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# Planning the resilient city: Concepts and strategies for coping with climate change and environmental risk

Yosef Jabareen *

*Faculty of Architecture and Town Planning, Technion–Israel Institute of Technology, Haifa 32000, Israel*

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ABSTRACT

This paper contributes to filling the theoretical and practical gaps of city resilience literature, which lacks multifaceted theorizing and typically overlooks the multidisciplinary and complex nature of urban resilience. Furthermore, most studies on the subject make use of general, vague, and confusing terminology. This paper suggests a new innovative conceptual framework (the Resilient City Planning Framework or RCPF) that addresses the critical question of what cities and their urban communities should do in order to move towards a more resilient state in the future. Accordingly, the RCPF takes complexity and uncertainty into account. It is affected by a multiplicity of economic, social, spatial, and physical factors and its planning involves a wide range of stakeholders. RCPF is a network of four interlinked concepts that together, provide a comprehensive understanding of City Resilience.

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## Introduction

In recent years, we have become increasingly aware of the huge risks that climate change poses to our cities. Climate change is likely to bring higher temperatures, sea level increase, more intense rainstorms, droughts and heat waves. It also poses particular threats to urban infrastructures. To name just a few, these include increased strains on materials and equipment, higher peak electricity loads and voltage fluctuations, transport disruptions, and increased need for emergency management (IPCC, 2007; NPCC, 2009; Wardekker et al., 2003). Furthermore, we have recently witnessed how natural disasters have cost lives and destroyed urban spaces and communities (Munn-Venn & Archibald, 2007). The tsunami and earthquake in Japan, the tsunami in the Indonesian island of Sumatra, and the flood covering large areas in Pakistan and Australia, which have taken tens of thousands of lives, are just a few among many tragic disasters. Importantly, the issue at stake is not the climate change impacts alone but "...a whole spectrum of global environmental changes that interplay with interdependent and rapidly globalizing human societies" (Folke et al., 2011) and the resulting risks that human settlements and humanity in general may face. It is clear that, in order to reduce the risk and impact of these threats and to increase the safety and wellbeing of their residents, cities and their communities must be more resilient and prepared to address the threats head-on. If they are not, their urban communities will live under continuous threat, and more and more will become vulnerable to risks (UNISDR, 2010). The critical question is, how resilient are contemporary cities and their different communities, and are they ready to face a multiplicity of challenges and uncertainties in the future? Most importantly, what should cities and urban communities do, at the present, in order to move from a vulnerable to a more resilient state? Moreover, since human action contributes to the altering of the ecosystem locally and globally (Chapin et al., 2011; Folke et al., 2011), how resilient should cities be in order to contribute to environmental protection and sustainability? Although a literature review reveals an important emerging scholarship on urban resilience, most studies on the subject make use of general, vague, and confusing terminology, and fail to conceptualize and theorize the phenomenon in a systematic manner. Therefore, this paper aims to fill the theoretical and practical gaps and answer the critical question regarding what cities and their urban communities should do in order to move towards a more resilient future state.

## The problem of resilience

The concept of resilience, in the urban context, was borrowed from studies on the manner in which ecological systems cope with stresses and disturbances caused by external factors (Davic & Welsh, 2004). From an ecological perspective, Holling (1973), who may be the first to define it (Barnett, 2001; Carpenter, Walker, Anderies, & Abel, 2001), suggests that resilience is "the persistence of relationships within a system" and "the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist" (Holling, 1973, p. 17). In other words, resilience is "the capacity of a system to undergo disturbance and maintain its functions and controls" (Gunderson & Holling, 2001).

* Tel.: +972 528655336.
*E-mail address:* jabareen@technion.ac.il

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Recently, the concept has also been applied to human social systems (Adger, 2000; Leichenko, 2011; Pelling, 2003); ecological urban resilience (Andersson, 2006; Barnett, 2001; Ernstson et al., 2010; Folke, 2006; Maru, 2010); economic recovery (Rose, 2004; Martin & Sunley, 2007; Pendall, Foster & Cowel, 2010; Pike, Dawley, & Tomaney, 2010; Simmie & Martin, 2010), disaster recovery (Colten, Kates, & Laska, 2008; Cutter, Boruff, & Shirley, 2003; Pais & Elliot, 2008; Vale & Campanella, 2005; Coaffee et al., 2008; UNISDR, 2010), and urban security and resilience against post-September 11th terrorism (Coaffee, 2006, 2009). Inspired by the concept of the resilient ecosystem, "resilience means the 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, 2010, p. 13).

Apparently, a striking weakness of the scholarship on the subject is its lack of multifaceted theorizing and the fact that it typically overlooks the multidisciplinary and complex nature of urban resilience. Because city resilience is a complex, multidisciplinary phenomenon, focusing on a single or small number of contributing factors ultimately results in partial or inaccurate conclusions and misrepresentation of the multiple causes of the phenomenon. Folke and others (2010) suggest that resilience is about dynamic and complex systems, which is characterized by multiple pathways of development, interacting periods of gradual and rapid change, feedbacks and non-linear dynamics, thresholds, tipping points and shifts between pathways, and how such dynamics interact across temporal and spatial scales (Folke et al., 2011, p. 721). Godschalk (2003, p. 14) contends that if we want to take urban resilience seriously, we need to build the goal of a resilient city in a multidisciplinary manner. Richard Little (2004) posits that resilience is about more than just physical robustness and will be less effective if restricted to a narrow discipline. Moreover, some scholars argue that critical urban issues "are typically treated as independent issues," and that "this frequently results in ineffective policy and often leads to unfortunate and sometimes disastrous unintended consequences" (Bettencourt & Geoffrey, 2010). In this context, Bettencourt and Geoffrey (2010, p. 912) conclude that "developing a predictive framework applicable to cities around the world is a daunting task, given their extraordinary complexity and diversity". Leichenko (2011, p. 164) concludes that urban resilience studies are grounded in a diverse array of literatures, and "while there is much overlap and cross-fertilization among these different sets of literature, each emphasizes different facets of urban resilience and each focuses on different components of cities and urban systems."

Another gap in the literature is related to measuring resilience and how to assess a system's resilience in general and urban resilience in particular. Mostly, the literature of resilience measurements has focused on ecosystems, and suggests quantitative indicators for such assessment. According to Gunderson and Holling (2001), resilience is measured by the magnitude of disturbance that can be experienced without the system flipping into another state and within which the system can absorb and still persist. Carpenter et al. (2001) suggest measurement of socioecological systems (SES) that focuses on its capacity. It appears that the resilience concept has been applied mostly to understand social–ecological systems and dynamics in areas that suffer disaster, rural communities in developing countries, and for improving livelihoods (Chapin, Kofinas, & Folke, 2009; Eakin & Wehbe, 2009; Enfors & Gordon, 2008; Folke et al., 2011; McSweeney & Coomes, 2011; Walker, Anderies, Kinzig, & Ryan, 2006; WRI, 2008). To sum up, the literature on measuring resilience overlooks cities and ordinary communities (see also Castello, 2011).

One example of this type of treatment is the new campaign launched by the United Nations International Strategy for Disaster Reduction in 2010, entitled *Making Cities Resilient* (UNISDR, 2010). The campaign aims to "promote awareness and commitment for sustainable development practices that will reduce disaster risk and increase the wellbeing and safety of citizens – 'to invest today for a better tomorrow'" (UNISDR, 2010). The UNISDR proposes a general and limited scope checklist of ten essentials to empower local governments and other agencies to implement the *Hyogo Framework for Action 2005–2015*. This framework focuses on "Building the Resilience of Nations and Communities to Disasters" (UN/ISDR, 2005), which was adopted by 168 governments in 2005. In *Resilient Cities*, Newman, Beatley, and Boyer (2009) also focus on only one dimension of resilience: the oil crisis. In this context, they point out that "a danger that few think about with such immediacy is the threat of the collapse of our metropolitan regions in the face of resource depletion – namely, the reduction in the availability of oil and necessary reduction in all fossil fuel use to reduce human impact on climate change" (p. 2). In this way, their book focuses less on urban resilience and more on "the challenges posed to metropolitan areas in the face of responding to their increased carbon footprint, dependence on fossil fuels, and impact on the irreplaceable natural resources" (2009, p. 2). In *The Resilient City*, Vale and Campanella (2005) focus on the narratives of resilience, the symbolic dimensions of disaster and recovery, and the politics of reconstruction. They argue that, to understand urban resilience is to understand the ways in which human narratives are constructed to interpret the meanings of urban reconstruction. *The Resilient City* by Walisser, Mueller, and McLean (2005), which was prepared by the Vancouver Working Group for the 2006 World Urban Forum, explores the resilience of small Canadian communities dependent on single resource industries by examining how they have coped with the economic and social pressures arising from widespread closures.

In summary, the major theoretical challenge regarding urban resilience facing many scholars today appears to be the development of a multidisciplinary theory that integrates a variety of urban dimensions such as social, economic, cultural, environmental, spatial and physical infrastructure, into a unified conceptual framework for understanding the resiliency of cities and how they should move towards a more resilient state. Therefore, this paper aims to fill the theoretical and knowledge-based gaps in this critical field by investigating the phenomenon of city resilience and developing a new multidisciplinary conceptual framework for understanding the complexity of urban resilience. In other words, this paper seeks to construct a more rigorous, careful basis for promoting and assessing resilience of cities.

## Methods

By nature, working on urban resilience requires "complex thinking and complex methods" (De Roo & Juotsiniemi, 2010, p. 90), and it also forces us to adopt a more holistic view (Batty, 2007). The basic assumption of this paper is that city and community resilience is a phenomenon that is complex, non-deterministic, dynamic in structure, and uncertain in nature. It is a phenomenon that is affected by a multiplicity of economic, social, spatial, and physical factors. Its planning involves a wide range of stakeholders including civil society, local and national governments, the private sector, and various professional communities, and it therefore affects a variety of urban communities and city residents.

In order to build the conceptual framework, a qualitative analysis method was used. This method is a grounded theory technique that attempts to "generate, identify, and trace a phenomenon's

major concepts, which together constitute its theoretical framework" (Jabareen, 2009). Each concept possesses its own attributes, characteristics, assumptions, limitations, distinct perspectives, and specific function within the conceptual framework. According to Deleuze and Guattari (1991), "every concept has components and is defined by them" and "there is no concept with only one component" (p. 15). These components define the consistency of the concept and are distinct, heterogeneous, and inseparable from one another (p. 19).

The methodology delineates the following stages in the building of a conceptual framework: (a) mapping multidisciplinary data sources, (b) reviewing the literature and categorizing the selected data, (c) identifying and naming the concepts, (d) deconstructing and categorizing the concepts, (e) integrating the concepts, (f) synthesizing, re-synthesizing, and making it all make sense, and (g) validating the conceptual framework. The process of constructing the conceptual framework involves extensive review and classification of the literature that addresses environmental, social, cultural, and urban aspects of resilience. This literature comes from a variety of disciplines, including sociology, anthropology, public policy, political science, economics, ecology, geography, and urban planning.

Accordingly, this paper conceptualizes city resilience as a network, or a theoretical plane of interlinked concepts that together provide a comprehensive understanding. This plane is composed of concepts that "can be abstracted from bodies and states of affairs" (Bonta & Protevi, 2004, p. 31). This conceptual framework is not merely a collection of concepts but rather, is a construct composed of consistent concepts in which each plays an integral role and is intrinsically linked to the other. Importantly, each concept has a number of components (sub-concepts) and the contribution of each concept to the urban resilience is the sum of the contributions of its components. Each component can be measured on a scale and a component may be measured both qualitatively and quantitatively, depending on its definition and the availability of data.

## Conceptual framework for resilient city and resilient community

As Fig. 1 demonstrates, the analysis reveals a conceptual framework that is composed of four main interrelated concepts and their components.

### *Concept 1: Vulnerability analysis matrix*

This concept is critical and significant for the resilient city and for its contribution to the spatial and socio-economic mapping of future risks and vulnerabilities. The role of the Vulnerability Analysis Matrix is to analyze and identify types, demography, intensity, scope, and spatial distribution of environmental risk, natural disasters, and future uncertainties in cities. In addition, this concept seeks to address how hazards, risks, and uncertainties affect various urban communities and urban groups.

In the context of climate change, vulnerability refers to the "degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of a system's exposure, its sensitivity, and its adaptive capacity" (CCC, 2010, p. 61). The concept of the Vulnerability Analysis Matrix is composed of four main components that determine its scope, environmental, social, and spatial nature. These four components are:

#### *Demography of vulnerability*

This component assesses and examines the demographic and socio-economic aspects of urban vulnerability. It assumes that there are individuals and groups within all societies who are more vulnerable than others and lack the capacity to adapt to climate change. Demographic, health, and socio-economic variables affect the ability of individuals and urban communities to face and cope with environmental risk and future uncertainties. These variables affect the mitigation of risk, response and recovery from natural disasters (Blaikie, Cannon, Davis, & Wisner, 1994; Ojerio, Moseley, Lynn, & Bania, 2011). Accordingly, many variables affect the vulnerability of individuals and communities. However, the main variables are income, education and language skills, gender, age, physical and mental capacity, accessibility to resources and political power, and social capital (Cutter et al., 2003; Morrow, 1999; Ojerio et al., 2011; United Nations Division for the Advancement of Women. _ 2001). As a result, socio-economically weak communities are more vulnerable to suffer negative impacts, including property loss, physical harm, and psychological distress (Ojerio et al., 2011; Fothergill & Peek, 2004).

#### *Informality*

This concept assesses the scale and social, economic, and environmental conditions of informal urban spaces. Informal spaces are unplanned, chaotic, and disorderly (Roy, 2010) and it is assumed that the scale and human condition of informal places within a city have a significant impact on its vulnerability. According to UN-HABITAT (2008), much urban expansion in developing cities takes place outside the official and legal frameworks of building codes, land use regulations, and land transactions. Resilience requires the inclusion of the poor, vulnerable communities, and informal places in the city and in the metropolitan area. Informal spaces are more likely to be vulnerable than others because of their low-income population and lack of infrastructure and services. Moreover, because of their socio-spatial character and large populations, contemporary cities are more vulnerable to a variety of risks and have the potential to become generators of new risks, such as failed infrastructure and services, environmental urban degradation, and the expansion of informal settlements. These aspects make many urban inhabitants more vulnerable to natural hazards and risks (UNISDR, 2010).

#### *Uncertainty*

Uncertainty can be defined as "a perceived lack of knowledge, by an individual or group, which is relevant to the purpose or action being undertaken and its outcomes" (Abbott, 2009, p. 503). Today, more than ever, we should acknowledge that environmental uncertainties pose new challenges to our cities and their communities, and challenge the way we have been thinking about their management and planning. Apparently, vulnerability assessments often ignore the non-climatic drivers of future risk (Storch & Downes, 2011) and uncertinities. Therefore, we need to map and draw the scenarios of uncertainties that may affect our cities as much as possible. Contemporary cities must develop a greater awareness of the need for policies that might eventually enhance resilience and reduce vulnerability to expected climate change impacts (Adger et al., 2001; Vellinga et al., 2009). Therefore, this component has a critical impact on urban vulnerability and requires the assessment of environmental risks and hazards that are difficult to predict but must be taken into account in city planning and risk management.

#### *Spatial distribution of vulnerability*

This component assesses the spatial distribution of risks, uncertainties, vulnerability and vulnerable communities in cities. Environmental risks and hazards are not always evenly distributed geographically, and some communities may be affected more than others. For example, those who are close to the shore may be affected more harshly by tsunamis than others. Mapping the spatial

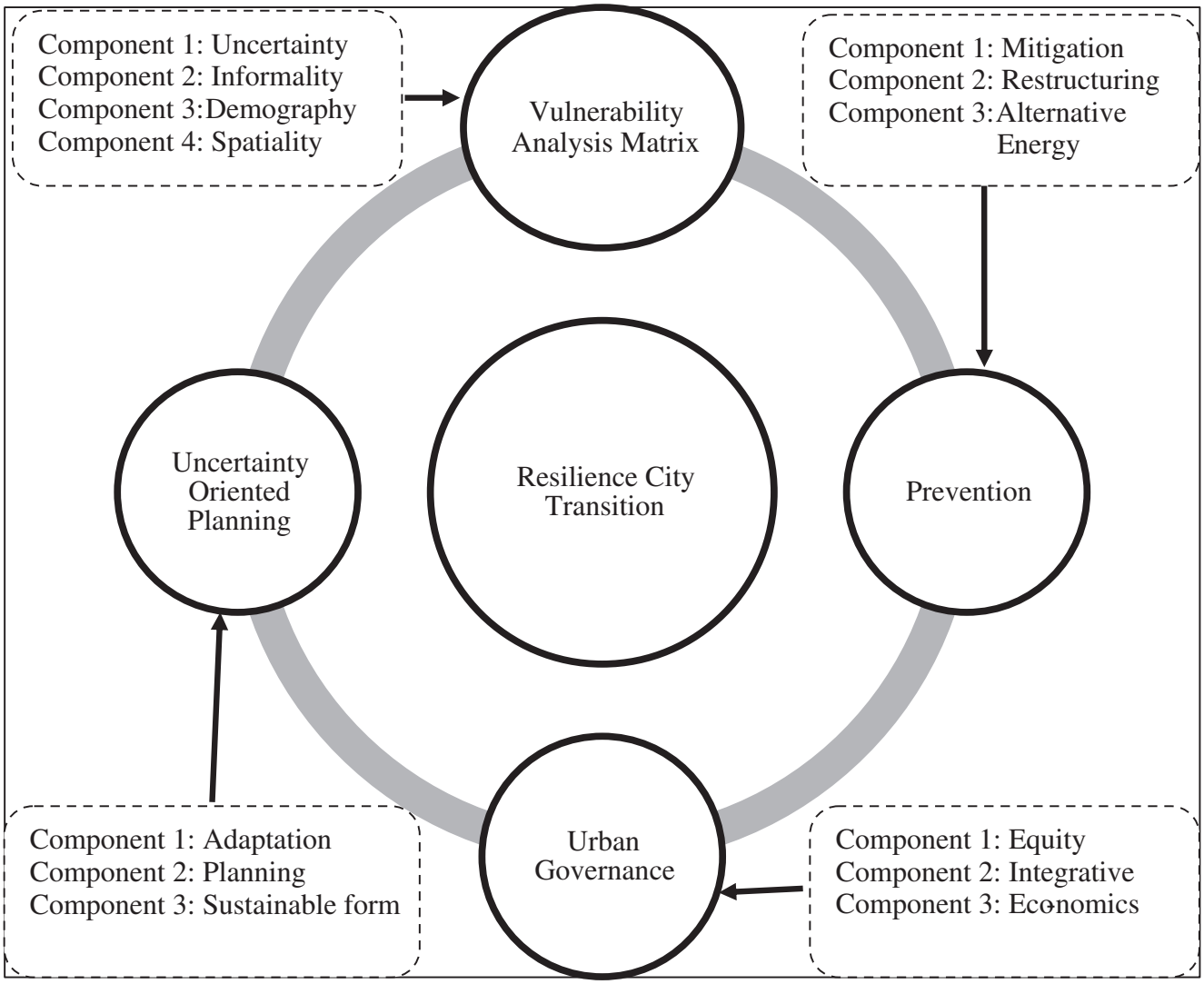



**Fig. 1.** Resilient city planning framework.

distribution of risks and hazards is critical for planning and management at the present and for the future. In addition, the communities that are most vulnerable to climate change impacts are usually those who live within more vulnerable, high-risk locations that may lack skills, adequate infrastructure and services (Satterthwaite, 2008).

*Concept 2: Urban governance*

This concept contributes to the governance of urban resilience. It focuses on the governance culture, processes, arena and roles of the resilient city. It is hypothesized that a more resilient city is one with inclusive decision making processes in the realm of planning, open dialog, accountability, and collaboration. It is one in which people and local stakeholders, including the private sector, various social groups, communities, civil society and grassroots organizations participate. A more resilient city is one in which governance is able to quickly restore basic services and resume social, institutional and economic activity after a disastrous events. Weak governance, on the other hand, lacks the capacity and competence to engage in participatory planning and decision making, and will typically fail to meet the challenges of resilience as well as increase the vulnerability of much of the urban population (Albrechts, 2004; Hardoy & Satterthwaite, 2009; Healey, 2007; Healey & Upton, 2010; UNISDR, 2010).

Without a doubt, cities 'have emerged as key players in the governance of climate change' (Bulkeley, 2010, p. 29). As such, understanding urban governance is a crucial aspect of understanding cities and their resiliency because it is related to measures of quality of life, as well as the quality and spatial organization of urban places, distributive justice, environmental well-being, and economic vitality (Healey, 2007). In addition, the large cities of today have recently been facing the major challenge of massive urban complexes, which create further need for proper governance (Healey & Upton, 2010).

According to Mirfenderesk and Corkill, the "ability of a governance system to adapt to uncertain and unpredicted conditions is a new notion" (2009, p. 152). Therefore, urban policies are critical in making cities more resilient and are crucial factors in bringing the governance of global environmental problems to urban contexts (Betsill & Bulkeley, 2007; Bulkeley & Newell, 2010; Biermann & Pattberg, 2008; Bulkeley, 2010; Okereke, Bulkeley, & Schroeder, 2009). It has become apparent that local authorities in all countries have a critical role in mitigating and adapting to climate change (Satterthwaite, 2008). Therefore, this concept suggests that in order to cope with uncertainties, risks and hazards that cities and

their communities may face, and make them more resilient, there needs to be a shift in urban governance. This shift will make urban governance more integrative, deliberative, and socially and eco-economically sound. Accordingly, this concept is composed of the three following components:

*Integrative approach*

In order to enhance the urban governance of climate change and cope with environmental disasters and uncertainties, there is a need to expand and improve local capacity through increasing knowledge, providing resources, establishing new institutions, enhancing good governance, and granting more local autonomy (Allman, Fleming, Wallace, 2004; Bai, 2007; Corfee-Morlot et al., 2009; Bulkeley, 2010; Holgate, 2007; Lankao, 2007; Bulkeley et al., 2009; Kern, 2008, p. 56). Because they are undertaken in a context of such great uncertainty, urban policy and planning aimed to counter climate change is too complex to be accommodated by conventional approaches. This context poses new challenges for collaboration among public, private, and civil institutions and organizations on all levels. Integrating the many different stakeholders and agents into the planning process is essential for achieving climate change objectives. Uncertainty and unpredicted conditions challenge the way cities are governed. Therefore, adaptive management requires new planning strategies and procedures that transcend conventional planning approaches by integrating uncertainties into the planning process and prioritizing stakeholders' expectations. Plans should also be "flexible enough to quickly adapt to our rapidly changing environment" (Mirfenderesk & Corkill, 2009). This component represents the integrative framework for city planning and adaptive management under conditions of uncertainty and the spectrum of collaboration that a plan proposes.

*Equity*

This component encompasses social issues such as poverty, inequality, environmental justice, and public participation in decision-making and space production. Therefore, it plays a central role in shaping a city's resilience. Scholars suggest that the impacts of climate change and other risks are unevenly distributed and socially differentiated, and are therefore a matter of local and international distributional equity and justice (Davies, Guenther, Leavy, Mitchell, & Tanner, 2008; IPCC, 2007; Kasperson & Kasperson, 2001; Tearfund, 2008). Resilience resources also appear to be unequally distributed, as seen in the United States in the aftermath of Hurricane Katrina (Mohai, Pellow, & Roberts, 2009; Satterthwaite, 2008). A more resilient city is one with less social inequalities and a fairer distribution of resilience resources. Among other things, it proposes the improvement of urban and local governance, poverty reduction, provisions for growth and employment, greater social equity, fresh business opportunities, more balanced ecosystems, better health systems, and improved education (UNISDR, 2010).

The impacts of climate change and climate change mitigation policies are socially differentiated, and are therefore matters of local and international distributional equity and justice (Adger, 2001, p. 929; O'Brien et al., 2004; Paavola & Adger, 2006). Some argue that inequality leads to greater environmental degradation and that a more equitable distribution of power and resources would result in improved environmental quality (Boyce, Klemer, Templet, & Willis, 1999; Agyeman, Bullard, & Evan, 2002; Solow, 1991, Stymne & Jackson, 2000). Mohai et al. (2009) go further by holding that climate change actually increases social inequality and that adaptive and resilience resources have apparently been distributed unequally, as demonstrated by the aftermath of Hurricane Katrina in the United States. Climate change injustice in countries around the world occurs along ethnic, gender, class, and racial lines (Mohai et al., 2009; Adger, Paavola, Huq, & Mace, 2006), and even emerges among neighborhoods and communities. Some hold that the reverse is also true: that inequality leads to greater environmental degradation and that a more equitable distribution of power and resources would result in improved environmental quality (Boyce et al., 1999; Agyeman et al., 2002; Solow, 1991; Stymne & Jackson, 2000).

*Ecological economics*

This component contributes to the assessment of the economic aspects of urban resilience and the economic engines cities put in place to meet climate change objectives and environmental hazard mitigation and reduction. It suggests that only environmentally sound economics can play a decisive role in achieving urban resilience and climate change objectives in a capitalist world.

Moreover, the economic resilience literature suggests that climate change is one of many types of shocks and stresses that urban economies face (Leichenko, 2011; Pike et al., 2010). As mentioned before, some studies identify factors that explain why resilience is uneven across places and demographic categories (Pike et al., 2010), and examine linkages between resilience and long-term growth or decline of cities and regions (Simmie & Martin, 2010).

Bulkeley (2010) argues that "it is the urban political economies of climate change that matter most in enabling and constraining effective action." Cities that are committed to climate change mitigation and sustainability should stimulate markets for environmentally friendly products and services, promote eco-friendly consumption, and contribute to urban economic development by creating a cleaner environment (David, 2006, p. 11; Mercer Human Resources Consulting, 2004). The European Commission (EC, 2010, p. 9) suggests that a "well designed climate policy, including a sufficiently high and predictable carbon price, could contribute to foster technological change, innovation in green activities and green growth." The American Recovery and Reinvestment Act, with an estimated total volume of USD 787 billion, contains approximately USD 68 billion for clean energy investment, including smart grids, energy efficient buildings, local and state renewable energy and energy efficiency efforts, and research and development for energy storage, as well as significant investment for carbon capture and storage (CCS). The Council of Economic Advisors estimates that clean energy investments will create more than 700,000 job-years of employment by the end of 2012 (Executive Office of the President, 2010). In addition, a recent EC study (2010) estimates the 2007 global market for green technologies at a volume of EUR 1400 billion, and energy efficiency and environmentally friendly energy is projected to reach a volume of EUR 1645 billion by 2020 (Federal Ministry for the Environment, 2009). Moreover, according to UNEP/NEF (2009), global public and private annual new investment in renewable energy and energy efficiency increased from USD 7.1 billion in 2002 to USD 118.9 billion in 2008 (UNEP, 2009).

*Concept 3: Prevention*

This concept suggests that in order to move towards greater urban resiliency and less vulnerability, cities need to seek to prevent environmental hazards and climate change impacts. This is composed of three main components that aim at preventing future catastrophes. These components assess urban mitigation policies to reduce hazards, involve the spatial restructuring of the city in order to prepare it for a future environmental disaster, and seek alternative clean energy. These components are:

*Mitigation*

This component assesses policies and actions that aim to reduce greenhouse gas emissions (GHG). Mitigation refers to an "action to reduce the sources (or enhance the sinks) of factors causing climate

change, such as greenhouse gases" (CCC, 2009, 2010, p. 61), and to "the reduction of GHG emissions and their capture and storage in order to limit the extent of climate change" (Bulkeley, 2010, p. 2.2). The EU has recently agreed to reduce emissions by 20% below the 1990 levels, by 2020. However, the agreement could potentially be amended to deliver a 30% reduction, if undertaken as part of an international agreement in which other developed countries agree to comparable reductions and appropriate contributions by more economically advanced developing countries.

*Restructuring*

This concept represents the ability and flexibility of a city to restructure itself in order to face social, environmental, and economic challenges. For example, the shift towards a knowledge-based economy and the emphasis on the production, trade, and diffusion of knowledge has triggered specific spatial structural transformation in cities (Cooke & Piccaluga, 2006). At the same time, cities vary in their strategies and ability to restructure, as well as their readiness to address uncertainties.

*Applying alternative energy*

This concept is perceived as a "defining issue of our time" (Yumkella, 2009, p. 1). Access to clean and affordable energy is one of the main prerequisites for sustainable economic and social development, and for making cities more resilient (UNIDO, 2009, p. 6). It is hypothesized, that cleaner, more efficient, and renewable use of energy is a key to achieving greater city resilience (CCC-Committee on Climate Change, 2010). Ecological energy is perhaps the most important concept for climate change. The clean, renewable, and efficient use of energy is a central theme in all planning that is involved in the achievement of climate change objectives. This concept evaluates how a plan addresses the energy sector and whether it proposes strategies to reduce energy consumption and to use new alternative and cleaner energy sources. This concept suggests that energy should be based on new low-carbon technologies in order to meet emissions reduction targets. For example, the target for 2050 in the UK is to reduce emissions by 80% in relation to the 1990 UK levels. Low-carbon technologies will be vital in generating cleaner forms of electricity, which can then be used for electric vehicles and heating, and for more energy efficient buildings (CCC, 2010). In this spirit, the American Recovery and Reinvestment Plan, proposed by President Barack Obama, calls for spurring "job creation while making long-term investments in energy, and infrastructure," and increasing "production of alternative energy" (White House, 2009).

*Concept 4: Uncertainty-oriented planning*

This concept suggests that planning should be uncertainty-oriented rather than adapting the conventional planning approaches. It suggests that climate change and its resulting uncertainties challenge the concepts, procedures, and scope of conventional approaches to planning, creating a need to rethink and revise current planning methods. Alternatively, this paper acknowledges not only the physical dimensions of planning to prevent hazards, but suggests that planning has a wider role to play that is closely associated with uncertainties. Abbott identified this role well when he said, "planning means, essentially, controlling uncertainty - either by taking action now to secure the future, or by preparing actions to be taken in case an event occurs" (2005, p. 237). Moreover, "the uncertainties about the overall impacts of climate change and accelerated sea-level rise are magnified many times over due to incomplete knowledge of individual ecosystems, patterns of causality and interaction between ecosystems, and patterns of causality and interaction between social and ecological systems" (Barnett, 2001, pp. 2 and 3).

The uncertainty concept is composed of three interrelated components as follows:

*Adaptation*

In order to counter climate change, there is a crucial need for uncertainty management that includes adaptation policies. Obviously, a resilience approach to a climate change adaptation should address uncertainties and limit impacts even if magnitude and direction are uncertain or unknown (Wardekker, de Jong, Knoop, & van der Sluijs, 2010, p. 995; Dessai & van der Sluijs, 2007). According to the Committee on Climate Change, adaptation is defined as an "adjustment of behavior to limit harm, or exploit beneficial opportunities, arising from climate change" (2010, p. 60). Adaptation is the task of modifying ecological and social systems to accommodate climate change impacts, such as accelerated sea-level rise, so that these systems can persist over time (Barnett, 2001). Barnett argues that adaptation is hard to grasp because it demands system-wide analysis and intervention.

Most cities and countries appear to be applying mitigation policies to address the human causes of climate change by reducing greenhouse gas emissions, but have failed to apply adaptation policies. The CCC (2010, page number) suggests that "even with strong international action on mitigation, past and present emissions mean that the climate will continue to change." In this way, adaptation and mitigation are not alternatives; rather, they are counterparts.

The new urban uncertainties posed by climate change challenges the concepts, procedures, and scope of planning. In order to cope with the new challenges, planners must develop a greater awareness and place mitigation and policies for adaptation, or actual adjustments that might eventually enhance resilience and reduce vulnerability to expected climate change impacts, as the focus of the planning process (Adger et al., 2007, p. 720). When we adopt adaptation measures, we acknowledge that the climate will continue to change and that we must take measures to reduce the risks brought about by these changes (Priemus & Rietveld, 2009). From this perspective, adaptation to climate change must be considered as indispensable (Vellinga et al., 2009). Moreover, adaptation planning, practices and policies should also consider statistical uncertainties, scenario uncertainties, or sometimes recognize ignorance (Walker, 2003). Wardekker et al. (2010) suggest that "scenario uncertainty" stems from limited predictability of the future, and that resilient systems can cope with statistical uncertainty. In addition, resilient systems should be able to deal with a continuous range of conditions, rather than only the 'average'.

Planners must also develop a better understanding of the risks that climate change poses to infrastructure, households, and communities. To address these risks, planners have two types of uncertainty or adaptation management at their disposal: (1) Ex-ante management, or actions taken to reduce and/or prevent risky events; and (2) Ex-post management, or actions taken to recover losses after a risky event (Heltberg et al., 2009). This concept evaluates a plan's adaptation strategies (*ex-post* and *ex-ante*) and policies in addition to the planning strategies for addressing future uncertainties stemming from climate change. In plan evaluation, the following questions need to be answered in order to fit within this concept: Does the plan include development projects for infrastructure design in order to reduce vulnerabilities and make the city more resilient? Does the plan enhance the city's adaptive planning capacity, or the ability of the planning system to respond successfully to climate variability and change?

The Commission of the European Communities (CEC) (2009, p. 3) suggests that "even if the world succeeds in limiting and then reducing GHG emissions, our planet will take time to recover from the greenhouse gases already in the atmosphere. Thus we will be faced with the impact of climate change for at least the next

50 years. We need therefore to take measures to adapt." The CEC (2009) regrets the "piecemeal manner" in which adaptation policies have been implemented and concludes that "a more strategic approach is needed to ensure that timely and effective adaptation measures are taken, ensuring coherency across different sectors and levels of governance" (CEC, 2009, p. 3).

*Spatial planning*

This component assesses the role of planning in transforming the city into a more resilient state. It "is the provision... of future 'certainty' in a complex, unstable, dynamic and inherently uncertain world" (Gunder & Hillier, 2009, p. 23). Therefore, planning plays a more central role in shaping all dimensions of the built environment, including in physical security and environmental and socio-spatial policies, and has a major impact on city resilience.

In order to reduce community vulnerability to natural hazards, planning scholars have advocated using land use management, and building and site design codes to regulate development in hazard prone areas (Burby, Deyle, Godschalk, & Olshansky, 2000; Godschalk, Beatly, Berke, Brower, & Kaiser, 1999; Nelson & French, 2002; Zhang, 2010). However, planning should expand its scope to include prediction and anticipation of risks and uncertainties as well as provide ways to cope with them.

*Sustainable urban form*

If the previous component of spatial planning focuses on macro urban *dimensions*, this concept focuses on the micro level and deals with urban design and the qualities of urban form, or what is known as "good city form," which has an impact on urban resilience. Urban design interfaces with many aspects of contemporary public policy: multiculturalism, city health, environmental justice, economic development, climate change, energy conservation, protection of the natural environment, sustainable development, and community liveability (Banerjee & Loukaitou-Sideris, 2010; MacKillop, 2012; Meijer, van der Adriaens, Linden, & Schik, 2011). The physical form of a city affects its habitats and ecosystems, the everyday activities and spatial practices of its inhabitants and, eventually, climate change (Jabareen, 2006). This component assesses spatial planning, architecture, design, and the ecologically-desired form of the city and its components (such as buildings and neighborhoods). Jabareen (2006) suggests the following set of nine planning typologies, or criteria of evaluation, which are helpful in evaluating plans from the perspective of eco-form:

*Compactness.* This refers to urban contiguity and connectivity, and suggests that future urban development should take place adjacent to existing urban structures (Wheeler, 2002). Compact urban space can minimize the need to transport energy, materials, products, and people (Elkin, McLaren, & Hillman, 1991). Intensification, a major strategy for achieving compactness, uses urban land more efficiently by increasing the density of development and activity, and involves developing previously undeveloped urban land, redeveloping existing buildings or previously developed sites, subdivisions and conversions, and the creation of building additions and extensions (Jenks, 2000, p. 243).

Even though urban compactness generally reduces energy consumption and it is certainly positive for mitigation, it can also have negative implications for adaptation, for instance by enhancing the urban heat island effect (more heat-absorbing materials resulting in increased heat-retention, decreased wind flow resulting in decreased convective cooling, etc.) and decreased options for water retention and infiltration. Furthermore, it might have implications for flexibility; e.g. having more landowners and capital-intensive high-rise buildings could make urban renewal (in the light of changed environmental or socio-economic conditions) more difficult.

*Sustainable transport.* This suggests that planning should promote sustainable modes of transportation through traffic reduction, trip reduction, the encouragement of non-motorized travel, transit-oriented development, safety, equitable access to all, and renewable energy sources (Cervero, 1998; Clercq & Bertolini, 2003).

*Density.* This affects climate change through differences in the consumption of energy, materials and land for housing, transportation, and urban infrastructure. High density planning can save significant amounts of energy (Carl, 2000; Walker & Rees, 1997; Newman & Kenworthy, 1989).

*Mixed land uses.* This indicates the diversity of functional land uses, such as residential, commercial, industrial, institutional, and transportation. It allows planners to locate compatible land uses in close proximity to one another in order to decrease the travel distance between activities, encouraging walking and cycling, and reducing the need for car travel, since jobs, shops, and leisure facilities are within close range to each other (Parker, 1994; Alberti, 2000; Van & Senior, 2000; Thorne & Filmer-Sankey, 2003).

*Diversity.* This is a multidimensional phenomenon that promotes other desirable urban features, including a larger variety of housing types, building densities, household sizes, ages, cultures, and incomes (Turner & Murray, 2001, p. 320). Diversity is vital for cities. Without it, the urban system declines as a living place (Jacobs, 1961) and the resulting homogeneity of built forms, which often produces unattractive monotonous urban landscapes, leads to increased segregation, car travel, congestion, and air pollution (Wheeler, 2002).

*Passive solar design.* This aims to reduce energy demands and provide the best use of passive energy through specific planning and design measures, such as orientation, layout, landscaping, building design, urban materials, surface finish, vegetation, and bodies of water. This facilitates the optimum use of solar gain and microclimatic conditions and reduces the need for the heating and cooling of buildings by means of conventional energy sources (Owens, 1992; Thomas, 2003; Yanns, 1998, p. 43). Truly, 'traditional urban planning methods used by architects and town planners are no longer safe and efficient' (Abbate, 2008, p. 129).

*Greening.* Also known as bringing "nature into the city," greening makes positive contributions to many aspects of the urban environment, including biodiversity, the lived-in urban environment, urban climate, economic attractiveness, community pride, health and education (Beatley, 2000; Swanwick, Nigel, & Helen, 2003; Forman, 2002; Dumreicher, Levine, & Yanarella, 2000; MacKillop, 2012).

*Renewal and utilization.* These refer to the process of reclaiming the many sites that are no longer appropriate for their originally intended use and can be used for a new purpose, such as brownfields. Cleaning, rezoning, and developing contaminated sites are key aspects of revitalizing cities and neighborhoods in addition to contributing to their sustainability and to a healthier urban environment.

## 4. Conclusions

This paper elaborated a new conceptual framework (the Resilient City Planning Framework; RCPF) that addresses the critical question of what cities and their urban communities should do in order to move towards a more resilient state in the future. Accordingly, *Resilient City Planning Framework* (RCPF) is defined

**Table 1**
Resilient city framework.

| Concepts | Components | Key questions (measurements) |
|---|---|---|
| Concept 1: Urban vulnerability matrix analysis | C1: Uncertainties | C1. What are the hazard and environmental uncertainties? |
| | C2: Informality | C2. What is the scope, geography, socio-economic, demographic, and physical characters of existing informal settlements in or closed to the city? |
| | C3: Demography | C3. What is the nature of vulnerable demography in the city by age, gender, health, and other social group? |
| | C4: Spatiality | C4.What is the spatial distribution of environmental hazards and risks? |
| Concept 2: Uncertainty oriented planning | C1: Adaptation | C1: What adaptation measures are taken to reduce risks and cope with future uncertainties? |
| | C2: Planning | C2: How do planning methods cope with uncertainties? |
| | C3: Sustainable form | C3: What are characteristics of the existing and planned urban form typologies? |
| Concept 3: Urban governance | C1: Equity | C1: Who participates in decision-making and planning regarding environmental and uncertainty issues? |
| | C2: Integrative | C2: Is the urban governance approach integrating institutional, legal, social, economic, and environmental aspects? |
| | C3: Eco-economics | C3: what is the nature of the existing and planned ecological economy? |
| Concept 4: Prevention | C1: Mitigation | C1: What mitigation measures are taken to reduce risks and to prepare the city for future environmental hazards? |
| | C2: Restructuring | C2: What are the proposed or planned spatial, physical, and economic restructuring policies that aim to face the environmental hazards and uncertainties? |
| | C3: Alternative energy | C3: How does the city address the energy sector and whether it proposes strategies to reduce energy consumption and to use new alternative and cleaner energy sources? |

as a network, or a theoretical plane of interlinked concepts, that provides a comprehensive understanding of City Resilience. The *Resilient City Planning Framework* is composed of four concepts. As described in this paper, each concept consists of specific components that define its nature and assess its contribution to the framework. The contribution of each concept to the framework of urban resilience is the sum of the contributions of its measurable components. Even though various measurement techniques may already exist for some of these components, a systematic approach to the measurement of all components should be prioritized in future research.

Each one of the four *Resilient City Framework* concepts has specific roles and domain in the RCT framework as seen in Fig. 1 and Table 1. The 'Urban vulnerability matrix analysis' focuses on the governance culture, processes, arena and roles of the resilient city. This concept is critical and significant for the resilient city for its contribution to the spatial and socio-economic mapping of future risks and vulnerabilities. The 'Urban governance' concept contributes to the holistic management of urban resilience. It focuses on urban policies and assumes that there is a significant need for a new approach to urban governance in order to cope with uncertainties and future environmental and climate change impact challenges. Urban governance suggests that the integrative governance approach, deliberative and communicative decision making measures, and ecological economics have a great impact on moving our cities towards improved urban resiliency. The concept of 'prevention' represents the various components that should be considered in order to contribute to the prevention of environmental hazards and climate change impacts. These components include mitigation measures, adaptation of clean energy, and urban restructuring methods. The fourth concept, 'uncertainty oriented planning', demonstrates that planning should adapt its methods in order to help cities cope with uncertainties in the future.

*Resilient City Framework,* the framework for City Resilience and Community Resilience, is a complex phenomenon, non-deterministic, dynamic in structure, and uncertain in nature. It is affected by a multiplicity of economic, social, spatial, and physical factors and its planning involves a wide range of stakeholders. It is important to mention that the proposed *RCPF* is not a deterministic framework, but a dynamic and flexible one that could be modified while respecting its fundamental concepts.

According to the *Resilient City Framework,* a resilient city is defined by the overall abilities of its governance, physical, economic and social systems and entities exposed to hazards to learn, be ready in advance, plan for uncertainties, 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.

## References


Abbate, C. (2008). A vicious circle. In R. Plunz, & M. P. Sutto (Eds.), *Urban climate change crossroads* (pp. 129–134), Ashgate.

Abbott, J. (2009). Planning for complex metropolitan regions: A better future or a more certain one? *Journal of Planning Education and Research, 28*, 503–517.

Adger, W. N. (2000). Social and ecological resilience. Are they related? *Progress in Human Geography, 24*(3), 347–364.

Adger, W. N. (2001). Scales of governance and environmental justice for adaptation and mitigation of climate change. *Journal of International Development, 13*(7), 921–931.

Adger, W. N., Paavola, J., Huq, S., & Mace, M. J. (2006). *Fairness in adaptation to climate change*. Cambridge, MA: MIT Press.

Adger, W. N., Agrawala, S., Mirza, M. M. Q., Conde, C., O'Brien, K., Pulhin, J., et al. (2007). Assessment of adaptation practices, options, constraints and capacity. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden & C.E. Hanson (Eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 717–743). Cambridge, UK: Cambridge University Press.

Agyeman, J., Bullard, R. D., & Evans, B. (2002). Exploring the nexus: Bringing together sustainability, environmental justice and equity. *Space & Polity, 6*(1), 77–90.

Albrechts, L. (2004). Strategic (spatial) planning reexamined. *Environment and Planning B: Planning and Design, 31*, 743–758.

Alberti, M. (2000). Urban form and ecosystem dynamics: Empirical evidence and practical implications. In K. Williams, E. Burton, & M. Jenks (Eds.), *Achieving sustainable urban form* (pp. 84–96). London: E & FN Spon.

Allman, L., Fleming, P., & Wallace, A. (2004). The progress of English and Welsh local authorities in addressing climate change. *Local Environmental, 9*, 271–283.

Andersson, E. (2006). Urban landscapes and sustainable cities. *Ecology and Society, 11*, 34.

Bai, X. (2007). Integrating global environmental concerns into urban management: The scale and readiness arguments. *Journal of Industrial Ecology, 11*, 15–29.

Banerjee, T., & Loukaitou-Sideris, A. (2010). *Companion to urban design*. New York: Routledge.

Barnett, J. (2001). Adapting to climate change in Pacific Island countries: The problem of uncertainty. *World Development, 29*, 977–993.

Batty, M. (2007). *Complexity in city systems: Understanding, evolution, and design*. MA: MIT Press.

Beatley, T. (2000). *Green urbanism: Learning from European cities*. Washington, DC: Island Press.

Betsill, M. M., & Bulkeley, H. (2007). Looking back and thinking ahead: A decade of cities and climate change research. *Local Environmental, 12*, 447–456.

Bettencourt, L., & Geoffrey, W. (2010). A unified theory of urban living. *Nature, 467*, 912–913 (21 October).

Biermann, F., & Pattberg, P. (2008). Global environmental governance: Taking stock, moving forward. *Annual Review of Environment and Resources, 33*, 277–294.

Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (1994). *At risk: Natural hazards, people's vulnerability, and disasters*, Routledge, London.

Bonta, Mark., & Protevi, John. (2004). *Deleuze and geophilosophy: A guide and glossary*. Edinburgh: Edinburgh University Press.

Boyce, J. K., Klemer, A. R., Templet, P. H., & Willis, C. E. (1999). Power distribution, the environment, and public health: A state-level analysis. *Ecological Economics, 29*(1), 127–140.

Bulkeley, H., & Newell, P. (2010). *Governing climate change*. London: Routledge.

Bulkeley, H. (2010). Cities and the governing of climate change. *Annual Review of Environment and Resources, 35*, 229–253.

Bulkeley, H., Schroeder, H., Janda, K., Zhao, J., Armstrong, A., Shu Yi, C., & Ghosh S. (2009). Cities and Climate Change: The role of institutions, governance and urban planning - Conference Paper. *5th Urban Research Symposium: Cities and Climate Change - Responding to an Urgent Agenda,* Marseille.

Burby, R. J., Deyle, R. E., Godschalk, D. R., & Olshansky, R. B. (2000). Creating hazard resilient community through land-use planning. *Natural Hazards Review, 1*(2), 99–106.

Carl, P. (2000). Urban density and block metabolism. In K. Steemers, & S. Yannas (Eds.), *Architecture, city, environment. Proceedings of PLEA 2000* (pp. 343–347). London: James & James.

Carpenter, S., Walker, B., Anderies, J. M., Abel, N. (2001). From metaphor to measurement: Resilience of what to what? *Ecosystems, 4*, 765–781. (CCC: Committee on Climate Change. 2010. Building a low-carbon economy – the UK's innovation challenge. <http://www.theccc.org.uk>).

Castello, M. G. (2011). Brazilian policies on climate change: The missing link to cities. *Cities, 28*(6), 498–504.

Cervero, R. (1998). *The transit metropolis: A global inquiry*. Washington, DC: Island Press.

CCC: Committee on Climate Change. (2010). *Building a low-carbon economy – the UK's innovation challenge*. <http://www.theccc.org.uk>.

CCC-Committee on Climate Change Adaptation. (2010). *How well prepared is the UK for climate change?* www.theccc.org.uk.

Chapin, F. S., III Kofinas, G. P., & Folke, C. (Eds.). (2009). *Principles of ecosystem stewardship: Resilience-based natural resource management in a changing world*. New York: Springer Verlag.

Chapin, F. S., III, Pickett, S. T. A., Power, M. E., Jackson, R. B., Carter, D. M., & Duke, C. (2011). Earth stewardship: A strategy forsocial–ecological transformation to reverse planetary degradation. *Journal of Environmental Studies and Sciences, 1*, 44–53.

Clercq, F., & Bertolini, L. (2003). Achieving sustainable accessibility: An evaluation of policy measures in the Amsterdam area. *Built Environment, 29*(1), 36–47.

Coaffee, J. (2009). *Terrorism,* Risk and the Global City: Towards Urban Resilience. Ashgate Publishing.

Colten, C., Kates, R., & Laska, S. (2008). Three years after Katrina: Lessons for community resilience. *Environment: Science and Policy for Sustainable Development, 50*, 36–47.

Cooke, P., & Piccaluga, A. (Eds.). (2006). *Regional development in the knowledge economy*. NY: Routledge.

Corfee-Morlot, J., Kamal-Chaoui, L., Donovan, M. G., Cochran, I., Robert A. et al. (2009). *Cities, climate change and multilevel governance*. Organisation for Economic Co-operative Development Environmental Working Paper No.14, Paris: OECD Published.

Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards. *Social Science Quarterly, 84*(2), 242–261.

Davic, R. D., & Welsh, H. H. Jr., (2004). On the ecological roles of salamanders. *Annual Review of Ecology, Evolution, and Systematic, 35*, 405–434.

David, H. (2006). *Sustainable New York City*. New York City: Design Trust for Public Space and the New York City Office of Environmental Coordination.

Davies, M., Guenther, B., Leavy, J., Mitchell, T., & Tanner, T. (2008). *Climate change adaptation, disaster risk reduction and social protection: Complementary roles in agriculture and rural growth?* Institute of Development Studies Centre for Social Protection and Climate Change and Disasters Group. IDS: Institute of Developing Studies.

De Roo, G., & Juotsiniemi, A. (2010). Planning and complexity. In *Book of abstracts: 24th AESOP annual conference* (p. 90), Finland.

Deleuze, G., & Guattari, F. (1991). *What is philosophy?* New York: Columbia University Press.

Dessai, S. J.P., & van der Sluijs, P. (2007). *Uncertainty and climate change adaptation—a scoping study, copernicus institute for sustainable development and innovation*. Utrecht: Utrecht University.

Dumreicher, H., Levine, R. S., & Yanarella, E. J. (2000). The appropriate scale for "low energy": Theory and practice at the Westbahnhof. In K. Steemers, & S. Yannas, *Architecture, city, environment. Proceedings of PLEA 2000* (pp. 359–363). London: James & James.

Eakin, H. C., & Wehbe, M. B. (2009). Linking local vulnerability to system sustainability in a resilience framework: Two cases from Latin America. *Climatic Change, 93*, 355–377.

EC-The European Commission. (2010). Commission Staff Working Documnet. Brussels, 26.5.2010. <http://ec.europa.eu/environment/climat/pdf/26-05-2010working_doc.pdf>.

Elkin, T., McLaren, D., & Hillman, M. (1991). *Reviving the city: Towards sustainable urban development*. London: Friends of the Earth.

Enfors, E. I., & Gordon, L. J. (2008). Dealing with drought: The challenge of using water system technologies to break dryland poverty traps. *Global Environmental Change, 18*, 607–616.

Ernstson, H., van der Leeuw, S., Redman, C., Meffert, D., Davis, G., Alfsen, C. et al. (2010). Urban transitions: On urban resilience and human-dominated ecosystems. *AMBIO: A Journal of the Human, Environment, 10*. doi.org/1007/s13280-010-0081-9.

Executive Office of the President, Council of Economic Advisers: The Economic Impact of the American Recovery and Reinvestment Act of 2009, Second Quarterly Report, January 13, 2010. <http://www.whitehouse.gov/the-press-office/economic-impact-american-recovery-and-reinvestment-act-2009-second-quarterly-report>.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. (2009). *GreenTech made in Germany 2.0*. <http://www.bmu.de/files/pdfs/allgemein/application/pdf/greentech2009_en.pdf>.

Forman, R. T. (2002). The missing catalyst: Design and planning with ecology. In T. Johnson Bart, & K. Hill (Eds.), *Ecology and design: Frameworks for learning*. Washington, DC: Island Press.

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change, 16*, 253–267.

Folke, C., Carpenter, S. R., Walker, B. H., Scheffer, M., Chapin, F. S., III, & Rockstro, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society, 15*, 20. <http://www.ecologyandsociety.org/vol15/iss4/art20/>.

Folke, C., Jansson, Å., Rockström, J., Olsson, P., Carpenter, S. R., Chapin, F. S., Crépin, A. S., et al. (2011). Reconnecting to the biosphere. *AMBIO: A Journal of the Human Environment, 40*(7), 719–738.

Fothergill, A., & Peek, L. (2004). Poverty and disasters in the United States: A review of recent sociological findings. *Natural Hazards, 32*(1), 89–110.

Godschalk, D. R. (2003). Urban hazards mitigation: Creating resilient cities. *Natural Hazards Review, 4*(3), 136–143.

Godschalk, D. R., Beatly, T., Berke, P., Brower, D. J., & Kaiser, E. J. (1999). *Natural hazard mitigation: Recasting disaster policy and planning*. Washington, DC: Island Press.

Gunder, M., & Hillier, J. (2009). *Planning in ten words or less: A Lacanian entanglement with spatial planning*. Ashgate.

Gunderson, L., & Holling, C. S. (Eds.). (2001). *Panarchy: Understanding transformations in human and natural systems*. Washington (DC): Island Press.

Hardoy, J., & Satterthwaite, D. (2009). *Urban Development and intensive and extensive risk, background paper for the ISDR global assessment report on disaster risk reduction 2009*. London: International Institute for Environment and Development (IIED).

Healey, P. (2007). *Urban complexity and spatial strategies: Towards a relational planning for our times*. New York: Routledge.

Healey, P., & Upton, R. (Eds.). (2010). *Crossing borders international exchange and planning practices*. Oxon: Routledge.

Heltberg, R., Siegel, P. B., & Jorgensen, S. L. (2009). Addressing human vulnerability to climate change: Toward a 'no-regrets' approach. *Global Environmental Change, 19*, 89–99.

Holgate, C. (2007). Factors and actors in climate change mitigation: A tale of two South African cities. *Local Environmental, 12*, 471–484.

Holling, C. (1973). Resilience and stability of ecological systems. *Annual review of ecology and systematics, 4*, 1–23.

IPCC-Intergov. Panel Clim. Change (2007). *Climate change 2007: Fourth assessment report of the intergovernmental panel on climate change*. Cambridge, MA: Cambridge Univ. Press.

Jabareen, Y. (2006). Sustainable urban forms: Their typologies, models, and concepts. *Journal of Planning Education and Research, 26*, 38–52.

Jabareen, Y. (2009). Building conceptual framework: Philosophy, definitions and procedure. *International Journal of Qualitative Methods, 8*(4), 49–62.

Jacobs, J. (1961). *The death and life of great American cities*. New York: Vintage Books.

Jenks, M. (2000). The acceptability of urban intensification. In K. Williams, E. Burton, & M. Jenks (Eds.), *Achieving sustainable urban form*. London: E & FN SPON.

Kasperson, R. E., & Kasperson, J. X. (2001). *Climate change, vulnerability and social justice*. Stockholm: Stockholm Environ. Inst.

Lankao, R. P. (2007). How do local governments in Mexico City manage global warming? *Local Environmental, 12*, 519–535.

Leichenko, R. (2011). Climate change and urban resilience. *Current Opinion in Environmental Sustainability, 3*(3), 164–168.

Little, R. (2004). Holistic strategy for urban security. *Journal of Infrastructure Systems, 10*(2), 52–59.

MacKillop, F. (2012). Climatic city: Two centuries of urban planning and climate science in Manchester (UK) and its region. *Cities, 29*(4), 244–251.

Maru, Y. (2010). Resilient regions: Clarity of concepts and challenges to systemic measurement systemic measurement. In *Socio-economics and the environment discussion*, CSIRO Working Paper Series. <http://www.csiro.au/files/files/pw5h.pdf>.

Mercer Human Resources Consulting. (2004). *Quality of Living Survey: New York City*. Private communication.

McSweeney, K., & Coomes, O. (2011). Climate-related disaster opens 'window of opportunity' for rural poor in northeastern Honduras. *Proceedings of the National Academy of Sciences, USA, 108*, 5203–5208.

Meijer, M., van der Adriaens, F., Linden, O., & Schik, W. (2011). A next step for sustainable urban design in the Netherlands. *Cities, 28*(6), 536–544.

Mirfenderesk, H., & Corkill, D. (2009). Sustainable management of risks associated with climate change. *International Journal of Climate Change Strategies and Management, 1*(2), 146–159.

Mohai, P., Pellow, D., & Roberts, J. T. (2009). Environmental justice. *Annual Review of Environment and Resources, 34*, 405–430.

Morrow, B. H. (1999). Identifying and mapping community vulnerability. *Disasters, 23*(1), 1–18.

Munn-Venn, T., & Archibald, A. (2007). *A resilient canada: Governance for national security and public safety*. Governance for National Security and Public Safety. <http://www.conferenceboard.ca>.

Nelson, A. C., & French, S. P. (2002). Plan quality and mitigating damage from natural disasters: A case study of the Northridge earthquake with planning policy considerations. *Journal of the American Planning Association, 68*(2), 194–207.

Newman, P., & Kenworthy, J. (1989). Gasoline consumption and cities: A comparison of US cities with a global survey. *Journal of the American Planning Association, 55*, 23–37.

Newman, P., Beatley, T., & Boyer, H. (2009). *Resilient cities: Responding to peak oil and climate change*. Island Press.

NPCC (2009). *New York City panel on climate change: Climate risk information*. <http://www.nyc.gov/html/om/pdf/2009/NPCC_CRI.pdf>.

O'Brien, R., Leichenko, U., Kelkar, H., Venema, G., Aandahl, H., Tompkins, A., et al. (2004). Mapping vulnerability to multiple stressors: Climate change and globalization in India. *Global Environmental Change, 14*, 303–313.

Ojerio, R., Moseley, C., Lynn, K., & Bania, N. (2011). Limited Involvement of Socially Vulnerable Populations in Federal Programs to Mitigate Wildfire Risk in Arizona. *Natural Hazards Review, 12*(2), 28–36.

Okereke, C., Bulkeley, H., & Schroeder, H. (2009). Conceptualizing climate governance beyond the international regime. *Global Environmental Politics, 9*, 58–78.

Owens, S. (1992). Energy, environmental sustainability and land-use planning. In B. Michael (Ed.), *Sustainable development and urban form* (pp. 79–105). London: Pion.

Paavola, J., & Adger, W. N. (2006). Fair adaptation to climate change. *Ecological Economics, 56*(4), 594–609.

Pais, J., & Elliot, J. (2008). Places as recovery machines: Vulnerability and neighborhood change after major hurricanes. *Social Forces, 86*, 1415–1453.

Parker, T. (1994). *The land use—air quality linkage: How land use and transportation affect air quality*. Sacramento: California Air Resources Board.

Pelling, M. (2003). *The vulnerability of cities: Natural disasters and social resilience*. London: Earthscan.

Pendall, R., Foster, K., & Cowel, M. (2010). Resilience and regions: Building understanding of the metaphor. *Cambridge Journal of Economic and Society, 3*(1), 71–84.

Pike, A., Dawley, S., & Tomaney, J. (2010). Resilience adaptation and adaptability. *Cambridge Journal of Regions, Economy and Society, 3*, 59–70.

Priemus, H., & Rietveld, P. (2009). Climate change, flood risk and spatial planning. *Built Environment, 35*(4), 425–431.

Rose, A. (2004). Defining and measuring economic resilience to disaster. *Disaster Prevention and Management, 13*(4), 307–314.

Roy, A. (2010). Informality and the politics of planning. In J. Hillier & P. Healey (Eds.), *Planning theory: Conceptual challenges for spatial planning* (pp. 87–107). Ashgate Publishing.

Satterthwaite, D. (2008). Climate change and urbanization: Effects and implications for urban governance. In *Presented at UN expert group meet. popul. distrib., urban., intern. migr. dev. UN/POP/EGMURB/2008/16*.

Simmie, J., & Martin, R. (2010). The economic resilience of regions: Towards an evolutionary approach. *Cambridge Journal of Regions, Economy and Society, 3*, 27–43.

Solow, R. (1991). *Sustainability: An Economist's Perspective*. The Eighteenth J. Seward Johnson Lecture. Woods Hole, MA: Woods Hole Oceanographic Institution.

Storch, H., & Downes, N. K. (2011). A scenario-based approach to assess Ho Chi Minh City's urban development strategies against the impact of climate change. *Cities, 28*(6), 517–526.

Stymne, S., & Jackson, T. (2000). Intra-generational equity and sustainable welfare: A time series analysis for the UK and Sweden. *Ecological Economics, 33*(2), 219–236.

Swanwick, C., Nigel, D., & Helen, W. (2003). Nature, role and value of green space in towns and cities: An overview. *Built Environment, 29*(2), 94–106.

Tearfund (2008). *Linking climate change adaptation and disaster risk reduction*. Web White Pap. <http://www.tearfund.org/webdocs/Website/Campaigning/CCAandDRRweb.pdf>.

CEC-The Commission of the European Communities. (2009). White paper: Adapting to climate change: Towards a European framework for action. Brussels.

Thomas, R. (2003). Building design. In R. Thomas, & M. Fordham (Eds.), *Sustainable urban design: An environmental approach* (pp. 46–88). London: Spon Press.

Thorne, R., & Filmer-Sankey, W. (2003). Transportation. In R. Thomas (Ed.), *Sustainable urban design* (pp. 25–32). London: Spon Press.

Turner, S. R. S., & Murray, M. S. (2001). Managing growth in a climate of urban diversity: South Florida's Eastward ho! Initiative. *Journal of Planning Education and Research, 20*, 308–328.

UNEP-United Nations Environment Programme/ New Economy Finance, Global Trends in Sustainable Energy Investment. (2009). Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency.

UN-HABITAT (2008). *State of the world's cities 2008/2009 – harmonious cities*. London: Earthscan. <http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2562>.

UNIDO-United Nations Industrial Development Organization (2009). *Energy and climate change: Greening the industrial agenda*. <http://www.unido.org>.

UNISDR-International Strategy for Disaster Reduction (2010). *Making cities resilient: My city is getting ready, 2010–2011*. World Disaster Reduction Campaign.

United Nations Division for the Advancement of Women (2001). *Environmental management and the mitigation of natural disasters: A gender perspective*. http://www.un.org/womenwatch/daw/csw/env_ manage/documents/EGM-Turkey-final-report.pdf (Accessed 07.07.09).

Vale, J. L., & Campanella, T. J. (2005). *The resilient city: How modern cities recover from disaster*. New York: Oxford University Press.

Vellinga, P., Marinova, N. A., & van Loon-Steensma, J. M. (2009). Adaptation to climate change: A framework for analysis with examples from the Netherlands. *Built Environment, 35*(4), 452–470. <http://www.climategovernance.org/docs/SP-CC-DRR_idsDFID_08final.pdf>.

Van, U.-P., & Senior, M. (2000). The contribution of mixed land uses to sustainable travel in cities. In K. Williams, E. Burton, & M. Jenks (Eds.), *Achieving sustainable urban form* (pp. 139–148). London: E & FN Spon.

Walisser, B., Mueller, B., McLean, C. (2005). *The resilient city. prepared for the world urban forum 2006 by the Vancouver Working Group*. Canada: Ministry of Community, Aboriginal and Women's Services, Government of British Columbia.

Walker, L., & Rees, W. (1997). Urban density and ecological footprints – An analysis of Canadian households. In R. Mark (Ed.), *Eco-city dimensions: Healthy communities, healthy planet*. New Society Publishers.

Walker, B. H., Anderies, J. M., Kinzig, A. P., Ryan, P. (2006). Exploring resilience in social-ecological systems through comparative studies and theory development. *Ecology and Society, 11*, 12. <http://www.ecologyandsociety.org/vol11/iss1/art12/>.

Wardekker, J. A., de Jong, A., Knoop, J. M., & van der Sluijs, J. P. (2010). Operationalising a resilience approach to adapting an urban delta to uncertain climate changes. *Technological Forecasting and Social Change, 7*(6), 987–998.

Wheeler, S. M. (2002). Constructing sustainable development/safeguarding our common future: Rethinnking sustainable development. *Journal of the American Planning Association, 68*(1), 110–111.

WRC- World Resources Institute (2008). *Roots of resilience: Growing the wealth of the poor?* Washington, DC: World Resource Institute.

Yanns, S. (1998). Living with the city: Urban design and environmental sustainability. In M. Eduardo, & S. Yannas (Eds.), *Environmantly friendly cities* (pp. 41–48). London: James & James.

Yumkella, K. K. (2009). *Forward. In energy and climate change: Greening the industrial agenda*. UNIDO-United Nations Industrial Development Organization (2010. P.1). <http://www.unido.org>.

Zhang, Yang. (2010). Residential housing choice in a multihazard environment: Implications for natural hazards mitigation and community environmental justice. *Journal of Planning Education and Research, 30*(2), 117–131.

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