while sensitivity and adaptive capacity form part of the concept of vulnerability.

perspective and making any necessary alternations, as appropriate. It is about "looking into what already exists", in order to "not re-invent the wheel", and to "pick people up from their doorsteps", and "build as much as possible on existing structures, mechanisms and procedures" (Jürgens, 2011).

Many studies have looked at mainstreaming (or integrating) cross-cutting issues such as climate change adaptation and disaster risk reduction into sector work. These include:

a) Guidance notes for integrating adaptation into recovery planning (IRP, n.d.);
b) Tools for mainstreaming risk reduction into development planning (e.g. Benson et al., 2007; LaTrobe and Davis, 2005; Mitchell, 2003); and
c) Benchmarking handbooks (e.g. Ballard et al., 2008; Stephenson, 2008) and other training material (e.g. ADPC, 2006; Care International, 2009; FAO/ILO, 2009; IISD, 2007; Oxfam, 2002; SDC, 2009; Tearfund, 2009, 2011).

Although these studies address different (and often quite specific issues) that are key to the integration of adaptation into urban planning and other sector work, they do not provide a comprehensive and operational understanding of mainstreaming, i.e. the strategies required to achieve sustainable change.

Such strategies are presented in Table 1. They were prepared on the basis of the analysis and systematization of existing mainstreaming studies and have been validated in practice (cf. Wamsler, 2009, 2013). Strategies I and II focus on the local programme level; Strategies III and IV on the operational capacity and functioning of the implementing body; and strategies V and VI on sector work in general. The latter includes the promotion of (more) distributed risk governance systems as well as science-policy integration through the creation of better opportunities for researchers, practitioners and policymakers to exchange information; the inclusion of practitioners and policymakers in academic projects; and stronger involvement of governments and policymakers in university education (cf. UNISDR, 2011).

Table 1: Overview of strategies to integrate climate change adaptation into urban planning

Strategies focused on the local programme level (e.g. urban development programmes)

- **Strategy I** (also called add-on risk reduction or adaptation)**:** Implementation of programmes or programme components that are explicitly and directly aimed at reducing or adapting to risk, and are not part of the implementing body's sector-specific work.
- **Strategy II** (also called programmatic mainstreaming)**:** Modification of sector-specific work to reduce the likelihood that programme measures increases risk and to maximize the measures' potential to reduce risk.

Strategies focused on the operational capacity and functioning of implementing bodies (i.e. city authorities)

- **Strategy III** (also called organizational mainstreaming)**:** Modification of the organization's management, policy, legislative corpus, working structures and project implementation tools in order to assure the integration of risk reduction and adaptation at the local programme level and to further institutionalize it.
- **Strategy IV** (also called internal mainstreaming)**:** Modification of an organization's operations and internal policies to reduce its own risk in terms of impacts created by disasters and climate change and assure its ongoing functioning.

Strategies focused on urban sector work in general and related educational bodies

- **Strategy V** (also called inter-organizational mainstreaming for risk governance)**:** Promotion of cooperation between urban actors to foster capacity development for risk reduction and adaptation and its harmonization within the management and functioning of different organizations (working in disaster response, recovery and development).
- **Strategy VI** (also called educational mainstreaming)**:** Support for a conceptual shift in sector-specific education so that risk reduction and adaptation are incorporated into the professional sphere.

Source: Adapted from Wamsler, 2013

The names of the six strategies are not crucial, and related measures can thus be found under many different headings. For example, the recent study by the United Kingdom Climate Impacts Programme on *Identifying adaptation options* discusses issues related to Strategy III under the

headings “Changing or developing regulations, standards, codes, plans, policy or programmes” and “Internal organizational development”; and Strategy V under the title “Working in partnership” (UKCIP, n.d.).

The term “resilience” has become prominent in disaster literature and an increasing number of articles and books discuss its meaning and how it has evolved (Béné et al., 2012; Cannon and Müller, 2010; Comfort et al., 2010; Zolli and Healy, 2012; etc.).[4] In a disaster risk perspective, resilience refers to “[t]he ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions” (UNISDR, 2009: 24). A disaster resilient city is therefore one that readily withstands or overcomes all types of disasters, including both climate and non-climate related, and small- and large-scale events.[5] In an ideal scenario, such a city empowers its inhabitants to cope with natural threats and therefore secures their livelihoods, and it rapidly adjusts its social, political and economic systems to compensate for damage, carry out repairs, and learn and evolve from experience (Wamsler, 2006). From this it follows that, in the context of climate change adaptation and disaster risk reduction, resilience can be seen as the antithesis of risk. Consequently, risk is generally discussed in relation to particular population groups, sectors or places, whereas resilience tends to be discussed in relation to what helps to protect them. However, this does not imply that cities will become completely disaster-resistant, or that the *only* goal of urban climate change adaptation and disaster risk reduction is to eliminate risk. Instead, the goal is to *work towards* disaster resilience and sustainability. This is achieved by expanding the focus from attempts to prevent, control, or resist extreme weather events into a broader systems resilience framing in which we learn how to live with a constantly changing, sometimes risky environment (Cannon and Müller, 2010; Morss et al., 2011; UNSIDR, 2012b).

Bringing together the terms of disaster, disaster risk, risk reduction, adaptation and resilience, a disaster resilient city can be understood as a city that has managed to successfully support measures to strengthen the capacity of individuals, communities and institutions to: (a) Reduce or avoid current and future hazards; (b) reduce current and future susceptibility to hazards; (c) establish functioning mechanisms and structures for disaster response; and (d) establish functioning mechanisms and structures for disaster recovery. This can only be achieved if city authorities and planners succeed in mainstreaming adaptation into urban planning by:

a. Ensuring that programme activities do not increase and, ideally, reduce current and future risk (cf. Strategy II, Table 1);
b. Institutionalizing risk reduction and adaptation so that its integration at programme level becomes a standard procedure (cf. Strategy III, Table 1);
c. Ensuring that their own organization can continue to function when faced with disaster and climate change (cf. Strategy IV, Table 1);
d. Cooperating with others to create a functioning multi-level system of governing urban risk (cf. Strategy V, Table 1); and possibly
e. Promoting the improved education of professionals regarding risk reduction and urban resilience (cf. Strategy VI, Table 1).

Related actions can be incremental or transformative; i.e. they either improve existing risk reduction approaches to maintain systems functions or provoke systemic change for long-term sustainability (IPCC, 2012; Pelling and Manuel-Navarrete, 2011).It results in the delivery of adaptation actions on the one hand, and the building of adaptive capacity on the other (cf. UKCIP, n.d; Wamsler, 2013).

4. THE CITY-DISASTERS NEXUS: A CONCEPTUAL FRAMEWORK

In-depth knowledge on the city-disasters nexus is crucial, allowing city authorities and planners to mainstream adaptation; that is: to modify their work so as to act upon increasing risk and, ultimately,

[4] This recent phenomena is however, controversial. Some argue that in replacing the term vulnerability, resilience conveniently takes the focus off the root causes of vulnerability (i.e. political and economic systems), and instead only looks at the need to build capacity (Cannon and Müller, 2010; Wamsler, 2013).
[5] In this context, the term climate resilience can be perceived as part of disaster resilience.

achieve disaster-resilient cities. The perception that disasters are the (uncontrollable) cause, and the destruction of the built environment is the effect, is widespread (Bosher, 2008). Consequently, planning responses are limited, mainly focussing on physical issues and the post-disaster context. The reality is, however, more complex.[6]

Urbanization brings about profound physical, environmental, socio-cultural, economic and political changes which mean that urban areas are unlike rural areas (LeGates and Stout, 2000; Mumford, 1968; UNHABITAT, 2007, 2011; Weber, 1966). Cities are thus characterized by distinctive physical, environmental, socio-cultural, economic and political features. It is necessary to understand these features in order to systematically and comprehensively analyse the reciprocal relationship between cities and disasters in a systematic and comprehensive way.

4.1 City features

Urbanization finds its visible expression in the **urban fabric**, which is characterized by distinctive **physical features** such as population density; land coverage and vegetation; architectural details; the organization of structures in space; and the relationship between buildings and topographic features (Table 2).[7]

Table 2: Distinctive physical features of cities: The urban fabric

Physical features	Urban characteristics
Population density	○ Population density and overpopulation (increased) ○ Access to marginal areas (reduced)
Land coverage and vegetation	○ Built-up surface area (increased) ○ Size, location and distribution of green and recreational areas (reduced) ○ Tree coverage (reduced) ○ Access to affordable space (reduced) ○ 'Consumption' of land (including rural land) (increased)
Architecture	○ Height of buildings (increased) ○ Differences in the height of buildings (more varied) ○ Construction materials and colours (different; more influential e.g. of streets) ○ Construction techniques (less traditional, more advanced) ○ Shape of buildings (more varied and/or more restricted)
Organization of structures in space	○ Distance between buildings (reduced) ○ Concentration and interdependence of buildings, services and technical infrastructure (increased) ○ Concentration and interdependence of political and economic centres (increased) ○ Orientation of buildings (more restricted) ○ Street layout and street orientation (denser, more restricted)
Relationship between buildings and topographic features	○ Proximity to large bodies of water (reduced) ○ Relation to nearby hills and valleys (more difficult to account for) ○ Sloping terrain (more difficult to account for)
Infrastructure	○ Infrastructure network density and connectivity (increased, more congested) ○ Dependency on infrastructure network (increased) ○ Flows (e.g. material and people) (increased)

Source: Adapted from Wamsler, 2013

Many of the environmental, socio-cultural and economic issues that make urban areas different to rural areas can be attributed to the above physical features of the urban fabric. This becomes

[6] This Chapter is based on a review of the following publications (amongst others): Adam, 1988; Baehring, 2011; Bosher, 2008; Brenner and Keil, 2006; EEA, 2012; Emmanuel, 2005; Givoni, 1998; Hall and Pfiffer, 2000; IFRC, 2010; Kay et al., 1982; Koch-Nielsen, 2002; Konya and Swanepoel, 1980; Legates and Stout, 2000; Mumford, 1968; Olgay, 1963; Roaf et al., 2005; Salmon, 1999; Simmel, 1960; Tacoli, 2012; Turpeinen, 2008; UNHABITAT, 2007, 2010, 2011; Wamsler et al., 2012; Wamsler and Lawson, 2012; Weber, 1966; Wirth, 1938; and Worldwatch Institute, 2007 (cf. Chapter 2: Methodology). References are only included in the following text when they refer to a specific publication (out of the ones mentioned above).

[7] Note that the characteristics and related connotations (i.e. increased or decreased) described in Tables 2–5 are only an indication and do not apply to all cities.

especially obvious when looking at the **environmental** changes. These changes are manifested in the **urban ecosystem**, which is characterized by distinctive features related to precipitation; wind; temperature; air quality; humidity; solar radiation; soil; water bodies; flora; fauna; noise; waste and waste water (Table 3) (Adam, 1988).

Most of the environmental features listed in Table 3 are directly related to the characteristics of the urban fabric. The main causes are the sealing of green areas for construction as well as high population density, which results in (amongst others) increased energy use, emissions and heat. The latter, known as the "heat island effect", is the result of heat storage, radiation and outlet air from heating, industrial processes, traffic, etc. (Adam, 1988).

Precipitation, wind, temperature, air, humidity and solar radiation are known as the abiotic ecological factors of the typical **urban climate.** The urban climate is generally rainier, less windy, hotter, more polluted, less humid, and cloudier than surrounding areas (Adam, 1988; Emmanuel, 2005; Givoni, 1998; Kay et al., 1982; Koch-Nielsen, 2002; Konya and Swanepoel, 1980; Olgay, 1963; Roaf et al., 2005; Salmon, 1999) although there are many intra-city differences (e.g. localized wind currents and turbulence).

Table 3: Distinctive environmental features of cities: The urban climate

Environmental features	Urban characteristics
Precipitation	o Rainfall (increased) o Snowfall (reduced)
Wind	o Wind speed and exchange (reduced) o Local wind circulation, gusts and turbulence (increased)
Temperature	o Temperature (increased)
Air quality	o Emissions (increased) o Dust particles (increased)
Humidity	o Air humidity (reduced) o Fog and cloud (increased) o Evaporation (reduced)
Solar radiation	o Amount of natural lighting (reduced) o Intensity of solar radiation (reduced)
Soil	o Ground sealing and compression (increased) o Soil quality (reduced)
Water bodies	o Ground water level (reduced) o Ground water quality (reduced) o Surface water quality (reduced) o Water flows (more regulated) o Dependency on other (rural) ecosystem services
Flora	o Vegetation cover (reduced) o Biodiversity of vegetation (reduced, specific city vegetation) o Growing season (increased) o Vegetation forms (generally reduced/ but specific forms on facades, roofs, etc.) o Dependency on other (rural) ecosystem services
Fauna	o Species biodiversity (generally reduced, overpopulation of some species)
Noise	o Noise (increased)
Waste and waste water	o Amount of waste (increased) o Type of waste (more hazardous) o Waste water (increased waste water/ increased mix of rainwater and backwater)

Source: Adapted from Wamsler, 2013

At first sight the **socio-cultural features** which characterize urban areas are less connected to the physical changes caused by urbanization. They manifest in a characteristic **urban society and culture** (**urban life**) which has distinctive features related to family structures; social cohesion; social inequality; public participation; values; and population diversity (Table 4) (LeGates and Stout, 2000; Wirth, 1938).

Table 4: Distinctive socio-cultural features of cities: The urban society and culture

Socio-cultural features	Urban characteristics
Family structures	o Nuclear family structures (increased) o Extended family structures (reduced) o Female-headed households (increased/reduced)
Social cohesion	o Sense of community (reduced) o Sense of family and family obligations (reduced) o Local leadership structures (reduced) o Anonymity (increased)
Social inequality	o Segregation of different population groups (increased) o Gender equality (increased)
Public participation	o Public participation (reduced)
Values	o New value systems (increased individualism, etc.) o Traditional/ indigenous knowledge (reduced) o Secularization (increased) o Consumerism, (increased; e.g. consumption of meat, fast food, energy) o Formal education (increased) o Illiteracy (reduced)
Diversity of people	o Population diversity/heterogeneous communities (increased)
Health and security	o Health status (generally increased; certain health problems, e.g. obesity may increase) o Violence and organized crime (increased)

Source: Adapted from Wamsler, 2013

In-depth analyses have however shown that several of these socio-cultural aspects of cities are directly linked to the physical features of the urban fabric. For example, high population density, overpopulation, lack of affordable space, and the lack of green and recreational areas can influence family structures, social cohesion and sense of community. In overcrowded conditions, issues such as competition for space and poor infrastructure (e.g. lack of, or leaking waste water pipes) can generate conflicts between neighbours. Likewise, the failure of infrastructure to provide adequate water, sanitation, drainage, roads and footpaths increases the health burden, workload and insecurity of residents, especially women (IFRC, 2010; Tacoli, 2012). For example, houses that lack water and sanitation force girls and women to seek toilets or washing areas away from their homes, and inadequate transportation infrastructure forces citizens to cross insecure areas. Furthermore, difficult access to urban areas, together with a lack of public leisure space can isolate certain groups (such as the elderly and women with small children) and make them even more "bound" to their compact homes.

Finally, urbanization leads to **economic and political** changes. These manifest in the **urban economy** and **governance system** which, unlike rural areas, relies upon non-agricultural (vs. agricultural) incomes and a money (vs. subsistence) economy; and which is characterized by urban-specific livelihood practices; resource availability; public expectations; and public reliance on institutions and social security systems (Table 5) (e.g. LeGates and Stout, 2000; UNHABITAT, 2007, 2011).

Table 5: Distinctive economic and political features of cities: The urban economy and governance system

Economic and political features	Urban characteristics
Agricultural vs. non-agricultural incomes	o Agricultural versus non-agricultural incomes (reduced)
Subsistence versus money economy	o Subsistence versus money economy (reduced) o Dependency on (rural) food market (increased) o Monetary income (increased) o Prices for goods and services (increased)
Urban livelihood practices	o Specialization versus diversification (increased; related overexploitation of natural assets increased) o Working space (reduced) o Use of housing as a productive asset (increased)
Resource availability	o Resource availability (increased) o Resource distribution (less equal)

Control power	○ Control of compliance with legal frameworks (increased)
Institutions	○ Presence and concentration of institutions and access to their services (increased)
Public expectations	○ Public expectations (increased)
Public reliance on institutions and social security systems	○ Public reliance on institutions, urban governance and social security systems (increased)

Source: Adapted from Wamsler, 2013

In this context, interconnections with the urban fabric are also manifold. Space restrictions make it impossible for citizens to be self-subsistent or rely upon agriculture as their main income source. Likewise, growing food (in combination with another job as a diversification strategy) is often not viable.

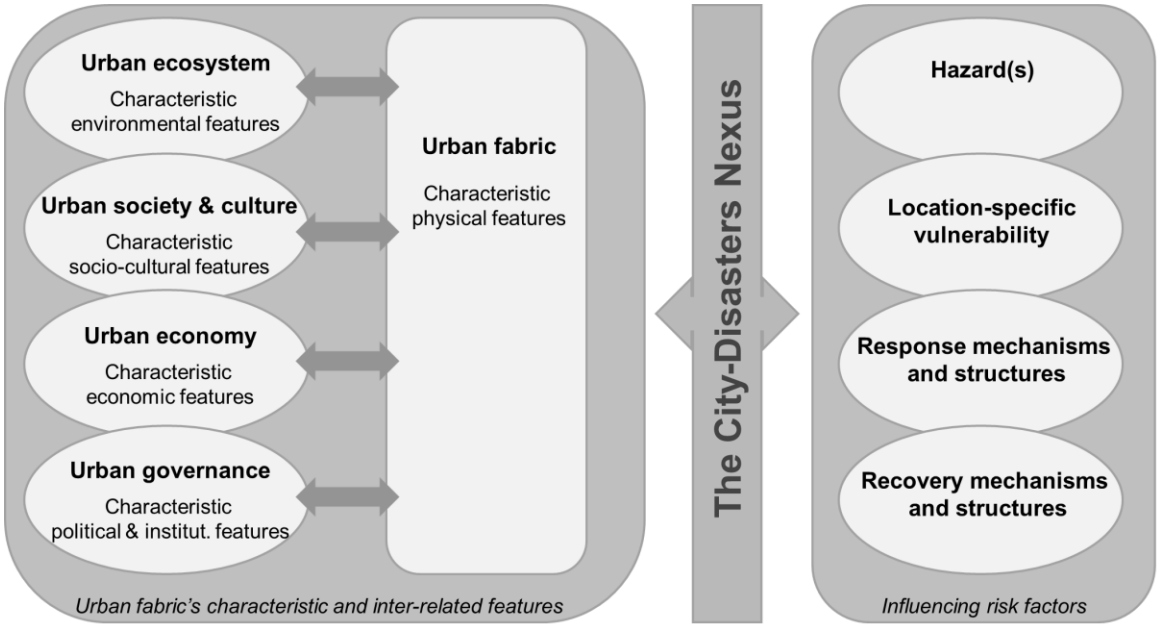
The spatial concentration of political and economic centres translates, on the one hand, into more resources and jobs (although they are not equally accessible) and, on the other hand, to increased expectations and reliance on institutions and social security systems. An example is the large number of urban migrants, who have moved far away from social safety nets such as the (extended) family. Many citizens thus rely on public authorities to solve their problems (including extreme weather events), rather than taking any risk reduction actions themselves (cf. Leonardsen, 2012; Wamsler and Lawson, 2012).

In sum, urbanization leads to a very characteristic urban fabric, ecosystem, climate, society, culture, economy and governance system. The physical, environmental, socio-cultural, economic and political features of cities influence each other. A comprehensive analysis of the city-disasters nexus needs to take all of these factors into account (Figure 1).

4.2 The influence of cities on disasters

A comprehensive and theoretically understanding of urban disasters requires linking the physical, environmental, socio-cultural, economic and political features of cities (presented in Section 4.1) with the factors that influence disaster risk and occurrence. As described in Chapter 3, risk level is influenced by: (a) hazards; (b) location-specific vulnerabilities; (c) disaster response mechanisms and structures; and (d) disaster recovery mechanisms and structures (Figure 1).

Figure 1: The City-Disaster Nexus



Source: Adapted from Wamsler, 2013

4.2.1 The influence of the urban fabric on hazards

The urban fabric has an influence on both the characteristics and occurrence of hazards (Figure 1). In sum, this research identified the following ways in which the urban fabric can exacerbate hazards, and ultimately increase the occurrence of disaster:

1. Intensification of existing hazards through an influence on the urban climate that results in increased rainfall, higher temperatures, local wind circulation, turbulence and gusts (Adam, 1988). There are clear vertical and horizontal intra-city differences. For example, urban flash floods may only affect a few streets in a community.
2. Direct creation of new hazards (e.g. fires and landslides) caused by architecture, the organization of structures in space, urban livelihood practices, etc. For example, fire can be caused by unsafe electrical connections or antennas or electrical equipment on top of buildings that attracts lightning (Worldwatch Institute, 2007). Landslides can be a direct consequence of the organization of structures in open space, for example building on watersheds that modify hydraulic regimes and destabilize slopes.
3. Expansion of the urban fabric into hazard-prone areas, which increases exposure. High population density, a lack of suitable inner-city land and related socio-economic issues can lead to the expansion of the urban fabric into hazard-prone areas (e.g. near to rivers or on steep slopes) or closer to other environmental hazards (e.g. toxic disposal sites, industrial or dangerous areas). This is true for both urban areas in general and individual sites where lack of space means that building on slopes, close to landfills or other potential hazards cannot be avoided.
4. Increased potential for compound hazards, due to the proximity of land intended for physical, social and economic functions (e.g. residential, industrial and transport purposes) (cf. EEA, 2012).
5. Creation of new hazards through emissions. High emissions directly add to increased heat and poor air quality. They also indirectly create new hazards through their contribution to climate change, which reshapes hazard occurrence both globally and locally (e.g. increased rainfall, snowfall, wind speed, temperature, droughts, heat and cold waves, and even earthquakes due to the melting of permafrost [Turpeinen, 2008]). In fact, climatic changes are likely to outweigh any potentially positive effects of the urban climate (such as reductions in snowfall and overall wind speed, or higher winter temperatures).
6. Dynamic urbanization processes that lead to constant changes in hazard patterns.

4.2.2 The influence of the urban fabric on vulnerability

In addition to its influence on hazards, the urban fabric also affects location-specific vulnerabilities. In sum, this research identified the following key ways in which the urban fabric can exacerbate location-specific vulnerabilities, and ultimately increase the occurrence of disaster:

1. Direct creation of vulnerabilities as many physical features of the urban fabric can themselves be seen as vulnerability factors. Examples are high concentration, closeness and interdependence of populations, buildings, services, infrastructure, economic and political centres. Cities do not only concentrate large numbers of people, they also tend to concentrate highly vulnerable people. These include poor and marginalized groups, and individuals who have been weakened by conflict, malnutrition, and HIV/AIDS or other diseases who often seek a better life in cities.
2. Indirect creation of vulnerabilities as the urban fabric has an influence on social, economic and political characteristics. Examples include:
   - Inadequate construction materials and techniques and the orientation of structures in space. This can partially be attributed to high densities and space restrictions, which constrain the layout, design and location of buildings. For example, a lack of space can make it difficult to adapt buildings to high winds or the direction of the sun (e.g. to catch a breeze or avoid direct mid-day sun), and building sites might not allow deep foundations (to withstand landslides). However, inadequate construction materials and techniques can also be attributed to social, economic and political factors that characterize urban life, the urban economy and urban governance systems and are related to the urban fabric. An example is informal settlements and the associated unwillingness (or inability) of politicians or local residents to invest in risk reduction and adaptation measures.

- Inadequate waste and waste water treatment infrastructure, which can lead to blocked drains, soil erosion, water-damaged walls and create breeding grounds for disease (e.g. by attracting vectors such as mosquitos and rats). This leads to increased risk and means that floods, landslides, earthquakes and disease have a greater impact.
- Economic specialization (as opposed to diversification), which makes populations vulnerable to the impact of disasters.
- Lack of social interactions with neighbours, which negatively affects social cohesion and consequently, any communal efforts to reduce and adapt to increased risk.

3. Creation of a domino effect where damage and secondary hazards that are created by the concentration, density and combination of all types of vulnerability factors, quickly spread (cf. EEA, 2012).
4. Destruction of (natural) hazard protections, such as windbreaks, flood walls, floodplains, slope stabilization, fresh air corridors or vegetation that is crucial for ground stability, permeability and cooling.
5. Increased vulnerability due to a weakened ability of the population to prioritize and take measures to reduce or adapt to increased risk. This is mainly due to the influence of the urban fabric on socio-economic factors (resulting in stressors such as urban violence or food insecurity) and ecological factors (that have a negative impact on health and wellbeing).
6. Constant changes in vulnerability patterns, which are due to dynamic urbanization processes (reshaped buildings and expansion of communities) and are difficult keep track of. Moreover, urban populations' differential vulnerability is more heterogeneous than in rural communities. This can be seen in terms of sources of income, income levels, habits, household size and composition, housing types, access to services, etc.

4.2.3 The influence of the urban fabric on mechanisms and structures for response and recovery

This research shows that the urban fabric can also have a negative effect on response and recovery mechanisms and structures, and ultimately increase the occurrence of disaster:

1. Increased requirements for functional, complex response and recovery mechanisms and structures. This is due to the huge population of cities, whose inhabitants live in vast and multifaceted urban settings.
2. Increased vulnerability of response and recovery mechanisms because urban disasters also affect centralized operations (i.e. their manpower, services, infrastructure, economic resources and governance structures).
3. Seriously hampered access, transport, collection and housing of the affected population. Emergency access, supplies, evacuation and resettlement are difficult due to inadequate and/or damaged buildings, lack of space, the remoteness of some area and other related socio-economic factors. For example, a dense urban fabric containing multi-storey buildings translates, if destroyed, into an enormous quantity of falling objects and rubble that blocks streets, makes public areas unsafe, and requires a major logistical effort for secure disposal.
4. Required additional and specialized response and recovery functions (e.g. for rubble clearance and providing security).
5. Lack of (accessible, affordable) space and other socio-economic factors makes housing populations affected by a disaster especially challenging. Experience shows that emergency shelter, refugee camps and post-disaster (re-)settlements do not work well if constructed far away from former homes and livelihoods; whilst cities often do not offer other secure solutions (Baehring, 2011).
6. Concentrations of people who cannot participate in response or recovery efforts due to the influence of the urban fabric on ecological factors that have a negative impact on health and wellbeing. Examples include:
   - Noise and other urban stressors: People are already stressed before the disaster and cannot handle additional stress factors.
   - Pollution, lack of light, inadequate water and sanitation and lack of green space cause illness.
7. Increased disruptive factors which reduce the capacity of people and institutions to respond and recover due to the influence of the urban fabric on ecological factors. Examples are:

- Reduction of natural lighting, fog and cloud: reduced visibility when no electric light is available.
- Noise: people cannot hear warnings.

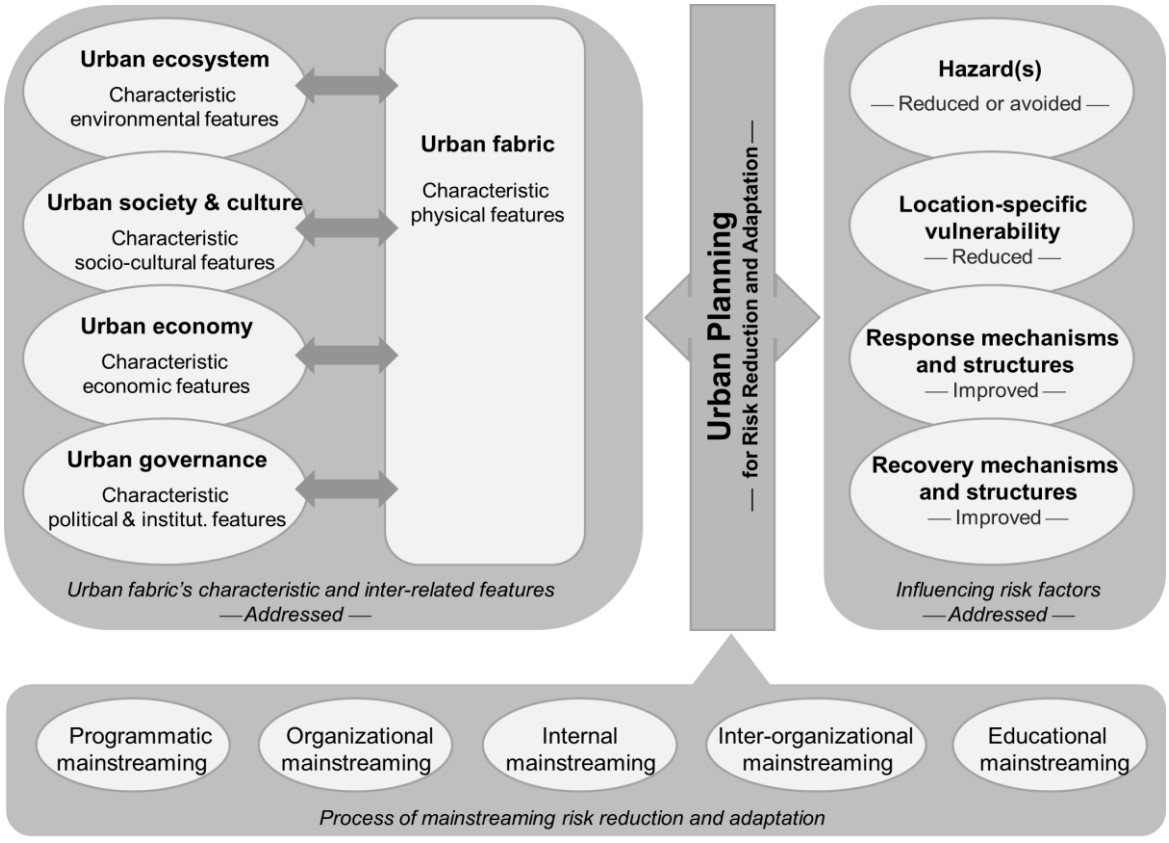
8. Increase of vulnerability factors that have a negative influence on response and recovery due to the influence of the urban fabric on socio-economic factors. These include fewer interactions with neighbours, exclusion and segregation, little sense of community, lack of local leadership structures, economic specialization, etc. For example, the exclusion and segregation of residents in marginal areas results in people not receiving disaster warnings or being unwilling to use emergency shelter (Wamsler et al., 2012).
9. Constant changes to the composition and layout of the urban fabric, which make it difficult to access up-to-date information (such as databases and maps) required for response and recovery.

The above analyses show that physical, socio-cultural, economic and political aspects of the urban fabric can influence hazards, vulnerabilities, and the mechanisms and structures for response and recovery. They are determinants for disaster risk and disaster impacts, and therefore need to be addressed as a part of a sustainable urban risk reduction and adaptation strategy.

5. URBAN RISK REDUCTION AND ADAPTATION: MEASURES AND STRATEGIES

The theoretical understanding of risk, adaptation and mainstreaming presented in Chapter 3 and the city-disasters nexus presented in Chapter 4 requires that planning for adaptation addresses all risk factors (i.e. hazards, vulnerability and deficiencies in response and recovery mechanisms) and takes into consideration the physical and non-physical features of the urban fabric (Figure 2). Importantly, sustainable transformation of this kind can only be achieved if adaptation becomes an inherent part of urban planning practice, which requires the use of different mainstreaming strategies (Figure 2; cf. Chapter 3). However, the review of current measures and strategies for climate change adaptation presented in this chapter reveals a different picture.

Figure 2: Planning for adaptation – in theory



Source: Adapted from Wamsler, 2013

A meta-evaluation of recent cross-country studies was carried out to assess current adaptation practice. This was complemented by information-rich country and city-specific studies (Table 6). The evaluation analysed urban adaptation measures (i.e. their focus with respect to risk factors and the city-disasters nexus), and their implementation (i.e. strategies promoted for mainstreaming adaptation into urban planning) (cf. Figure 2).

The analysis turned out to be challenging as, even in countries where climate change adaptation has been acknowledged as an important issue for urban planning, little has been done (Carmin et al., 2012; Greiving and Fleischhauer, 2012; Mickwitz et al., 2009; UNISDR, 2012c). In practice, urban planning is of only marginal interest. Most national adaptation strategies have not yet translated into planning practice, and other countries do not have such strategies. Consequentlywhile it is generally recognized that the role of spatial planning for adaptation should be strengthened, practices are still poorly developed. Nevertheless, and despite huge variations between countries (Gagnon-Lebrun and Agrawala, 2006), several important conclusions could be drawn. These findings are presented in the following section and are summarized in Table 7.

Table 6: Overview of the comparative studies for meta-evaluation of current adaptation practice

Cross-country studies & compilations (Authors, year & titles)
Brooks et al., 2009. Prioritizing climate change risks and actions on adaptation – a review of selected institutions, tools, and approaches
Carmin et al., 2012. Progress and challenges in urban climate adaptation planning: Results of a global survey
Davoudi et al., 2010. Planning for climate change: strategies for mitigation and adaptation for spatial planners
EEA, 2012. Urban adaptation to climate change in Europe: Challenges and opportunities for cities together with supportive national and European policies
European Commission, 2009. Commission staff working document accompanying the White paper - Adapting to climate change: towards a European framework for action - Impact assessment
Fujikura and Kawanishi, 2010. Climate change adaptation and international development: making development cooperation more effective
Gagnon-Lebrun and Agrawala, 2006. Progress on adaptation to climate change in developed countries: an analysis of broad trends
Greiving and Fleischhauer, 2012. National climate change adaptation strategies of European states from a spatial planning and development perspective
Kazmierczak and Carter, 2010. Adaptation to climate change using green and blue infrastructure: a database of case studies (GRABS)
Lourenço et al., 2009. Outcomes of the 1st international CIRCLE workshop on climate change adaptation
Massey and Bergsma, 2008. Assessing adaptation in 29 European countries
Meister et al., 2009. Floating houses and mosquito nets: emerging climate change adaptation strategies around the world
Mickwitz et al., 2009. Climate policy integration, coherence and governance
Ribeiro et al., 2009. Design of guidelines for the elaboration of regional climate change adaptation strategies
Roggema, 2009. Adaptation to climate change: a spatial challenge
Schuster, 2008. Klimaanpassungsstrategien in Europäischen Nachbarländern (Climate change adaptation strategies in Germany's neighbouring countries)
Swart et al., 2009. Europe adapts to climate change: comparing national adaptation strategies
UNISDR, 2004. Living with risk: a global review of disaster reduction initiatives
UNISDR, 2010a. Local governments and disaster risk reduction: Good practices and lessons learned. A contribution to the "Making Cities Resilient" Campaign
UNISDR, 2010b. Making cities resilient: My city is getting ready. World Disaster Reduction Campaign
UNISDR, 2011. Climate change adaptation and disaster risk reduction in Europe: A review of risk governance
UNISDR, 2012c. Making cities resilient report 2012: My city is getting ready ! A global snapshot of how local governments reduce disaster risk
Country and/or city-specific studies (Authors, year & titles)
Alam and Rabbani, 2007. Vulnerabilities and responses to climate change for Dhaka
German Stadtklimalotse, 2012 (German online decision-support system for climate change adaptation)
Greater London Authority, 2010. The draft climate change adaptation strategy for London
Jabeen et al., 2010. Built-in resilience: learning from grassroots coping strategies for climate variability
UK Adaptation Wizard, 2011 (UK online decision-support system for climate change adaptation)

5.1 Prevailing adaptation measures

The first observation is that the proposed hazard-specific adaptation measures are surprisingly similar and independent of context (Table 7). Examples of such measures include the use of vegetation to reduce temperature; increasing the height of electricity installations in flood areas; marking flood levels on houses; and rainwater harvesting and storage to address water scarcity or droughts.

Second, most of the implemented or proposed measures are physical interventions; that is: so-called "grey" or "hard" measures, which aim at reducing hazard exposure or reducing the vulnerability of buildings and infrastructure to make them more capable of withstanding hazard impacts (Table 7). It is only in recent years that city authorities have increasingly started to search for "soft" structures and "green" measures to complement grey measures (a trend primarily observed in more developed communities). City authorities take both a direct and indirect approach to "grey infrastructure": directly, through the implementation of physical measures in the construction of new housing or public infrastructure; indirectly, through the revision of related legislation (e.g. building codes or tax incentives) or guidelines for the construction of disaster- and climate-resistant housing and infrastructure. Examples of physical measures include the use of the building facades as windbreaks; vertical kerbs as a flood retention device; road surfaces that resist temperature variations; underground cabling; or construction material that increases the albedo effect (i.e. the reflectivity) of building facades and roofs. Unfortunately, the analysis also shows that most adaptation measures address physical and non-physical factors separately. In other words, although the social, cultural, economic, political and institutional characteristics of cities are closely interlinked with the physical features of the urban fabric (and turn them into hotspots of risk), they receive little attention. Consequently, urban planning for adaptation is not used to its full potential, which may lead to reduced resilience. Exceptions include measures that focus on the link between the urban fabric and its ecosystem and these were, in fact, the measures most frequently seen in the evaluation (see also the third aspect outlined below).

Third, most urban adaptation measures aim to improve water management of cities to reduce the risk of floods, landslides, extreme temperatures, urban drought and the urban heat island effect. Typically, they directly address the link between the urban fabric and environmental factors (Table 7). Grey measures to improve water management include the construction, improvement or maintenance of dikes, sewerage and drainage systems, open water channels and retention ponds. More developed communities give high importance to green and blue infrastructure, which includes the re-naturalization of ecosystems, and implies working *with* natural processes instead of against them. Examples are: planning residential and commercial areas to include open space; avoiding impervious surfaces to aid water absorption; the preservation of wetlands to defend against flooding; the creation of natural ecosystem buffers for vulnerable water bodies and low-lying areas; the use of vegetation on roofs and vertical surfaces (e.g. green walls) to reduce water run-off and absorb heat; and in general, greater priority being given to the restoration and maintenance of green areas and open space. One example is the city of Berlin, which introduced the Biotope Area Factor (BAF) that expresses the ratio of the area covered by vegetation to the total land area of any urban development (Kazmierczak and Carter, 2010; Davoudi et al., 2010; Greater London Authority, 2010). What makes the use of blue, open and green spaces for risk reduction and adaptation so attractive is that they also improve citizens' quality of life and provide recreational areas and places that can foster social interaction. In contrast, less developed communities give lower priority to green and blue infrastructure. Instead they give more consideration to grey measures, such as the creation and improvement of technical infrastructure for rain, waste water, and waste management. A lack of financial resources means that city authorities in middle- and low-income nations sometimes combine these measures with low-tech practices, such as the distribution of plastic sheets (to help channel rain and waste water and to protect slopes from landslides) or the organization of cleaning days (to reduce the risk of clogged water channels).

Fourth, most of the assessed cities place great emphasis on hazard-avoidance measures – areas that are already prone to disasters (and which may be even more endangered in the future) are forbidden to be used for further development (Table 7). Typically, high-income nations pursue this goal through the enforcement of land use plans and policies, or the relocation of critical infrastructure (such as

schools and hospitals) to safer areas. In contrast, in many low- and middle-income nations, a lack of enforcement capacity often translates into a wider variety and combination of measures to gain control over the use of risk areas. Examples include small-scale measures such as local monitoring groups and signposting, but also more far-reaching measures such as tax incentives, the transformation of high-risk areas into parks, rights exchange schemes, and land exchange, pooling and readjustment programmes.

Fifth, response preparedness and, to an even greater extent, recovery preparedness receive little attention (Table 7). Exceptions include: efforts to improve early warning systems; emergency plans for health and social care systems; and the construction of emergency shelters and evacuation roads. As for recovery preparedness, the most typical measures are the provision of insurance and other social protection systems (including the creation of insurance policies that do not foster risk taking).

Finally, in the European context, particular importance is given to the identification of adaptation measures that may also reduce greenhouse gas emissions. The buzzword is "climate planning" (Davoudi et al., 2010), which seeks to combine climate change mitigation and adaptation. This development must be understood in the context of planning practices that have in many high-income nations focused on climate change mitigation; the "adaptation turn" of planners is very recent (Davoudi et al., 2010). In contrast, in middle- and low-income nations, more attention is given to: (a) informal low-tech measures that can be implemented at community and household level, and (b) bottom-up approaches and populations' capacity to cope in order to compensate for a lack of institutional, financial and technological resources (Meister et al., 2009).

5.2 Prevailing mainstreaming strategies

First, most studies explicitly or implicitly stipulate that adaptation should be presented as a mainstreaming (or cross-cutting) issue, and not as an additional and separate aspect which should overrule other planning issues (Table 7). This observation is independent of the specific (developed or developing nation) context, and is a major breakthrough.

Second, most efforts are aimed at the mainstreaming of adaptation at policy level (part of strategy III: organizational mainstreaming), while particular adaptation measures or specific planning instruments are of less interest. This is a major frustration for planners who struggle to "translate" the "high-level-talk" to their day-to day work (Carmin et al., 2012; Greiving and Fleischhauer, 2012; UNISDR, 2012c). There is a particular focus on the implementation and integration of (national and municipal) adaptation strategies and their integration in different sectors, especially in high-income nations (Table 7). While national strategies are very different in terms of format, goals and the stakeholders involved, most do not provide sufficient guidance on how to achieve mainstreaming. Examples include: the definition of responsibilities, working structures and provision of ongoing support for implementation; cost estimates and availability of resources such as manpower and know-how; the incorporation of risk reduction and adaptation into governmental and municipal budgets; and the revision of tools – ranging from risk assessment to planning and systematic reporting (Mickwitz et al., 2009; Ribeiro et al., 2009; Swart et al., 2010). At the municipal level emphasis is given to the revision of building codes, urban development regulations and land-use planning (Table 7). However, a lack of resources and institutional capacity means that many middle- and low-income countries find it difficult to integrate climate change concerns into municipal or national policies and regulatory frameworks (UNFCCC, 2007). In addition, actions have little impact when cities are characterized by settlements that spring up independent of any official plan or regulation (Bicknell at al., 2009).

Most advances in tool modification are observed in the context of risk assessment, which is a necessary precondition for all types of adaptation measures. As an example, the *Territorial State and Perspectives of the European Union* provides guidelines for risk management improvements in relation to climate change (European Union, 2011). While few of these guidelines have been considered, integrated risk assessments are among the more widely used tools (Greiving and Fleischhauer, 2012). However, such risk assessments pay little attention to the city-disasters nexus (described in Chapter 4).

Many other advances relate to the enhancement of inter-institutional cooperation, synergy creation, and the harmonization of risk reduction and adaptation to improve current risk governance structures (i.e. mainstreaming strategy V: inter-organizational mainstreaming; cf. Table 7). This is based on a general consensus that the successful implementation of adaptation planning is highly dependent on the level of commitment and leadership provided by local authorities, and their interaction with other urban stakeholders. In other words, weak risk governance capacity is understood to be at the core of the current lack of adaptation practice (EEA, 20112; UNHABITAT, 2007, 2011). In high-income nations, most emphasis is given to improved coordination and cooperation between urban authorities, and the creation of public–private partnerships. Citizens are not thought to contribute to improved risk governance structures. However, in low- and middle-income nations, the comparatively greater involvement of non-governmental organizations (NGOs) in risk reduction and adaptation also leads to greater importance being given to civil society organizations and citizens at risk.

Finally, unlike organizational and inter-organizational mainstreaming, programmatic, internal and educational mainstreaming is given little attention (Table 7). Programmatic mainstreaming requires in-depth knowledge of the population's vulnerability and location-specific links between the urban fabric and disasters, which is not available to most city authorities. Adding some "simple" activities targeted at risk reduction and adaptation is often the easiest way out. Furthermore, there seemed to be few modifications to city authorities' internal operations to ensure the protection of staff and the organization in case of disaster (e.g. the protection of the organization's infrastructure and equipment; staff security; access to disaster information; and a back-up communication plan). As for educational mainstreaming although there seems to be greater momentum towards closer cooperation between city authorities, universities and other educational bodies, in practice it is still scarce. On the one hand, educational and research institutions only have a limited role in actual practice, while on the other hand city authorities and professional planners have little influence on research agendas, curricula development and education (UNISDR, 2011b), which results in a weak science-policy interface.

Table 7: Differences and similarities between measures and strategies promoted in low-, middle- and high-income nations

Similarities: Not context specific	**Adaptation measures** (What?)**:** o Adaptation measures promoted in formal areas are very similar; differences mainly relate to the specific location's level of exposure. o Strong focus on a grey infrastructure approach to risk reduction and adaptation. o Emphasis on reducing or avoiding hazards and reducing physical vulnerabilities. o Emphasis on: (a) keeping disaster-prone areas free from further development; and (b) developing guidelines for climate-resilient construction of housing and infrastructure. o Preparedness for response receives little attention; preparedness for recovery even less. o Physical, social, cultural, economic, political and institutional aspects tend to be addressed separately. o Many efforts focus on water management through grey, green and blue measures, which address links between the urban fabric and environmental factors (an exception to the previous point) o Little focus on the social, cultural, economic, political and institutional characteristics of cities that are closely interlinked with the physical features of the urban fabric and increase risk levels.
	Mainstreaming strategies – implementation process (How?)**:** o Risk reduction and adaptation is increasingly seen as a mainstreaming issue for planning, and not as a separate issue. o The predominant mainstreaming strategy is organizational mainstreaming with a focus on modifying policies, regulations and tools (particularly risk assessment tools). Little attention is however given to the revision of financial mechanisms, organizational structures and planning tools. o Second in importance is inter-organizational mainstreaming that improves risk governance structures and cooperation between urban stakeholders. o The implementation of separate add-on risk reduction and adaptation measures is used more frequently than modifications to planners' day-to day work. o Programmatic, internal and educational mainstreaming is given little consideration (in contrast to organizational and inter-organizational mainstreaming).
Differences: Specific to	**Adaptation measures** (What?)**:** o More focus on environment-oriented measures that address the link between the urban fabric and

high-income countries	urban ecology. o Focus on the implementation of win-win or no-regret solutions (such as green infrastructure). o Special interest in combining adaptation measures with climate change mitigation measures (to reduce greenhouse gas emissions). o Better social protection systems; higher level of social security (income security and access to essential services, in particular health and education).
	Mainstreaming strategies – implementation process (How?)**:** o More top-down approaches (but increasing interest in participatory methods). o Focus on the implementation process of adaptation mainstreaming, whilst particular measures or specific planning instruments are of less interest. o Organizational mainstreaming: the majority of related strategies are focused on the revision of land-use planning and urban development regulations. o Inter-organizational mainstreaming: Focus on cooperation and communication between urban authorities to improve risk governance; less involvement of civil society organizations and citizens.
Differences: Specific to low- and middle-income countries	**Adaptation measures** (What?)**:** o Greater focus on basic and technical infrastructure (to improve rain, waste water and waste management) and less emphasis on green and blue infrastructure (and the links between urban and environmental issues). o More hazard-specific measures as opposed to multi-hazard, win-win and no-regret solutions (as specific risk is more present/ evident). o Greater involvement of NGOs, community-based organizations (CBOs) and citizens, leading to increased attention being given to low-tech measures, temporary solutions, locally-based measures and participatory approaches to adaptation. o More focus on a variety of response (and in part, recovery) preparedness measures. o More anti-poverty interventions that link risk and poverty reduction and focus on asset enhancement, empowerment, livelihood support and health (which also addresses the link between the urban fabric and socio-economic issues).
	Mainstreaming strategies – implementation process (How?)**:** o Inter-institutional cooperation: Focus on cooperation between urban stakeholders, with greater involvement by NGOs, civil society organizations and citizens at risk to improve risk governance structures. o Organizational mainstreaming: Related action can have little impact due to uncontrolled development, together with a lack of resources and institutional capacity. This hampers the integration of climate change concerns into national and municipal policies and tools. o As a result: More community-based and bottom-up approaches, different techniques and methods taken at the household level, less involvement of planners and formal planning processes (especially in marginal areas).

Source: Adapted from Wamsler, 2013

6. CONCLUSIONS

Climate change poses a serious threat to sustainable urban development and places many cities at risk. City authorities are increasingly faced with the challenge of finding ways to include adaptation strategies into their work. However, to date few cities have developed comprehensive models for climate change adaptation. This paper contributes to knowledge development on local adaptation planning through a critical review and comparison of theoretical and practical approaches.

Theory suggests that resilient cities can only be achieved if adaptation planning includes measures that address all risk factors. At the same time, planning must target not only the characteristic physical features of the urban fabric, but also related environmental, socio-cultural, economic and political aspects, which can turn cities into risk hotspots. It is argued that a sustainable transformation of this kind can only be achieved if adaptation becomes an inherent part of urban planning practice, which requires the use of a set of mainstreaming strategies. This can lead to both incremental and transformative actions; that is: improving existing risk reduction approaches to maintain system functions and, if necessary, provoking systemic change for long-term sustainability.

However, this review of current practice demonstrates a different reality. Hardly any of the examined city authorities combined the range of possible adaptation measures, and mainstreaming consisted of single actions rather than taking a comprehensive approach.

The argument that the suitability of any adaptation measure has to be clarified in each individual case is too often used to justify missing integrative concepts in (national and municipal) adaptation strategies and practice.[8] If sustainable urban transformation is the aim, adaptation needs to be systematized and systematically incorporated into urban planning practice. This is crucial as even the fundamental principles of traditional planning become questionable in a context of increasing risk and climate change. For example, infrastructure (roads, telecommunication, water supply, etc.) that is bundled into the same space or development corridors may reduce urban resilience, which relies upon redundancy and replaceable elements.

Improved science-policy integration and decision support systems for organizational learning are a first step forward in assisting city authorities to (further) incorporate mainstream adaptation into urban planning practice. For example, the integration of scientific knowledge into local policies can be promoted through: "translating" scientific outcomes into policy recommendations; training and dissemination of research outcomes; seminars on adaptation and risk reduction focused on the science-policy interface; the creation of opportunities for researchers, practitioners and policymakers to exchange information; the inclusion of policymakers and practitioners in research projects; and increasing the involvement of local government in universities. In addition, decision support systems can provide city authorities with information on:

- Potential adaptation measures to: (i) avoid or reduce hazards, (ii) minimize location-specific vulnerabilities, and (iii) improve mechanisms and structures for response, and (iv) recovery;
- Potential adaptation measures, which use physical interventions as an entry point to address interrelated non-physical risk factors of the city-disasters nexus;
- Potential mainstreaming strategies and step-by-step guidance for their implementation;
- Methods and tools for achieving sustainable urban risk governance, involving urban authorities, civil society and citizens at risk;
- Synergies and conflicts that may result from a particular combination of adaptation measures and mainstreaming strategies;
- Good practice, research and other relevant background documents from low-, middle- and high-income nations to facilitate both North-South and South-North knowledge transfer.

Naturally, the development of an appropriate model and related frameworks (including concepts, guidelines and policy recommendations) requires both scientific input and political will, and is not in itself sufficient to stimulate policy action and urban transformation. It is clear that the many competing interests and demands on the resources of national and municipal governments and aid organizations influence political commitment. However, the promotion of adaptation and risk reduction as cross-cutting topics (that should, as a matter of good practice, be incorporated into urban planning) may help to reduce the understanding that they are in direct competition with other fields.

[8] Other potential barriers include issues such as a lack of financial resources, data availability, coordination, political will, participation and public awareness; fragmented knowledge bases on risk reduction and adaptation; goal conflicts; and unclear responsibilities (Wamsler, 2013). An in-depth analysis of these barriers was, however, outside the scope of this paper.

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