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Risk, resilience, and environmentally sustainable cities ☆

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ABSTRACT

In recent years, ideas of security and resilience have become increasingly embedded in urban planning and design practice, and in national security and energy policy, as attempts have been made to make the built environment and critical energy infrastructure more resistant to disruptive challenges. This has taken place with particular regard to the threat of climate change and to the security challenges faced by many cities as a result of the threat of terrorism. In this context, this paper explores the possible synergies between security and environmental issues, and policies connected to the planning, design, and engineering of the built environment. As the paper illustrates, there may be opportunities for further integration between these areas of concern.

1. Introduction

Growing concern about international terrorism and environmental sustainability is leading to widespread discussion of the security and pricing of energy supply (Dorian et al., 2006; Migone, 2007; Yergin, 2006), and to attempts to predict future supply trends through national and international policy commitments. Such forecasting has tended to focus on a number of core predictions: that perceived instability in the Middle East will mean less reliable energy supplies and necessitate new international alliances; that a movement back towards nuclear power is almost inevitable; and that the enhancement of energy conservation policies and the adoption of new energy-efficient technologies are required.

At a smaller spatial scale, the design and protection of the built environment has also received widespread attention. Here the concern is the impact of natural hazards (Pelling, 2003) or of a large-scale terrorist attack (Coaffee, 2003) on the functioning of large urban areas and their energy supplies (Greenburg et al., 2007; Sahir and Qureshi, 2007). At the same time, the Intergovernmental Panel on Climate Change (IPCC) claims that the possible redesign of residential and commercial buildings might cut 29% of projected greenhouse gas emissions by 2020 (IPCC, 2007).

Given the possible disruptive challenges that might interrupt energy supply, these concerns with energy security are often connected with broader civil contingency policies, disaster management, and emergency planning (see Little, 2004). In particular, the concept of resilience is increasingly used to describe how cities and regions are attempting to embed security and risk management features into their built environment and their systems of governance as part of a broader drive towards more 'safe' and sustainable communities (Coaffee and Bosher, 2008). For example, in the UK the utilities sector is central to the governance of 'UK resilience' and is obligated to prepare plans and develop response strategies to cope with supply disruption (UK Resilience, 2008).

Resilience, more particularly economic resilience, can be defined as "the ability of an entity or system to maintain function (e.g. continue producing) when shocked" (Rose, 2007, p. 384). It describes the ability of nation states and governance agencies to develop disaster mitigation processes and 'hardened' critical national infrastructure to ensure it can continue operating within the global economy at its regular capacity. As Greenburg et al. (2007, p. 732) note: "If the electrical power system is resilient, then a terrorist attack on the system is likely to have only short-term consequences".

Despite the growing importance of resilience, there still appears to be a resistance on behalf of policy makers and built environment professionals to incorporating such risk management into their design, planning, and construction processes, mainly as a result of cost constraints (Dainty and Bosher, 2008). Measures are needed both to resist disruption and to recover rapidly afterwards. Attaining urban and economic resilience will demand a paradigm shift in the way in which security policy is written and how built environment professionals add risk mitigation measures to their everyday practices (Bosher, 2008; Godschalk, 2003).

2. 'Risk society' and the politics of safe and sustainable cities

Uncertainty and risk generated by the threat of natural hazards are key features involved in shaping the built environment.

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In recent decades the emergence of what German sociologist Ulrich Beck called a 'risk society' has seen an increased emphasis placed upon anticipatory risk management measures as defining characteristics for organising contemporary society (Adams, 1995; Beck, 1992, 1999). Such priorities have become embedded in policy discourses and are increasingly important in the construction of urban areas (Branscomb, 2004; Coaffee and Rogers, 2008; Howe and White, 2004; Raco, 2003).

Today, risk has evolved into a concept that goes well beyond the idea of financial loss. Douglas (1994), for example, argued that risk perceptions are related to a whole series of cultural factors reflecting a number of economic and political values. It is often associated with a set of newly defined 'mega-scale' risks, which "cannot be delimited spatially, temporally, or socially: they encompass nation-states, military alliances, and all social classes, and by their very nature, present wholly new kinds of challenge to the institutions designed for their control" (Beck, 1995, p. 1). As Giddens (1999, p. 34) further notes, risk is omnipresent in an interdependent world: "Whichever way you look at it we are caught up in risk management. With the spread of manufactured risk, governments can't pretend such management isn't their business. And they need to collaborate, since very few new-style risks have anything to do with the borders of nations."

During the 1980s and 1990s this focus upon risk, and in particular mega-scale risk, was largely centred upon concerns with nuclear power, particularly in the wake of accidents such as Three Mile Island in 1979 and Chernobyl in 1986, and upon climate change.

If nuclear accidents and climate change represented acts one and two of the 'world risk society' play (Beck, 2008), the events of September 11 became the third act, signalling the 'universalising' of the fear of terrorist attacks:

> Terrorism operating on a global scale has opened a new chapter in world risk society. A clear distinction must be made between the attack itself and the terrorist threat which becomes universal as a result of it. (Beck, 2002, pp. 46–47)

In this geo-spatial and geo-political context, several key questions have emerged. How have policy communities reacted to such risks? What are the perceptions that flow from cultural and political notions of universal uncertainty and risk? What could be the implications for the evolution of sustainable built environments?

3. UK national responses to climate change and energy insecurity

Although initial concerns with the 'risk society' were stimulated by environmentalism, more recent appraisals have focused upon the need to counter the occurrence and impact of international terrorism and the fear of catastrophic attack against urban areas and their critical infrastructures. Sites of energy production and transmission are often regarded as being vulnerable to attack, and as requiring increased fortification (Alexander et al., 2004). Resilience—reliable supplies and stable costs—is regarded as vital for energy security (see for example IEA, 2001) due to the growing reliance of developed nations on imported energy and the increased likelihood of supply disruption (Costantini et al., 2007). The geo-political tensions surrounding the attainment of this goal add an entirely new dimension to the traditional pillars of energy security: energy efficiency, diversification of energy supplies, and dealing with volatility (Sahir and Qureshi, 2007; World Bank Report, 2005). This is leading in many cases to national legislation (e.g. the US Energy Policy Act of 2005) that seeks to reduce reliance on foreign energy supply (Mignone, 2007).

In Europe, the 2007 Energy Policy—*An Energy Policy for Europe*—stressed sustainability, security, and competitiveness (Commission of the European Union, 2007). Likewise in the UK, these concerns have recently been articulated in the national security strategy published for the first time in March 2008. *The National Security Strategy of the United Kingdom: Security in an Interdependent World* (Cabinet Office, 2008) aimed to set out how the UK Government would address and manage a diverse but interconnected set of security challenges in both the short and long term "to safeguard the nation, its citizens, our prosperity and our way of life" (p. 3). Although largely focused upon countering terrorism, security was however viewed in a more holistic sense in this document, including the insecurity that might result from climate change, supply-side energy issues (reliance on imported fuel from politically unstable areas—see for example Geller, 2003), and enhanced global demand for energy, especially in western nations and emerging nations such as India and China (see for example Li, 2008).

In the National Security Strategy, issues of climate change, and how nations can help mitigate its risks and prepare for its consequences, were seen as "potentially the greatest challenge to global stability and security, and therefore to national security" (p. 18). Although many of the impacts of climate change will have a direct effect in the UK, it is argued that the most notable impacts will be on "those countries least able to deal with them, and therefore most likely both to suffer humanitarian disaster but also to tip into instability, state failure, or conflict" (p. 18). The national security strategy set out a series of broad responses to tackle the cause and effect of climate change (p. 50). They include:

- defensive measures such as greater protection against flooding and sea-level surges;
- modifications to plans for development and the management of resources, such as increased water efficiency, and changes to agricultural crops and practices to mitigate water stress and food insecurity;
- changes to energy policy to tackle the causes of climate change, achieve a reduction in global carbon emissions, and meet rising global energy demand in a sustainable way.

In short, the UK Government aims to move towards a low-carbon economy through technological innovation and behavioural transition. Equally, given the interdependent nature of the global risk society, the UK Government's concern is not restricted to national issues. It envisages the UK having "a leading role to play in multilateral efforts to tackle climate change, including helping to set binding, ambitious commitments to reduce greenhouse gas emissions" (p. 50) and launching investigations into how long-term climate change will impact upon poverty and regional global conflict.

The National Security Strategy also regards the global demand for energy as a key driver of insecurity, especially in the context of climate change, and one that is set to intensify and enhance the potential for conflict:

> Barring revolutionary developments in alternative energy, the competition for energy supplies will also increase. On present projections, global energy demand will be more than 50% higher in 2030 than today, at the same time as the supply of oil and gas becomes increasingly concentrated, much of it in regions with potential for political instability. (p. 18)

In the UK, energy insecurity is related to concerns about competition for energy and for energy security. The overarching

aim is to develop a secure and stable supply of energy and hence reduce vulnerability to 'energy shocks', and to do so in a way that helps meet climate change targets. Concerns about resource scarcity will necessitate attempts to lower dependency on oil and gas from insecure regions (see for example House of Commons, 2007), by "promoting policies to improve energy efficiency; increasing supplies from renewable sources; and putting a value on carbon emissions, enabling low-carbon technologies to compete with other forms of energy production" (Cabinet Office, 2008, pp. 51–52).

The arguments for reducing energy consumption in response to climate change, particularly in more compact 'energy-efficient' cities, are well rehearsed. They have been embedded in UK and European policy making through 'sustainable development' agendas (Defra, 2005; DETR, 1999), which as Nadin (2007, p. 51) highlights, identify spatial planning as "a key lever in making the necessary changes in other policy sectors to meet emission and energy targets". In the UK the most recent planning policy advances related to climate change and energy production include the 2004 Planning and Compulsory Purchase Act and the 2007 Planning White Paper (CLG, 2007).

In particular, the shrinkage of the electricity infrastructure is now one of the guiding principles of 'smart growth' movements, which aim to increase energy conservation and reduce environmental degradation (Barnett, 2007). The increased use of smaller-scale renewable energy sources might reduce the vulnerability of today's highly centralised and 'brittle' energy infrastructure system to catastrophic events. This is not a new argument, but rather one that is gaining increased political support—see for example Lovins and Lovins (1981). In the UK, Grubb et al. (2006, p. 4050) note that "low carbon scenarios are associated with greater strategic security of supply…", while the 2007 Energy White Paper (DTI, 2007) highlighted the urgent need to rethink spatial planning as well as the UK's reliance on imported fuel and its energy production methods. The Energy White Paper also launched a consultation about the suggestion that the UK should refocus energy production on nuclear power. This suggestion has raised concerns about cost and possible environmental pollution (Oxford Research Group, 2007) as well as serious security challenges, a long-running concern among the counter-terrorism community (see for example Bunn and Bunn, 2002).

4. Integrating security and environmental sustainability

Concern for environmental sustainability, linked to climate change and the related fear of natural disaster, is as important as possible terrorist risk as an influence on city and building design. This points to the need to think critically about building resilience into critical urban infrastructure to take account of both security and environmental issues. This push to incorporate resiliency principles into systems of planning and design has been undertaken in many cities in the context of widespread urban revitalisation. This presents opportunities to integrate an array of security features into the design and maintenance of the city in response to the occurrence of and fear of crime and terrorism (Atkinson and Helms, 2007) alongside tackling concerns for environmental sustainability (McEvoy et al., 2006; Roaf et al., 2005).

4.1. The 'secure' and 'green' city

The potential complementarities between the security and environmental agendas were the driving force behind a symposium organised by the Public Entity Risk Institute in the USA in January 2008. From that Perelman (2008) highlights that recent terrorist attacks and natural disasters have focused attention upon the inadequate resilience of US infrastructure, which is in need of urgent renewal. He argues that such 'reinvention' is being driven by two 'independent policy movements' which both focus upon disaster risk management (p. 2). They are the sustainability movement, aiming at environmental protection and resource efficiency, which is particularly concerned with green designs for buildings and other infrastructure, and the homeland and national security movement, which responds to the threats of attacks or disaster and is particularly concerned with infrastructure security.

He further argued that there is often friction between these two political agendas. This, he says, is counter-productive and costly, while "possibilities to reconcile their competing demands, to date have gotten little attention either from policy makers or infrastructure professions" (p. 2).

However, the security and environmental sustainability agendas confronting planners, architects, developers and other built environment professionals are not as unconnected as they might first appear. As Paradis and Tran (2007) note: "On the surface, it may appear that secure/safe design has little relationship to sustainable design. Yet, security and safety measures, such as those for anti-terrorism must be considered within a total project context, including impacts on occupants and the environment, regardless of the level of protection deemed appropriate."

In the UK, the Sustainable and Secure Buildings Act (2004) is a major policy advance in countering crime and terrorism in the context of environmental sustainability and resilience. This Act, along with a set of building regulations, was developed to further the conservation of fuel and power, aid the protection or enhancement of the environment, facilitate sustainable development and help in the prevention or detection of crime or terrorism. The Act also meant that for the first time the physical security of buildings was legislated for.

However, the focus so far has been more on the 'greening' of buildings (for example through the increased focus upon BREEAM standards and eco-construction) than on embracing the requirements of security (Dance, 2005). Rydin et al. (2006) have suggested that the 'green' aspects of the Act and related guidance have been treated with a laissez-faire attitude, and that a review of the government literature "could lead to the conclusion that sustainable construction is largely a matter for the construction industry itself to innovate and self-regulate, and for building inspectors to consider in enforcing building regulations". Similar conclusions could also be drawn for the security aspects of the Act. It may be that future alteration of the built environment in response to risk (especially terrorism) is likely to be driven by a number of design and governance mechanisms which will also have implications for environmental sustainability and energy efficiency (Coaffee and Bosher, 2008).

4.2. Design alteration to balance security and sustainability

At the micro scale of building design, greater integration and balancing of sustainability and security are needed as key underlying principles that can help make the built environment more adaptable and resilient to a variety of potential disruptive challenges (Oberle et al., 2005). These goals can sometimes be in conflict but at other times might work in synergy. The critical question remains: How can these priority concerns be planned in a joined-up way? (Coaffee and Bosher, 2008; Paradis and Tran, 2007). These twin objectives could become embedded within building and planning codes or guidance for sustainable construction. US codes for federal facilities and public buildings are

leading the way in exploring ideas of joining-up energy conservation and security for practical reasons, and importantly for cost savings (Harris et al., 2002). However, in the USA, there are very few building designs which combine concerns with energy efficiency and security aside from federal or government buildings.

Conflicts between security and sustainability might include: increasing the glazing on a building for increased sunlight and reduced heating bills, which from a security perspective increases the glass hazard in the event of an explosion (the need here is for laminated glass or the application of anti-shatter film), or the need for target hardening through protective building perimeters which can increase the concreting of open space and increase the urban heat island effect and water run-off. Measures to increase building resilience might well increase the electrical loads of buildings (Coaffee and Bosher, 2008).

By contrast, synergies between security and sustainability might include developing landscaping systems that are 'green' and can help crime prevention through environmental design principles. Examples include ponds and trees acting as physical barriers instead of expanses of concrete and rows of steel bollards. It is also possible that such ponds and landscaping features could be used as security features as well as part of Sustainable Urban Drainage Systems that are designed to reduce the occurrence and impact of flooding in urban areas (White and Howe, 2005). Integrating security with other building systems at the design stage can reduce energy use, as can the use of thick thermal walls or window film. These improve insulation while providing additional blast resistance. Furthermore, developing what engineers refer to as a 'tight building envelope' can reduce the infiltration of cold air and improve a building's thermal performance, and limit exposure to potentially harmful chemical, biological or radiological airborne agents. Table 1 identifies a series of safe design strategies and how they might be integrated with sustainable design opportunities.

There is now an economic opportunity, especially for new build projects, to incorporate energy-efficiency and security features. This would let them contribute to what Harris et al. (2002) term "the larger goals of an economy less vulnerable to energy supply and infrastructure disruptions" and allow them "to generate long-term energy cost savings that will in turn lower the net cost of essential security improvements" (p. 6). As Perelman (2008, p. 5) notes, "green infrastructure investments can offer near-term, tangible returns from efficiencies in energy and resource use that just-in-case investments in hazard risk mitigation often do not".

It is important to identify the barriers to integrating security and energy-efficiency measures in the built environment. A particular concern is that the professional cultures of security and sustainability professionals may militate against joint working practices (Coaffee and Bosher, 2008). The competing scenarios of 'more of the same' alongside isolated agendas of security and sustainability, and the preferred multidimensional agenda of resilience, are represented in Fig. 1.

In future decades it is most likely that the sustainability agenda will provide the most appropriate policy vehicle for the achievement of resilience, with security seen as an essential element of corporate and organisational responsibility alongside economic, environmental and social concerns.

Ultimately, the task of ensuring that resilience is built into design and management systems will involve risk management measures. But a focus on issues of safety through the lens of energy conservation is also needed so that a better integration of security and sustainability becomes possible. The following list

Table 1
Integrating strategies for safety, security and sustainability (adapted from Paradis and Tran, 2007, cited in Coaffee and Bosher, 2008)

Strategies for safety and security	Sustainable design considerations/ opportunities
Access control	
Secure site perimeter and use barriers to prevent passage of vehicles	Integrate with sustainable landscaping scheme. Use natural and/or environmentally friendly barriers (e.g. trees, retention ponds, recycled-content planters, etc.)
Install electronic access systems (e.g. parking, elevators)	Use energy-efficient systems. Consider renewable and/or distributed energy resources
Surveillance	
Place windows and doors to allow for good visibility and avoid spaces that permit concealment	Integrate with daylighting scheme
Design lighting to reinforce natural surveillance and install intrusion devices and video systems and use screen and tracking systems	Integrate with building automation and control systems. Use energy-efficient systems. Consider renewable and/or distributed energy sources, such as solar power night lighting
Blast protection	
Use building configurations to better resist blast shock waves	Integrate with passive solar design and daylighting scheme
Maximise distances between parking and buildings	Integrate with alternative transportation plans
Size and locate windows with detonation points in mind	Integrate with daylighting scheme
Use blast or ballistic resistant glazing and increase strength of exterior cladding and non-structural elements	Use blast or ballistic resistant and energy-efficient window films. Use sustainable materials. Consider thermal benefits of strengthened cladding options
Chemical, biological, radiological protection	
Elevate fresh-air intakes	Integrate with energy-efficient systems
Reduce need for utilities	Consider renewable and/or distributed energy resources
Apply external air filtration and use internal air filtration technologies	Integrate with building automation and control systems
Secure vulnerable areas (e.g. mail rooms, loading docks, storage)	Consider dedicated ventilation and/or exhaust systems

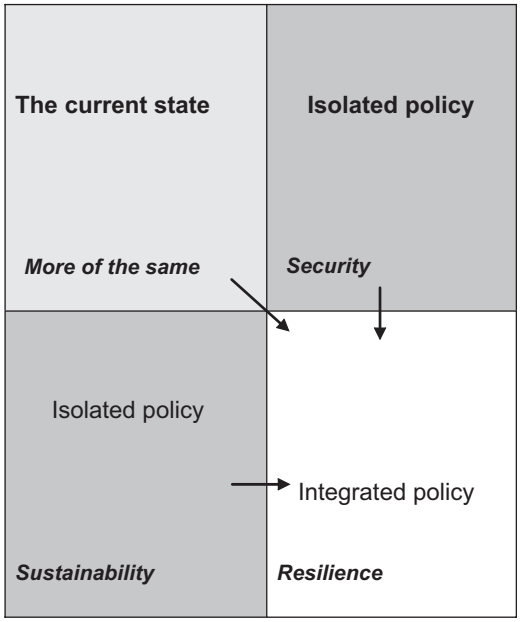

Fig. 1. Alternative scenarios for balancing security and sustainability (adapted from Perelman, 2008, p. 6).

summarises the key advances in this field that might be expected by 2050.

- There are a broad range of interconnected risk and resiliency challenges related to sustainable energy management. Strategic policy advances are likely to continue to emphasise the linkage between securing stable energy supply, climate change and greenhouse gas emissions, reducing energy consumption, developing renewable energy sources, and broader security policy focused upon human-induced hazards and natural disasters.
- It is likely that energy insecurity will be a significant cause of global conflict. This will mean linking energy and security policy nationally and internationally.
- At the urban scale a greater integration and balancing of sustainability and security as key underlying principles is needed in the planning, design, and construction of the built environment. This is a key issue, as predictions see a large potential for green buildings to contribute to climate change mitigation. Likewise, natural disasters are likely to increase in frequency and intensity, and the war on terror is already being viewed as one of long-term conflict.
- These goals of security and sustainability have traditionally been undertaken by separate policy communities. They will be required to alter their ways of working if greater integration is to be achieved. There is an increasing requirement that these be hybridised into a system of 'resilient planning' and are not seen as polar opposites. Here 'resilient planning' encompasses design and construction changes and alterations in systems of governance and management.
- That said, an appreciation is required that the integration of security and sustainability agendas can sometimes be in conflict although at other times they might work in synergy.
- Importance should be placed upon identifying the barriers that restrict the opportunities to integrate security and energy-efficient measures in the built environment. In the future, a more inclusive approach to integrating security and environmental sustainability should be advanced through greater collaboration between a wide range of stakeholders.
- It is with new-build structures that the greatest opportunity exists to embed green and security features into the built environment. Designing-in such measures at the pre-construction phase is vital, as retrofitting will be much more costly and will reduce the effectiveness of the measures.
- Potential exists for future approaches not to focus only upon key target risks (such as government or military buildings or critical infrastructure) but additionally to mainstream integrated solutions across the development of the urban environment. The embedding of security principles is now a key concern. It exists within an overall paradigm of sustainability by which policy makers can consider multiple types of risk in planned or existing developments. They may consider it in the context of broad issues such as community safety, or by the analysis of large-scale hazards and risks.
- At a national level, there is likely to be further integration of security policy with energy, climate change and spatial planning policy. This will give strategic focus to the protection of critical urban infrastructure, including energy resources, in terms of homeland security and also internationally.
- Although advances in technology have not been discussed in this paper, technology is likely to be a key mediating factor, particularly with regard to climate change mitigation.

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