Title: Urban resilience: two diverging interpretations

Revised draft submitted on 24-05-2014

Journal of Urbanism: International Research on Placemaking and Urban Sustainability

***Corresponding author**: Dr Silvio Caputo, Senior Research Assistant, Coventry University*

***Address**: Department of the Built Environment, Architecture and Building, Faculty of Engineering & Computing, Coventry University, 3 Gulson Road, Coventry CV1 2JH*

***Telephone**: 024 7623 6423*

***E-mail**: silvio.caputo@coventry.ac.uk*

***Co-authors**:*

Dr Maria Caserio, BA, PhD, Research Fellow, Birmingham City University

Professor Richard Coles, BSc, PhD, Head of the School of Architecture Research, Birmingham City University

Professor Lubo Jankovic, BSc, PhD, FIAP, CEng, MCIBSE, Senior Lecturer, Birmingham City University

Professor Mark R. Gaterell, BEng, MPhil (Cantab), PhD, DIC, MCIWEM, CEnv, Professor of Sustainable Construction, Coventry University

Text: 7447 main text + 2067 references

TITLE - *URBAN RESILIENCE: TWO DIVERGING INTERPRETATIONS*

Abstract - This paper uses two diverging interpretations of resilience to review and assess current UK policies for urban resilience. Both developed in scientific studies, the first interpretation is based on a mechanistic model of systems that can recover their original state after shocks, and the second is based on an evolutionary model enabling adaptation to disturbances. The literature review demonstrates that at present urban resilience is predominantly associated with the former. By contrast, only few policies and studies are inspired by the latter, although this is better suited to analyse dynamics of urban adaptation and manage cities accordingly. The contribution of this paper to an understanding of urban resilience is therefore twofold. First, an identification of the long-term consequences on the built environment associated with each model is provided, with the mechanical model ultimately hindering adaptation. Second, some approaches to generate effective responses to environmental and societal change are identified. Ultimately, this paper emphasises that the idea of a resilient city is fit for this age characterised by uncertainty, albeit it requires the recognition within planning practice that urban adaptation cannot be attained with current methodologies, and that much can be learned from theories on the resilience of ecosystems.

Keywords: urban resilience; urban systems; urban adaptability

1 - Introduction

Recently, resilience has come to prominence within the sustainability debate to the point of becoming a ubiquitous term. The idea of a man-made system which can continue to function in the face of disruption provides a useful concept in this age of rapid change and uncertainty, where fast shifts can trigger adverse consequences which are difficult to foresee and prevent. In the UK, recent studies have researched strategies to attain the resilience of national systems such as food (Foresight, 2011; SDC, 2011), transport (HM Government, 2011) and power (Foresight, 2008). Internationally, the UN has published a report on the resilient planet (2012) and on resilient cities (UNISDR, 2012). Within the urban planning and design domain, the concept has become prominent in disaster research (Bosher and Dainty, 2011) as well as in relationship to climate change, both for developing and developed countries. The UK government, for example, has issued guidance for planning and delivering a built environment resistant to floods and other natural hazards (see DCLG, 2006; DCLG, 2007a; HM Government, 2011) as well as safe from crime (ODPM, 2004). The academic community has joined the debate by producing an abundant body of work on subjects that include: a resilient water sector (Hamilton, 2009); resilience to flooding (Lamond and Proverbs, 2009); resilient urban design to counter terrorism (Coaffee et al, 2008); and resilience of communities (Magis, 2010).

One of the most influential definitions of resilience was developed by Holling (1973) in ecology studies, where he moved away from an equilibrium-centred model of systems' behaviour to one characterised by oscillations of state, with resilience attained through a degree of instability in order to buffer external shocks. One merit of this conceptualisation is to offer a useful, dynamic model for systems to cope with change through a permanent condition of modification and adaptation. Transposing this property of natural systems to man-made or man-managed systems such as cities, however, presents substantial difficulties. It requires the transition from a deterministic approach to planning to one that is responsive and flexible, in line to the one promoted by adaptive planning and strategic planning (see Wilkinson, 2012; Ahern, 2011; Hillier, 2005). These recent planning theories move away from a mechanistic perspective to one inspired by life sciences and systems thinking, in which methodologies based on the non-linearity of events and the open-endedness of processes integrate those based on statistical methods. Planning is a practice aimed at governing urban growth which accommodates societal needs. Strategic and adaptive planning contest the idea that this growth can follow a predicted course of events to attain desirable aims, and favours the design of processes enabling the built environment to be reactive to change over its lifetime similar to an organism.

Over the last decades biological processes have already been scrutinised in order to develop new insights in other fields of knowledge. Georgescu-Roegen, for example, in his studies on bio-economy (Georgescu-Roegen, 1972; Bonaiuti, 2003), demonstrates the flaws of classical economic (and also

Marxist) theories that are based on the assumption of the circularity of economic processes (supply and demand) as if these happened in a closed system in which resources are never lost through production. An alternative economic model should reflect the evolutionary process of the human species and society, thus taking into account current environmental concerns and the inevitability of increased entropy caused by the exploitation of these resources. His description of the market and market dynamics is based on similarities with evolutionary theories in which competition and cooperation are both critical elements for the survival of species, whereas today the self-regulatory power of the market is left to competition only. Before him, Capra (1997) invoked a new perspective for all sciences based on the study of life sciences. Similarly, the critique of Mumford (1961) to urban planning was also based on the assumption that cities, like organisms, should have limits to growth. If ignored, these can impair the liveability of citizens.

With urban resilience becoming a common term to evoke the strength of key systems and cities, it is legitimate to question if the way this is currently understood draws from the underpinning 'biological' theories or if it is rather used as a metaphor devoid of any innovative approach to urban development. The contribution of this paper is to review relevant literature in order to analyse the way urban resilience is understood today by asking: are these interpretations facilitating new approaches to planning that learn from mechanisms of adaptability of ecosystems? Conversely, what does resilience stand for and imply in terms of urban performance? In order to do so, a brief review of the concept of resilience is first presented, and two definitions of resilience are identified, coinciding with a mechanistic and evolutionary interpretation. These two definitions are used as the template for subsequent literature review on urban resilience from the UK and elsewhere, in which consequences related to the implementation of each approach to resilience are also evaluated. The review demonstrates that this concept is often used as the mere capability of the built environment to resist adverse environmental or man-induced threats, whereas the interpretation of resilience in ecology studies offers a conceptual model that has very different implications. The former can result in attempting to defend and retain spatial configurations and social arrangements while preventing threats. The latter implies spatial and organisational modifications in response to changing conditions. This distinction is crucial, since depending on the approach to resilience adopted, urban strategies can lead to unintended and even undesirable outcomes. Finally, by comparing two different views to urban resilience as well as related consequences, the literature review allows the identification of some principles through which urban adaptation (i.e. resilience) can be attained. These principles resonate with those identified and discussed within the domain of resilient social-ecological systems, in which resilience is attained through a process of co-adaptation enabling the functionality of both systems (see Folke et al., 2002). In this article, the empirical application of such principles in urban design and planning is illustrated.

2 - Resilience theories

The first definition of resilience presented here is derived from physics, where it is traditionally used to connote the capability (and velocity) of a material or system to regain internal equilibrium and return to its original state after a shock (Norris et al., 2007). In structural terms, it can be defined as the quantity of strain that a system can store before permanent damage occurs. Nature offers abundant examples of resilient structures. For example, fragile threads composing spider webs can absorb the impact of insects or wind and return to the initial configuration (Gordon, 1978). The second definition is characterised (if observed over a sufficiently long period of time and a sufficiently large scale) by oscillations of state. Resilience is thus 'the amount of change the system can undergo and still retain the same controls on function and structure' (Holling and Walker, 2003). For example, a forest can undergo cycles in which its combination of tree species varies in response to pests, droughts, and fires. In adapting to such shocks, the ecosystem changes configuration (i.e. state) while retaining the same range of species and ecological landscape (Holling, 1973). Herein, the focus is on a far more complex form of equilibrium attained by constant internal fluctuations leading to a highly flexible capacity of adapting to external interferences (Capra, 1997).

Seen in the perspective of system's stability, the first definition aforementioned refers to a single attractor affecting the equilibrium, with resilience measuring the velocity with which the system returns to its original configuration, thus showing a steady, persistent state (Pimm, 1987). The second one refers to a stability landscape where more attractors (i.e. droughts, pests, etc.) determine variations of the initial system's configuration, with typical functions being maintained (Gallopin, 2006). Figure 1 shows diagrams illustrating both systems' behaviours. Based on this distinction, Gallopin identifies three degrees of stability: the first one (engineering resilience (see also Holling, 1996)) is the property of a system to regain its equilibrium. The second (ecological resilience) is characterised by shifts of state within the same stability landscape (i.e. resilience for ecological systems as defined by Holling). Finally the third implies changes in the stability landscape itself with the structural identity of the system being maintained, until eventually the system moves towards an entirely different state configuration.

PLACE HERE FIGURE 1

Resilience is a concept fit for exploring strategies for adaptation, intended here as the capacity of modifying behaviour in order to adapt to changing environmental conditions (Smit and Wandel, 2006) at large. Climate change effects (i.e. extreme climatic events, etc.) and consequences of globalisation (i.e. increased consumption patterns, fight for resources, etc. (see Young et al., 2006)) can generate uncertainty and environmental and social disruption to which society must adapt. However, in order for resilience to offer a useful framework for societal adaptation or even a metaphor for exploring pathways for building adaptive capacity (see Pickett et al, 2004), this concept must be transposed to the domain of social systems. A substantial body of work investigates the interaction between social and ecological systems (SES) (Walker et al., 2004; see also Folke et al., 2010), analysing factors causing interferences between the two and researching principles for mutual adaptation. Panarchy (Gunderson and Holling, 2002; see also Folke, 2006), for example, is a theoretical model of SES adaptive cycles, the four phases of which (i.e. exploitation, conservation, release and re-organisation) are represented as the Möbius loop. This loop conveys the iterative nature of adaptability, with each cycle ending in a re-organisation of the system adapting to ever-changing conditions (Folke, 2006; Walker et al., 2004; see also Gotts, 2007). The inevitability of the re-configuration of systems, dictated by the interaction between systems and the exploitation of one impinging on the other, shows that resilience requires flexibility of configuration rather than preservation of a given system's state.

Carpenter et al. (2001) provide accounts of human activities that have an impact on ecosystems such as lakes and rangelands. Agricultural and farming practices can trigger eutrophication of the water and modifications in the range of plants of the ecosystems. Strategies to strengthen the resilience of human and ecological systems can vary according to the type of resilience pursued, originating different long-term consequences. For example, following an engineering resilience approach, high concentration of phosphate in the water as a consequence of the use of chemical fertilisers could be tackled with a temporary ban that would restore desirable water conditions. This would allow the economic regime of the region to continue without variation after a lapse of time. Eventually, however, the end of the ban would reiterate eutrophication. Alternatively, organic techniques of cultivation may be adopted or local economy could be redirected towards different business opportunities (e.g. tourism). This would entail substantial changes within the SES and the identification of different attractors composing the stability landscape towards which the SES could swing (i.e. ecological resilience). Finally, an entirely different systems' configuration could occur (e.g. communities abandoning the area). In other words, the engineering resilience approach aims to protect the existing configuration of the social system with its modalities of ecosystem's exploitation, whereas an ecological resilience approach explores modifications of the social system in order to attempt a form of co-adaptation. By extension, an approach to urban planning and governance based on conservation of spatial and organisational conditions regarded as optimal at the onset of the planning process can be compared to engineering resilience. In an engineering resilience perspective, transformation can be seen as a threat and urban policies are usually focused on establishing a steady state in permanent (albeit unattainable) balance. Conversely, an approach in line with ecological resilience acknowledges the impossibility of resisting change and the necessity of reconfiguring in order to pre-empt threats.

Recently, urban studies started to draw from studies about ecological and SES resilience and adaptation, in order to develop new insights on the impact of urbanisation on the environment and on urban adaptation to climate change. Some of the theories outlined in this section have been used to articulate frameworks to help manage, for example, transition processes of communities whose livelihood and socio-economic structure is threatened by a changing climate (see Pelling, 2013). Alberti (1999a; 1999b), in analysing different impacts that specific forms of urban development can have on the environment, draws from Holling's studies in ecological systems. She identifies density, connectivity, grain, and urban form as urban parameters that can determine the degree of environmental damage or strengthen the resilience of cities and surrounding natural environment (Alberti and Marzluff, 2004; Alberti et al., 2003; see also Alberti, 2005). Yet, urban resilience is poorly understood in practice. In which way can theories on resilience inform the planning and design of buildings and infrastructures, not only for their capability to resist climate change but also shocks triggering processes of, for example, dereliction or malfunctioning? The following section reviews literature on urban resilience, using the concepts of engineering and ecological resilience to explore the impact of relevant policy and guidance on the built environment.

3 – Literature review

Literature on urban resilience is vast, comprising categories such as infrastructure (HM Government, 2011; Rogers et al., 2012) and communities (Pelling, 2011). It is beyond the scope of this paper to review them exhaustively, rather to use some of them to discuss the two models of resilience identified in the previous section. To this end, three categories are examined, which focus on some of the most compelling threats for the built environment: resilience to flooding, man-made hazards, and climate change. An initial archival and web search was carried out in order to identify literature specifically focusing or quoting each of these categories. A preliminary review of more than one hundred publications allowed a final selection, which includes academic studies and policy papers. All publications which loosely cited urban resilience without offering specific practical guidance or theoretical contribution were discarded. Some of these publications, for example, use urban resilience almost as an attribute of sustainability, with no clear distinction between the two terms. Only those which offered a coherent vision in connection to urban adaptation were finally reviewed. The initial search particularly targeted reports and guidance from the UK government or other UK influential institutions, since these are likely to have a major diffusion and impact amongst practitioners. Reports from the Department of Environment, Food and Rural Affairs and the Environment Agency, for example, were selected to analyse policies for the resilience to flooding, together with guidance issued by the Royal Institution of British Architects. Academic studies were also reviewed when these were developed by authors with a recognised expertise in the specific field investigated. For example, papers from Coaffee (director of the Resilient City Laboratory at Warwick University) were included. He has written extensively on resilience and urban living especially from the standpoint of security and the built environment. A number of academic studies and reports from other European countries and the US were also included whenever they offered clear examples of policies with strong affinities with the ecological model of resilience, or provided a critique of policies attaining to an engineering model of resilience.

3.1 – Resilience to flooding

This category is extremely relevant for the UK. In 2009, in England only, around 5.2 million residential and commercial properties were identified in areas at risk of flooding (EA, 2011). Policies and guidance for flood prevention and mitigation is provided both at a regional/national level for hydro geological management (i.e. management of coasts, waterways, groundwater, etc.) and specifically for the built environment. The DEFRA report 'Making space for water' (2005) outlines a resilience strategy based also on the development of better risk warning tools, monitoring, management and defence improvements, as well as the commitment to develop further evidence base with which strategies can be optimised periodically (i.e. every three years). This enables revisions of the overall strategy and implementation agenda, which can respond to new elements arising and new knowledge developed. The 'National Flood and Coastal Erosion Risk Management Strategy for England' (EA, 2011) establishes hierarchies of governance, and recommends actions to augment local understanding of risks and risk management, and to quicken transmission of information to communities. This definition of procedures finalised the efficacy of implemented strategies and design responses accordingly, as well as the attempt to establish feedback loops enabling fast reaction from communities, suggests a systemic approach to flood management on a broad scale. There seems to be recognition that environmental conditions are in constant evolution, that environmental and human systems are interacting, and that solutions proposed today must change in time. Conversely, the strategy developed for the built environment seems to follow a different direction. 'Making space for water' (DEFRA, 2005) and former planning policies (DCLG, 2009) introduce at an urban scale the concepts of buildings' resilience and resistance. Four building design principles are given (DCLG, 2009; see also DCLG, 2007a): flood avoidance (i.e. rising buildings or habitable parts of buildings, above flood levels); flood resistance (i.e. preventing water access inside the building through barriers); flood resilience (i.e. building structure and components capable of resisting the impact of water); and flood repairable (i.e. damaged building elements easily repairable).

Resistance and resilience are used here to connote an engineering approach, in which adaptation is attained through enhanced physical defence, finalised at maintaining conventional modalities of life regardless of the mutating environmental conditions. One of the risks of this strategy is highlighted in a report from RIBA (2009), which warns against adhering to those principles without careful consideration of their impact on the quality of the places. For example, car parking as a measure for flood avoidance may engender poor quality of the public realm, unattractive visual solutions, and lack of passive surveillance on the street. Folke et al. (2010) warn against the dangers of increasing 'specified' resilience at the expenses of the 'general' resilience of the whole system. Specified resilience is developed if the focus lies on a particular element of the system rather than on its entirety. For example, structural and typological solution for buildings may protect communities from water although they may impair their quality of life. A useful way for identifying ultimate aims of actions for resilience is suggested by Carpenter et al. (2001). It consists of formulating the question: resilience for what and to what? Is the objective of the action to develop resilience to floods for buildings, or rather to develop resilience to attain a higher quality of social life?

By using long-term simulations to identify measures for mitigation, 'Future Flooding', a report from Foresight (2004), seems to embrace an ecological resilience model. Therein, adaptation strategies are outlined that focus on a long time lapse (2030 to 2100), thus imagining a magnitude of urban transformation that could not be considered with conventional planning methodologies, which usually limit their scope to years rather than decades. Some of the ensuing recommendations include the development of higher modelling capabilities to foresee future flooding risks and, more importantly, the actual acknowledgment of the inevitability of surprises. To come to terms with this, urban elements such as brownfield areas and green corridors can be retained, possibly expanded and used not only as habitat for biodiversity, and mitigation of urban heat island effects, but also as 'safety valves' for the passage of floodwater. In this way, the city form is reorganised so as to buffer shocks by harnessing rather than opposing water.

A step further in this same direction can be found in the water strategy of the Rotterdam City Council (Municipality of Rotterdam, 2007; see also Royal Haskoning, 2011), coordinated at a larger scale with that of the Delta Management (Deltacommissie, 2008). Holland has a long history of water engineering as well as a tradition of living on the water (i.e. houseboats). Recently, entire floating developments have been designed and constructed with a range of diverse dwelling typologies, in which alternative living arrangements are experimented that can cope with rising water levels (Kloos and de Korte, 2007). In planning ahead for more effective coastal and fluvial defences, the Delta report acknowledges the uncertainty of environmental change and the need for a multiple response that can buffer unexpected water levels in many ways, thus reducing risks. Concomitantly, it calls to view water as a resource, with new urban and building typologies using floods as an opportunity for innovation. Water squares, floating gardens and waterways are identified as new urban features. Diversity of responses is also used as an occasion for cultural learning by turning flood mitigation measures into urban spaces sensitive to climatic events. City dwellers can perceive spatial modifications happening in response to climatic changes and learn to live with them.

3.2 - Man-made hazards

Man-made hazards causing disruption can be generated by terrorist action, human induced system and component failure (Hamilton, 2009), and general crime. A prolific stream of disaster studies analyses this complex issue. Arguably, safety and security are today regarded as major planning concerns, and addressed in some of the most influential UK governmental guidelines for sustainable urban development. 'By Design' (DETR, 2000) refers to safety as a fundamental requisite for public spaces. Former planning policies (ODPM, 2005) explicitly indicate crime prevention as critical for the establishment of sustainable communities. For this purpose, 'Safer Places' (ODPM/Home Office, 2004) offers guidance for planning and designing crime-free neighbourhoods. Therein, seven principles are given: Access and Movement, Structure, Surveillance, Ownership, Physical protection, Activity, and Management and Maintenance. Safe places are those where circulation, access and use facilitate active surveillance by the community, and physical configuration and technologies allow passive surveillance. Effective surveillance technology (i.e. CCTV, etc) can be used to deter crime and control access. Buildings must be designed to be safe: the larger the glazed surface, the higher the risk in case of blast. Finally, management and maintenance are crucial to retain over time the quality of the place, which is in turn crucial for the community to develop a sense of place and care for their neighbourhood. The terrorist attack in London in July 2005 magnified public concerns for safety, and exposed the fragility and vulnerability of critical components of the built environments (Bosher, 2009). Consequently, other principles were introduced (see RIBA, 2010; see also Home Office, 2010). For example, a particular attention to the design and management of places likely to attract crowds was recommended, as well as their classification according to the level of risk, which would help implement proportional counter-measures.

In this broad picture, urban resilience is connoted as the capability for places to resist and recover (Bosher and Dainty, 2011) or buffer the effect of disasters (Manyena, 2006). Reliance to achieve it is placed on surveillance, the physical configuration of spaces and buildings, and communities' participation. Coaffee et al. (2008) suggest that any preventive measure for crime and terrorism, since spatially and socially restrictive, needs to be endorsed by the local community. There are, however, contradictions implicit in an approach that counters man-made hazards through restrictions, with the line dividing security and individual rights dangerously blurred. Raco (2003), for example, notes that security, inclusiveness, and diversity are all factors regarded in policy as crucial to developing sustainable communities, although the former (at least in its current interpretation) can conflict with the others (Raco, 2003). Some studies show that particularly in the US, policies aimed at augmenting the resilience of communities and the prevention of terrorist acts can be wielded to implement a state of permanent emergency. In this context the use of resilience is part of a rhetoric that justifies security measures progressively turning into pervasive control (see Walker and Cooper, 2011; see also Swanstrom, 2002). Ulrich Beck (2009) has sharply analysed the positive feedback loops of staged, televised threats feeding collective fears worldwide and implicitly justifying the escalating response of national security policies equating threats to actual catastrophes. The policy focus thus slips away from root causes such as social inequity, exclusion, religious and cultural diversities, which are primary drivers of social unrest. Similarly to the approach to flooding discussed above, herein the purpose of resilience is to protect and maintain a seemingly desirable societal state, anterior to events that projected terrorist threats to the centre stage. Ironically, the excess of protective measures lead inevitably to change the conditions that characterise and make attractive that particular desirable state. In other words, an engineered approach to resilience hinders a wider analysis on security since it privileges a detailed form of resilience as opposed to a general one.

Such an approach can have a tangible impact on the built environment, since it supports the multiplication of urban typologies designed to protect and exclude. The precinct or enclave, for example, has been traditionally used in cities to embody secular, religious, or cultural institutions (i.e. universities, religious buildings, etc.; see Mumford, 1961). Today, the proliferation of this urban type used for residential development (i.e. gated communities), with the communal modalities of living to which dwellers must conform, magnifies social divides and impairs urban connectivity. Gated communities are on the rise in the US, in the UK, and elsewhere (de Duren, 2009; Blandy and Lister, 205; see also Fainstein, 2005), with occupiers both from high and middle income groups (Sanchez et al., 2005). Reasons contributing to the expansion of this phenomenon include: sense of fear, distrust of institution to provide sufficient protection, and in some cases lower property costs (i.e. suburban gated communities) (de Duren, 2009). The commercial version of the precinct is represented by retail centres, which today are at the heart of many urban regeneration strategies in the UK (Raco, 2003). In retail centres, access, entrance, circulation, and internal rules are all designed to exclude those perceived as potential social disruptors, and open spaces with no clear ownership are carefully 'designed-out', regarded as areas that attract those who pose threats (Raco, 2003). Moreover, scale, infrastructure and configuration of these commercial precincts are difficult to adapt to new use and users, thus affecting the flexibility of the urban fabric where they are located. Increasing control on public spaces is another consequence of the attempt to 'sanitise' the built environment (Pierce and Williams, 2011). Privatisation of public spaces is gathering pace, with cash-strapped councils negotiating upgrading works from private investors that in turn retain a degree of control on their use (Vasagar, 2012).

Arguably, the debate on urban resilience and man-made hazards can lead to questioning current models of society, thus requiring responses that go far beyond the urban design and planning domain. It is possible to expose some consequences on the built environment of a view to resilience based on 'resistance and recovery', although it would be difficult to identify alternatives that could be associated with an 'ecological' approach to resilience. Nevertheless, it can be said that a careful long-term evaluation is needed on the impact of the proliferation of urban typologies designed to protect, since these can amplify fears that originated them, and can influence future modalities of urban living and the urban fabric at large. Coaffee and Rogers (2008) advocate a stronger community involvement through participation in the decision-making processes and the research of synergies between security measures and other strategies (Coaffee, 2008). Environmental performance of buildings, for example, may be compatible with some security requirements (e.g. thicker walls can provide thermal mass and defend from attacks). Crossing specific forms of knowledge may open new directions, help widen the scope of analysis, and help develop forms of resilience that can reconcile security with an inclusive society.

3.3 - Resilience to climate change

The high level of carbon emissions associated with buildings has a substantial impact on air pollution and climatic changes. This can directly affect cities also through higher temperatures, flooding, extreme weather events (i.e. rainfall and wind), and soil subsidence (see Zari, 2010; Steemers, 2003; Gething, 2010). Indirect consequences can be equally significant and include: disruption to local economies (see Campanella, 2006) and peaks of immigration from countries particularly hit by climatic changes (Steemers, 2003). Since these new conditions will be experienced long-term, mitigation and adaptation strategies must be pursued simultaneously (DCLG, 2007b; Steemers, 2003; Roaf, 2005). In this context, resilience is used to connote the capability of cities to attain objectives that sustainability policies establish (e.g. zero carbon emissions), in the face of new environmental conditions that the society is only beginning to experience.

One of the most common approaches used to attain such an objective is the technology-driven tightening of construction standards, which is supposed to achieve both mitigation and adaptation. By means of a higher degree of energy performance, structural strength, and resource efficiency (i.e. higher spare capacity or redundancy) buildings are buffered against effects of future climatic conditions. In the UK (and also elsewhere) the regulatory framework for construction and planning, and voluntary efficiency targets exceeding mandatory ones such as BREEAM and Code for Sustainable Homes (BRE, 2011; DCLG, 2010), provide professional guidance. Therein, there is a particular focus on the abatement of carbon emissions. BREEAM clearly states that buildings attaining Excellent and Outstanding are the best demonstration of their contribution 'to meet the UK's legal obligation on climate change as defined in the Climate Change Act 2008' (BRE, 2011). However, in contrast with the objective of policies for energy efficiency, trends of energy use are on the rise, the adoption of alternatives to fossil fuel is slow and the capability to replace conventional fuel unclear (Hook and Tang, 2013). Technology-based solutions may fail if not complemented by the abatement of demand from users, although these have the advantage of allowing minimum disruption of current socio-economic arrangements. Another major drawback of the UK regulatory framework is the lack of mechanisms for monitoring buildings performance after delivery. BREEAM offers the option to audit buildings in their post-occupancy phase, although this form of assessment is not widely used (Fenner and Ryce, 2007). Effective monitoring, however, would require shifting the focus from the delivery of buildings to their whole-life cycle as well as maintenance, renovation and repair, thereby enabling longer life cycles and operational optimisation to changing climatic conditions (de Wilde and Coley, 2012; Zari, 2010). Finally, a further drawback is represented by existing regulations privileging generalized solutions rather than a contextual approach. In terms of climatic changes, for example, weather conditions will change according to the location and its peculiar environmental conditions thus requiring localized strategies for resilience (de Wilde and Coley, 2012; Wamsler et al, 2013).

There seems to be an overlapping of meaning in the approach to climate change reviewed here, for which resilience and sustainability become interchangeable terms. Targets for energy efficiency invoked until not long ago in the name of sustainability are now claimed as instrumental to urban resilience. By contrast, notwithstanding the need to reduce carbon emission in order to attain sustainability targets, urban resilience is about investigating conditions necessary to deliver those objectives over time. These strategies, as discussed above, need to be context-specific, flexible in time and systemic, thus going beyond the mere definition of technical requisites for high environmental performance as those specified in rating codes. Some strategies for resilience based on a holistic analysis of the UK urban context can be found in recent studies. For example, in the UK, there is a tendency to deliver new residential buildings rather than restructure and renovate the existing built asset. The Sustainable Development Commission (2006; see also Power, 2010) points out that at present the refurbishment of unused building stock could meet much of the demand for new dwellings, and save a large quantity of emissions associated with the new built. Policies privileging the sustainable upgrading of existing buildings can shift the emphasis from urban growth to urban reuse, thus supporting a paradigm of qualitative (rather than quantitative) growth. From another perspective, Sieverts argues for a sustainable retrofitting of suburbs rather than their elimination on the grounds of environmental inefficiency (see also Williams et al, 2012). This could be also achieved by taking advantage of the peculiarities of this particular urban form. For example, low densities would allow local food production.
In discussing climate change policies and their efficacy within the context of a fast changing world, Elmqvist (2013) points out that cities cannot be sustainable (i.e. self-supporting) thus resilient individually. Each one can be resilient to some extreme events but not to a general decline caused by environmental, economic, and social reasons. A more effective approach is thereby to pursue resilience at a broader scale by networking with other cities. This could create, for example, a diversity of local economies and symbiotic local resources and services, a network of infrastructures that can cope with individual disruptions, a wider strategy for vegetation as a carbon sink, and would provide a forum for sharing experiences and different forms of knowledge. In turn, this urban network could set the basis for a transition to new forms of urbanisation capable of adapting to disruption and reducing resources' exploitation.

4 – Discussion

The majority of the literature reviewed in the previous section uses the concept of urban resilience in a restricted perspective, in which the configuration of the urban system is protected since regarded as the only one fit to achieve some desired purposes. To this end, particular elements of the system are strengthened under the assumption that this will pre-empt hazards. For example, structures of buildings are reinforced and their typology modified in order to sustain the impact of floods and keep away water from ground floors. This allows the design of urban development to follow conventional spatial and organisational patterns, albeit with some consequences on liveability. It also prevents designers and planners from taking a wider view to problems that are too vast and interconnected to be dealt with through conventional approaches. In this perspective, technology-driven and top-down solutions are too often privileged since perceived as the fastest and more reliable route to problem-solving, and in order to avoid the danger of failure implicit in any experimentation of alternatives. This conservative stance is contradicted by events that demonstrate the great imprecision of current and future predictions with regard to, for example, the magnitude and frequency of floods and the associated level of disruption.

It must be noted that from all literature reviewed the term resilience is randomly used, and strategic lines of action or guidelines for its attainment do not seem to reflect any particular conceptualisation. It is therefore important to link the term with theoretical models of reference that can help structure approaches and make them comparable. It seems evident, however, that for the majority of the literature reviewed, the idea of urban resilience it is not inspired by an evolutionary view of cities but rather by one that is mechanical and reversible. In this latter approach, resilient cities are those that can swing back to their original state. It is a misleading view that does not take into account the long-term risks of opposing change. Strategies that ring-fence the stability of urban systems must be necessarily tightened whenever the threat is perceived as escalating. Bouncing back to normality therefore can imply the progressive intensification of defence mechanisms offering a degree of adaptation to, but not mitigation of, the threat. In turn, this can also imply scaling up the drawbacks of such defence mechanisms up to the point that those become unsustainable or trigger the transition towards an undesirable reconfiguration. By contrast, urban resilience approaches which reflect the definition of ecological resilience allow adjustments within a stability landscape: by acknowledging risks inherent in preventive strategies, they attempt a reorganisation of the system that can buffer unknown intensities of hazards. This is attained analysing the interplay between ecological and social systems as well as its repercussions, to address subsequently root causes of such repercussions. In turn, this allows a co-adaptive evolution of both systems, following a dynamic, reiterative pattern such as that outlined in the Panarchy's adaptive cycle.

The comparison between urban policies inspired by the models of engineering resilience and ecological resilience enables the identification of approaches that facilitate adaptation. These diverge from those conventionally used in planning practice (see Table 1). For example, Foresight's report on Future Flooding, DEFRA's report on water and, to an extent, the Planning Strategy of the City of Rotterdam are all based on a long-term analysis, utilising tools such as scenario-analysis and other types of futures simulation. In this way, the boundaries of stability landscapes can be identified by envisaging the plausible evolutions of urban systems. Likewise, in some of these reports and studies, context-specific solutions are sought together with the implementation of a range of solutions fulfilling similar purposes (i.e. redundancy) in order to ensure functionality in the event that some of them fail. These three particular approaches are briefly analysed below for their capacity to develop adaptability. They present similarities with the four principles for the adaptability of social-ecological systems promoted by Folke et al. (2002; 2002b) in their studies on resilience (i.e. learning to live with change and uncertainty; nurturing diversity; combining different types of knowledge; and creating opportunity for self-organization). Nurturing diversity, for example, can be associated with redundancy. Living with uncertainty, in terms of urban planning, requires the identification of the stability landscape. Finally the combination of different types of knowledge points at the need for the systematic implementation and evaluation of experimental solutions as a practice embedded in planning. In other words, Folke et al focus on the articulation of a management strategy which is flexible and not prescriptive, evolutionary and not deterministic, thus shifting the accent from structure to process. This strategy allows re-adjustments (and re-organisation) when evidence shows particular solutions are ineffective.

PLACE HERE TABLE 1

A first approach to urban resilience consists in adopting a long-term view to urban development. This should not be accomplished through the use of forecasts but rather through the utilisation of a structured approach to uncertainty. Urban design and planning can develop plans based on trends, projections, and forecasts, which do not usually leave space for the unforeseen (Foresight, 2008). However, in order to deliver flexible urban re/development, these must be complemented with other tools which help endow a degree of indeterminacy and open-endedness. This would leave options open, thus attempting to build adaptive capacity. For this purpose, some on-going studies focus on methodologies enabling practitioners and decision-makers to examine simultaneously multiple options to development with risks connected to each one, thus introducing within the decision-making process multiplicity and flexibility. Trajectories and visions of long-term futures (Hillier, 2011), 'virtualities' unseen in the present (Balducci et al, 2011) are all tools used as forms of strategic planning. Jabareen (2013) includes 'uncertainty oriented planning' as a pre-requisite to deliver resilient cities. This is a planning methodology which considers 'statistical uncertainties, scenario uncertainties, or sometimes ignorance', as well as predictions or anticipation of future risks. Recently, other methodologies, based on an exploratory scenario analysis have been developed, which specifically deal with urban re/development (Rogers et al, 2011). What these methodologies have in common is the recognition of the impossibility of designing an adaptive built environment based on predetermined, restrictive, spatial visions. Instead, establishing objectives and ensuring that these are accomplished over time requires the analysis of those drivers that can trigger change as well as the design of response mechanisms that can function over an extended time cycle. An attitude to 'future thinking' begs for a systemic approach that chimes with complex systems theories on which studies about resilience of ecological and SES systems are based (Capra, 1997). Scenarios can be based on quantitative indicators capturing all urban dimensions (see Gallopin, 2006), thus being fit for the analysis of relationships between the built environment and socio-economic dynamics. In other words, scenarios help analyse cities as complex systems that change over time.

Another principle enabling resilience is redundancy, intended here as the co-existence of diverse options fulfilling the same purpose and ensuring functionality in the event of failure of one of them (e.g. diversity of urban spaces to store excess water in Dutch cities; diversity of dwelling typologies on water; etc.). Redundancy can be attained also through the identification of synergies amongst seemingly diverse realms or sectors, which in turn prompts the design of buildings, spaces and infrastructure that can (or can adapt to) be used in multiple ways. In this perspective, redundancy links directly with uncertainty and multiplicity as defined and discussed above, in that it allows the built environment to be used diversely in response to different needs as they (predictably or unpredictably) arise. Policies facilitating the temporary reuse of unused private or public space, for example, can be regarded as attempts to exploit the versatility of the built asset to trigger economic growth or avert urban decline. A case in point is represented by German policies for the interim use of urban spaces (Blumner, 2006), designed to facilitate the temporary occupation of buildings or open areas in the period between earmarking and actual re/development (which can be very long), thus offering communities and groups opportunities to start activities, and experiment new spatial arrangements that can be replicated when successful. It is a way to increase the number of attractors towards which the urban configuration can swing whenever necessary or suitable, thus expanding the stability landscape of the urban system. Experimentation could be therefore identified as a corollary to this principle, if not another principle in itself. Entering the uncharted territories of planning for uncertainty arguably requires a systematic process of trial and error, as well as monitoring. Above all, as Folke et al (2002) point out in outlining principles for building adaptive capacity within SES systems, it requires acceptation of experimentation as an essential component within sustainable development policies. This is not simple, since experimentation entails also failure.

Finally another emerging principle for resilience is a particular attention to local traditions and context. In the literature review this principle has come to the fore in at least two important ways. Firstly, it has emerged as the need to move from generalised solutions and the one-fits-all attitude towards contextualised approaches. Secondly, it has emerged as the capability of capitalising on the particular local cultural history. Both require more sophisticated policies and decision-making tools that are capable of reconciling supranational and national objectives with local situations. They also require attention to existent or emerging local socio-economic patterns that can in turn inform urban development accordingly (for an account of this topic as a key element of the urban evolutionary process, see Childs, 2001). This principle too is rooted within the design debate. Jacobs (1993 [1961]) gave compelling accounts of the capability of some communities to inject livelihood in urban areas through cohesion and local economy, and of the short-sightedness of planners displacing those communities for unnecessary radical renewal.

Clearly these principles are only a first step towards the development of a framework for urban resilience and more in-depth research is needed. It will be important, however, for such research to recognize the critical role that studies about the resilience of ecological and SES systems can play.

5 – Conclusions

Like the post-industrial city and the sustainable city, the resilient city is a metaphor capturing the particular circumstances and needs that characterise a phase of society. Within the current volatile political, economic and environmental situation, adaptation at all levels is critical to the positive performance of cities. Adaptation, however, is better understood in evolutionary terms whereas most of the literature presenting strategies for the attainment of urban resilience does not endorse this view. More importantly, guidelines for urban resilience and reports do not generally refer to any specific conceptualisation of resilience but rather loosely use it as synonym of endurance. In doing so, the term is emptied of those contents that make it fit for this age, thus unable to prompt a new approach to urban planning that focuses on adaptation. An ecologically inspired model of urban resilience would require a deeper understanding of ecosystems' behaviour applied to urban systems, which in turn can suggest suitable and effective approaches to planning. In the absence of this type of understanding it will be difficult to ascertain the long-term efficacy of urban policies, many of which approach resilience with conventional tools and strategies. In this article, the analysis of some alternative urban strategies inspired by the ecological model of resilience helps to identify some of the most effective design and planning tools and principles. A deeper understanding of resilience is instrumental to identifying pathways for a transition to more sustainable forms of cities, since it help focus on the process enabling a vision (i.e. sustainable urban development) to be put into practice over time, no matter what the future holds. In turn, tools for implementing such a vision can support a new mindset for those who plan, implement and manage the transition process. In this perspective a theory of urban resilience becomes a critical component of broader theories of sustainable urban development.

References

Adger, W. N. (2006) Vulnerability, Global Environmental Change 16, pp 268 – 281

Ahern, J. (2011) From fail-safe to safe-to-fail: Sustainability and resilience in the new urban world. Landscape and Urban Planning 100, pp 341–343

Alberti, M. (1999a) Urban Patterns and Environmental Performance: What Do We Know? Journal of Planning Education and Research 19 (2), pp 151-163

Alberti, M. (1999b) Modeling the urban ecosystem: a conceptual framework, Environment and Planning II Planning and Design 26, pp 603 – 630

Alberti, M. (2005) The Effects of Urban Patterns on Ecosystem Function, International Regional Science Review 28, pp 168 - 192

Alberti, M. and Marzluff, J.M., (2004) Ecological resilience in urban ecosystems: linking urban patterns to human and ecological functions. Urban Ecosystems, 7 (3), pp 241–265

Alberti, M., Marzluff, J.M., Shulenberger, E., Bradley, G., Ryan, C. And Zumbrunnen, C. (2003) Integrating Humans into ecology: Opportunities and challenges for studying ecosystems. BioScience 53 (12), pp 1169-1179

Balducci, A., Boelens, L., Hillier, J.,Nyseth, T. and Wilkinson, C. (2011) Strategic spatial planning in uncertainty: theory and exploratory practice, Town Planning Review, 82 (5), pp 481-501

Beck, U. (2009) World at Risk (Polity Press, Cambridge)

Blandy, S and Lister, D. (2005) Gated Communities: (Ne)Gating Community Development?, Housing Studies 20(2), pp 287–301

Blumner, N. (2006) Planning for the Unplanned: Tools and Techniques for Interim Use in Germany and the United States, Deutsches Institut für Urbanistik

Bonaiuti, M. (ed) (2003) Bioeconomia: verso un'altra economia ecologicamente e socialmente sostenibile, (Bollati Boringhieri, Torino)

Bosher, L. (2009) Briefieng: Researching a more resilient built environment, Urban Design and Planning 162 (DP2), pp 59–61

Bosher L and Dainty A (2011) Disaster risk reduction and 'built-in' resilience: towards overarching principles for construction practice, Disasters 35(1), pp 1 - 18

Building Research Establishment. (2011) BREEAM New Construction – Non Domestic Buildings – Technical Manual 2011. BRE, London

Campanella, T. J. (2006) Urban resilience and the recovery of New Orleans, Journal of the American Planning Association 72 (2), pp 141-146

Capra, F. (1997) The web of life: a new synthesis of mind and matter (Harper Collins, London)

Carpenter, S., Walker, B., Anderies, M/ J. and Abel, A. (2001) From Metaphor to Measurement: Resilience of What to What? Ecosystems 4, pp 765 - 781

Childs, M. C. (2001) Civic Ecosystems. Journal of Urban Design 6 (1), pp. 55-72
Coaffee, J. (2008) Risk, resilience, and environmentally sustainable cities, Energy Policy 36, pp. 4633 - 4638

Coaffee, J. and Rogers, P. (2008) Rebordering the City for New Security Challenges: From Counter-terrorism to Community Resilience, Space and Polity 12(1), pp 101–118

Coaffee, J, Moore C, Fletcher D and Bosher L (2008) Resilient design for community safety and terror-resistant cities, Proceedings of the Institution of Civil Engineers - Municipal Engineer 161 (ME2), pp 103–110

de Duren, N. R. L. (2009) Urban Planning and State Reform: From Industrial Suburbs to Gated Communities, Journal of Planning Education and Research 28, pp310-322

de Wilde, P. and Coley, D. (2012) The implications of a changing climate for buildings, Building and Environment 55, pp 1 – 7

Deltacommissie (2008) Working together with water (Hollandia printing)

Department for Communities and Local Government (2006) Planning Policy Statement 25:
Development and Flood Risk (DCLG, London)

Department for Communities and Local Government (2007a) Flood Resilient Construction: Improving the Flood Performance of New Buildings (RIBA Publishing, London)

Department for Communities and Local Government (2007b) Planning and Climate Change: Supplement to Planning Policy Statement 1 (TSO, London)

Department for Communities and Local Government (2009) Planning Policy Statement 25: Development and Flood Risk Practice Guide (DCLG, London)

Department for Communities and Local Governments (2010) Code for Sustainable Homes: technical guide – December 2010 (DCLG, London)

Department for Environment, Food and Rural Affairs (2005) Making space for water (DEFRA Publications, London)

Department of the Environment, Transport and the Regions – CABE (2000) By design - Urban design in the planning system: towards better practice (DETR, London)

Elmqvist, T. (2013) Urban Sustainability and Resilience - Why We Need to Focus on Scales. Available at http://www.thenatureofcities.com/author/thomaselmqvist/, downloaded on 13-06-2013

Environment Agency/DEFRA (2011) Understanding the risks, empowering communities, building resilience - National flood and coastal erosion risk management strategy for England (Environment Agency, Bristol)

Fainstein, S. F. (2005) Cities and Diversity: Should We Want It? Can We Plan For It? Urban Affairs Review 41(1), pp 3-19

Fenner, R. A. and Ryce, T. (2008) A comparative analysis of two building rating systems. Part 1: Evaluation. Engineering Sustainability 161 (1), pp. 55–63

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

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., Walker, B., Bengtsson, J., Berkes, F., Colding, J., Danell, K., Falkenmark, M., Gordon, L. Kasperson, R., Kautsky, N. Ann Kinzig, Levin, S., Mäler, K. G., Moberg, F. Ohlsson, L., Olsson, P., Ostrom, E., Reid, W., Rockström, J., Savenije, H. and Svedin, U. (2002) Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations, Minister of the Environment, Stockholm. Available at www.mvb.gov.se, downloaded on 11-02-2013

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S. and Walker, B. (2002b) Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. AMBIO: A Journal of the Human Environment, 31(5), pp437-440

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T. and Rockström, J. (2010) Resilience Thinking: Integrating Resilience, Adaptability and Transformability, Ecology and Society 15(4): 20. [online] URL: http://
www.ecologyandsociety.org/vol15/iss4/art20/

Foresight (2004) Future Flooding (The Government Office for Science, London)

Foresight (2008) Sustainable Energy Management and the Built Environment Project Final Project Report (The Government Office for Science, London)

Foresight (2011) The Future of Food and Farming: Challenges and choices for global sustainability (The Government Office for Science, London)

Gallopın, G. C. (2006) Linkages between vulnerability, resilience, and adaptive capacity, Global Environmental Change 16, pp 293–303

Gething, B (2010) Design for future climate: opportunities for adaptation in the built environment (Technology Strategy Board)

Georgescu-Roegen, N. (1972) The entropy law and the economic problem. The ecologist 2(7), pp 13-18

Gordon, J. E. (1978) Structures: why things don't fall down (Penguin Books, London)
Gotts, N. M. (2007) Resilience, panarchy, and world-systems analysis. Ecology and Society 12(1): 24. [online] URL: http://www.ecologyandsociety.org/vol12/iss1/art24/

Gunderson, L.H., Holling, C.S. (Eds.), 2002. Panarchy: Understanding Transformations in Human and Natural Systems (Island Press, Washington)

Hamilton, W. A. H. (2009) Resilience and the city: the water sector, Urban Design and Planning 162 (DP3), pp 109–121

Hillier, J. (2005) Straddling the Post-Structuralist Abyss: Between Transcendence and Immanence? Planning Theory 4(3), pp 271–299

Hillier, J. (2011) Strategic navigation across multiple planes -Towards a Deleuzean-inspired methodology for strategic spatial planning. Town Planning Review, 82 (5), pp 503-527

HM Government-DEFRA (2011) Climate Resilient Infrastructure: Preparing for a Changing Climate (The Stationary Office, London)

Holling, C. S. (1973) Resilience and stability of ecological systems. Annual review of of Ecology & Systematics 4, pp 1-23

Holling, C.S., 1996. Engineering resilience versus ecological resilience, pp. 31–43. In: Schulze, P.C. (Ed.), Engineering within Ecological Constraints (National Academy Press, Washington)

Holling, C.S. and Walker B.H. (2003). Resilience defined. In: International Society of Ecological Economics (ed.), Internet Encyclopedia of Ecological Economics. See http://www.ecoeco.org/pdf/resilience.pdf. Accessed 02.12.2011.

Hook, M. and Tung, X. (2013) Depletion of fossil fuels and anthropogenic climate change - A review, Energy Policy 52, pp 797 – 809

Home Office (2010) Crowded places: the planning system and counter-terrorism (Home Office, London)

Jabareen, Y. (2013)Planning the resilient city: Concepts and strategies for coping with climate change and environmental risk. Cities 31, pp 220–229

Jacobs, J. (1993 [1961]) The death and life of great American cities (The Modern Library, New York)

Kloos, M. and de Korte, Y. (2007) Mooring site Amsterdam - Living on water (ARCAM/Architectura & Natura Press)

Lamond, J. E. and Proverb, D. G. (2009) Resilience to flooding: lessons from international comparison, Urban Design and Planning 162 (DP2), pp 63–70

Magis K (2010) Community Resilience: An Indicator of Social Sustainability, Society and Natural Resources 23, pp 401–416

Manyena, S. B. (2006) The concept of resilience revisited, Disasters 30(4), pp 433−450

Mumford, L. (1961) the City in History (Harcourt)

Municipality of Rotterdam (2007) Watreplan Rotterdam: working on water for an attractive city (Municipality of Rotterdam/Delta Water Board)

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F. and Pfefferbaum, R. L. (2008) Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness, American Journal of Community Psychology 41, pp 127–150

Office of the Deputy Prime Minister (2005) Planning Policy Statement 1: Delivering Sustainable Development (ODPM, London)

Office of the Deputy Prime Minister/Home Office (2004) Safer Places: the Planning System and Crime Prevention (ODPM, London)

Pelling, M. (2011) Adaptation to climate change: from resilience to transformation (Routledge, London)

Pickett, S. T. A., Cadenasso, M. L. and Grove, J. M. (2004) Resilient cities: meaning, models, and metaphor for integrating the ecological, socio-economic, and planning realms, Landscape and Urban Planning 69, pp 369–384

Pierce T and Williams A (2011) The Sanitised City: If You've Done Nothing Wrong… - in: Williams A and Donald A (eds), The Lire of the City: from Slums to Suburbs (Pluto Press, London)

Pimm, S. L. (1984) The complexity and stability of ecosystems, Nature 307, pp 321-326

Power , A. (2010) Housing and sustainability: demolition or refurbishment? Urban Design and Planning 163(4), pp 205-216

Raco, M. (2003) Remaking Place and Securitising Space: Urban Regeneration and the Strategies, Tactics and Practices of Policing in the UK, Urban Studies 40(9), pp 1869 – 1887

Roaf, S. (2005) Adapting building and cities for climate change (Architectural Press, Oxford)

Rogers, C. D. F., Lombardi, D. R., Leach, J. M. and Cooper, R. F. D. (2011) The Urban Futures Methodology applied to Urban Regeneration, Engineering Sustainability, 165(1), pp 5-20

Rogers, C. D. F., Bouch, C. J., Williams, S., Barber, A. R. G., Baker, C. J., Bryson, J. R., Chapman, D. N., Chapman, L., Coaffee, J., Jefferson, I. and Quinn, A. D. (2012) Resistance and resilience – paradigms for critical local infrastructure, Proceedings of the Institution of Civil Engineers: Municipal Engineer 165(2), pp 73–84

Royal Haskoning (2011) Building the Water Sensitive City: Water in the city of the future (VHP/Royal Has e koning)

Royal Institute of British Architects (2009) Climate Change Toolkit – 07. Designing for flood (RIBA, London)

Royal Institute of British Architects (2010) Guidance on designing for counter-terrorism (RIBA, London)

Sanchez, T. W., Lang, R. E. and Dhavale, D. M. (2005) Security versus Status?: A First Look at the Census's Gated Community Data, Journal of Planning Education and Research 24, pp 281-291

Smit, B. and Wandel, J. (2006) Adaptation, adaptive capacity and vulnerability, Global Environmental Change 16, pp 282–292

Sieverts, T. (2003) Cities without cities: an interpretation of the zwischenstadt (Routledge)
Steemers, K. (2003) Towards a research agenda for adapting to climate change, Building Research & Information 31(3 - 4), pp 291 – 301

Sustainable Development Commission (2006) 'Stock Take': delivering improvements in existing housing. (SDC, London)

SustainablDevelopment Commission (2011) Looking back, looking forward – Sustainability and UK food policy 2000-2011 (SDC, London)

Swanstrom (2002) Are Fear and Urbanism at War? Urban Affairs Review 38(1), pp 135-140

United Nations (2012) Resilient People, resilient planet – A future worth choosing (United Nations)

United Nations Office for Disaster Risk Reduction (2012) Making Cities Resilient – Report 2012 (UNISDR)

Vasagar, J. (2012) Sold-off cities: the rise in private ownership of public spaces (In: The Guardian 12-06-2012)

Young, O. R., Berkhout, F., Gallopin, G. C., Janssen, M. A., Ostrom, E. and van der Leeuw, S. (2006) The globalization of socio-ecological systems: An agenda for scientific research, Global Environmental Change 16, pp 304–316

Walker, B.H, Holling, C.S. Carpenter, S.R. and Kinzig. A. (2004) Resilience, adaptability and transformability in social–ecological systems, Ecology and Society 9(2):5. [online] URL: http://www.ecologyandsociety.org/vol9/iss2/art5

Walker, J., and Cooper, M. (2011) Genealogies of resilience: From systems ecology to the political economy of crisis adaptation. Security Dialogue 42(2), pp 143-160

Wamsler, C., Brink, E. and Rivera, C. (2013) Planning for climate change in urban areas: from theory to practice, Journal of Cleaner Production 50, pp 68 - 81

Wilkinson (2012) Social-ecological resilience: Insights and issues for planning theory, Planning theory 11(2), pp 148–169

Williams, K., Joynt, J. L. R., Payne, C., Hopkins, D. and Smith, I. (2012) The conditions for, and challenges of, adapting England's suburbs for climate change, Building and Environment 55, pp 131 – 140

Zari, M. P. Biomimetic design for climate change adaptation and mitigation, Architectural Science Review, 53(2), pp 172 - 183