RESEARCH NOTE

IDENTIFYING THE SECURE CITY: RESEARCH TO ESTABLISH A PRELIMINARY FRAMEWORK

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Résumé
Les centres urbains sont vulnérables à plusieurs menaces telles que le terrorisme, le changement du climat et la diffusion de maladies. Or, il y a très peu d'outils disponibles pour évaluer ces problèmes. Nous proposons une approche préliminaire pour évaluer la vulnérabilité des systèmes urbains aux chocs futurs basés sur le modèle de Panarchy (Panarchy Framework) de l'écologie du paysage. Selon Panarchy, la vulnérabilité d'un écosystème est déterminée selon trois caractéristiques génériques : (1) la richesse (ressource) disponible dans le système, (2) le degré de connectivité des différentes composantes du système et (3) le degré de diversité qui existe dans le système. Selon cette approche les systèmes qui sont riches, non diversifiés et hautement intégrés sont extrêmement vulnérables. La richesse d'un système de production et de distribution alimentaire peut-être mesurée en employant l'approche des économistes du développement pour évaluer comment la pauvreté affecte la sécurité de ce système. La diversité peut-être mesurée en employant les différentes approches que les investisseurs utilisent pour mesurer la diversité des portefeuilles d'investissement afin d'évaluer le risque financier. La connectivité d'un système peut-être évalué en employant les différentes approches que les chimistes utilisent pour évaluer la circulation de produits chimiques au sein de l'environnement. Cette approche peut conduire à de meilleurs outils d'aménagement pour la création de politiques visant à réduire la vulnérabilité des centres urbains. Cette approche peut

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également aider les planificateurs urbains ou régionaux à identifier les points vulnérables d'un système par rapport aux chocs et aux perturbations éventuelles.

Mots clés : Vulnérabilité, Villes Durables

Abstract
Urban centres are vulnerable to remote threats (terrorism, climate change, the spread of disease), yet there are few tools available to assess these problems. We propose a preliminary framework to assess the vulnerability of urban systems to future shocks based on landscape ecology's "Panarchy Framework." According to Panarchy, ecosystem vulnerability is determined by three generic characteristics: (1) the wealth available in the system, (2) how connected the system is, and (3) how much diversity exists in the system. In this framework, wealthy, non-diverse, tightly connected systems are highly vulnerable. The wealth of urban systems can be measured using the approach pioneered by development economists to assess how poverty affects food security. Diversity can be measured using the tools investors use to measure the diversity of investment portfolios to assess financial risk. The connectivity of a system can be evaluated with the tools chemists use to assess the pathways chemicals use to flow through the environment. This approach can lead to better tools for creating policy designed to reduce vulnerability, and can help urban or regional planners identify where systems are vulnerable to shocks and disturbances that may occur in the future.

Key words: Vulnerability, Resilience, Sustainable Cities

Identifying the Secure City: looking to build a preliminary framework[1]

Some threats that cities face, such as earthquakes, can be dealt with through the technical expertise of the engineers who build the infrastructure that physically surrounds us (American Society of Civil Engineers, 2003). The events of September 11th and the SARS outbreak, however, emphasize that despite our best technical efforts urban centers remain vulnerable to remote threats that are impossible to predict. This has led both journalists and academics to consider urban security in a new light. For example, some scholars suggest that global transportation, energy, information and economic systems are so interwoven that these systems are fundamentally vulnerable. Problems can quickly spread, cascading to create ever-increasing levels of chaos in urban regions (Homer-Dixon, 2002). Predicting these types of "global" threats and anticipating how urban systems will respond is difficult because the complex interrelated systems that support urban society behave in inherently unpredictable ways (Bar-Yam, 1992; Holland, 1995; Kauffman, 1995; Waldrop, 1992; Williams, 1997). Addressing these sorts of problems is not commonly associated with urban planning, which traditionally deals with issues that tend to stop at the town border. Nevertheless, urban boundaries are porous to the threats that dominate today (climate change, terrorism, the spread of disease from remote locations), so it is helpful to situate the city in a broader socio-economic and biophysical context. This allows us to establish a basic framework for understanding remote and complex threats. Armed with this framework we can begin building tools that may be useful to the urban planning community to assess whether individual cities have the capacity to withstand major disturbances. It must be acknowledged, however, that this level of planning, which goes far beyond urban areas, also goes beyond the responsibility of urban planners and must include regional planners and even higher administrative levels of policy development.

One set of tools to address these sort of risks are top-down modeling driven approaches. These include the global circulation models used to predict climate change. Due to scientific uncertainty, it has not been possible thus far to apply these models effectively at the regional level. (Cline, 1996; Intergovernmental Panel on Climate Change, 2001a, 2001b; Kandlikar & Risbey, 2000; Mendelsohn, Nordhaus, & Shaw, 1994; Reilly, 1999; Reilly, Hohmann, & Kane, 1994). Even general trends can be difficult to predict. For instance, there is considerable disagreement on the potential impacts of world trade: some models predict that economic globalization will lead to inequality and environmental degradation, while others conclude that it is our best tool for reducing poverty and conserving rare species (Bradshaw & Smit, 1999; Ervin, 1997; Greunspecht, 1996; Halweil, 2002; Potter, 2000). The difficulty with this top-down approach is that it requires good data from all parts of the globe, and the quality of data varies tremendously from location to location. Another problem is that the complexity of these systems eludes our best modeling attempts.

A different approach is to assess whether a community has the capacity to adapt to change rather than trying to predict change itself. This has led to definitions of resilient communities and characterizations of communities that possess social capital (Berkes & Folke, 1998; Boggs, 2001; Carpenter, Walker, Anderies, & Abel, 2001; Pretty, 2003; Putnam, 2000). Although academically interesting, this kind of "bottom-up" approach implies that everything ecological, social and political must be considered (Yohe & Tol, 2002). The result is a mass of information that is too complex to provide useful policy making tools (Fraser, Mabee, & Slaymaker, 2003) and it is unclear how we can separate useful and relevant information from that which is merely superfluous or anecdotal.

To find a balance between the overly complex and the simplistic, we propose applying a set of principles derived from the field of landscape ecology to help expose vulnerability in urban systems. Landscape ecology is relevant because most ecosystems experience disturbances such as forest fires, windstorms and pest outbreaks (Attwill, 1994). While the timing and nature of these disturbances are difficult to predict, the impact of a disturbance always depends on three key general characteristics of the ecosystem: the wealth present in the system, the connectivity of individuals within the system as well as the connectivity between systems, and the diversity associated with the system (Gunderson, Holling, & Peterson, 2002; Gunderson & Holling, 2002; Holling, 2001). For example, the impact of a forest fire will be dictated by the amount of fuel available for the fire to consume (wealth), the forest's linkages to other resources (connectivity), and the age and species distribution of the flora and fauna being destroyed (diversity). A fire in a large, mature forest that is densely planted and only made up of a few species will have greater impact than a fire in a remote, small, and poorly stocked forest; thus, the former system is more vulnerable to the threat of fire than the latter.

While these three characteristics were first used to describe ecological systems, there is some evidence to suggest they can be effectively applied to human networks as well. The Irish Potato Famine, for instance, resulted when a large number of communities depended entirely on an agro-ecosystem that was biologically wealthy, closely connected and had low diversity (Fraser, 2003). Forest fires that occur in close proximity to human settlement, such as the wildfires in California or British Columbia, have much greater economic impact than do remote disturbances. This framework has also been used to draw parallels between the development of human networks, such as the Hindu caste system, and the evolution of ecosystems (Berkes & Folke, 2002).

Diversity is probably the easiest of the three characteristics to apply to urban systems. For example, for the cities of the Western world, our primary source of food comes from grain production, which is situated far from the city in a non-diverse agricultural system that specializes in a very small number of genetically similar crops. By their very nature, the agro-ecosystems that cities depend on are vulnerable since biologically diverse agricultural systems are better able to withstand pest outbreaks than simple ones (Altieri, 1999; Benbrook, 1990; Gliessman, 1998; Mannion, 1995). This system vulnerability has led international bodies such as the United Nations Global Environment Fund and the International Development Research Council to call for greater diversity in the food systems (Global Environment Facility, 2000; IDRC, 1992). To apply this to urban planning, it is necessary to understand the various ways that a city obtains its basic requirements such as food. If this is deemed to be too highly specialized urban planners can take steps to diversify these systems (see Figge (2002, 2004) for a methodological discussion on how to identify risk in terms of diversity in the food system). In the case of the food system, promoting urban or peri-urban agriculture could do this. Although not as common in the Western world, where urban agriculture is mostly associated with specific cultural groups who have a strong traditional ties with gardening (Fraser & Kenney, 2000), urban agriculture is an extremely important component of urban livelihoods in the developing world, especially amongst poorer communities (Brook & Davila, 2000; Fraser, 2002a; Maxwell, Levin, & Csete, 1998).

If a system is tightly connected to the region around it, disturbances can quickly spread and an area will be vulnerable to remote threats. The 2003 SARS outbreak in Ontario illustrates this point, as Toronto's medical system was thrown into chaos because of a chance occurrence in rural China when a virus jumped from a cat to a human. One way to assess connectivity is to evaluate the various pathways of material, labour and capital that flow through an urban region. By tracking these pathways, it may be possible to safeguard cities by changing our practices at the source. For example, in Walkerton, Ontario, seven people died and an estimated 2300 became ill when bacteria infected drinking water in the spring of 2000. Although the problem was eventually blamed on failures in the water safety system (Hrudey, Huck, Payment, Gillham, & Hrudey, 2002), the source of the problem was the connection between livestock faeces and municipal wells. Manure had been spread on fields overlying a shallow aquifer near one of the town's wells immediately prior to an intense spring rainfall (O'Connor, 2002). The rain soaked fields provided a transport mechanism that carried the pathogens through the soil and into the groundwater source. Ironically, municipal planners had long been aware of the connection between drinking water quality and surface agricultural activities, but recent changes in water quality monitoring created an opportunity for the threat to translate into a catastrophe.

Wealth, which landscape ecologists consider a characteristic of vulnerability, is the most difficult to apply to an urban setting. When used in an ecological context, wealth refers to a rich supply of biomass that is attractive to opportunistic pests (Holling, 2001). This is similar to some wealthy trans-national corporations that may be less able to innovate and adapt to new circumstances than smaller, less wealthy organizations (Homer-Dixon, 2000; Saul, 1993). However, financial wealth can also reduce vulnerability. For example, rich communities are better able to afford houses that do not collapse during earthquakes. Therefore, to apply wealth as a characteristic of vulnerability, we must first distinguish between biologically wealthy ecosystems, where wealth indicates a vulnerable system, and human systems where wealth can help build adaptability. We must then assess whether an organization is so large and entrenched that it is unable to use its wealth to find novel solutions to changing conditions.

Policy makers and planners can use this framework, and characterize urban systems in terms of wealth, diversity and connectivity, to expose areas where our society is vulnerable to unanticipated threats. For example, our food system is extremely efficient and provides urban residents with abundant low-cost and high quality food. One reason that food production is so efficient, however, is that crops are produced in tightly connected, biologically wealthy and non-diverse farms. The simplicity and connectivity of this system allows farmers to plant, tend and harvest vast areas of one crop, maximizing biological productivity (Friedland, 1994; Friedland, Barton, & Thomas, 1981). Crops can then be gathered, processed, turned into food and shipped at low economic cost due to the high connectivity and low diversity in the system. The tremendous wealth in this system is also partly due to the fact that regions specialize in producing only those commodities that they have a comparative advantage in (Gillis, Perkins, Roemer, & Snodgrass, 1992; McCalla & Josling, 1985). This example has all the traits of a vulnerable system with a limited capacity to respond to shocks.

This leads to a number of policy implications; to reduce vulnerability, planners can ensure that urban regions have access to local food producing regions, which would diversify food sources in the case of a failure. Maintaining local agricultural capacity, however, is controversial as small scale farms on the periphery of major cities are often uneconomical because they cannot compete with major food producing regions (Fraser, 2002b, Submitted). Planners are, therefore, faced with a trade-off: at what point is it ok to sacrifice resilience in favour of a larger-scale, more efficient system to provide us services? Economic realities have driven society to create systems that do not have unnecessary duplication in many different regions, and achieve economies of scale by situating key activities in those regions where activities can be done at the least cost. Conversely, planners must also design systems with adequate backups, or redundancies, so that if a key node in the system is damaged, lives and livelihoods are not too affected. The need to achieve a balance between efficiency and security in a world dominated by complex global systems creates a tension for planners that cannot be addressed with tools presently available.

This conundrum is exemplified by North America's power system, which is so centralized and tightly coupled that failure of a generator in Ohio in the summer of 2003 led to system collapse and blackouts across a huge area of Canada and the United States. Decentralizing the system, thereby reducing connectivity, may be the best way of reducing vulnerability, however, may lead to even greater problems.[2]

The benefit of using this framework from landscape ecology is that it can reduce the number of variables under consideration, which makes the remaining information more useful in developing a planning tool. It is only a framework, however, not a predictive model, and as such makes no attempt to anticipate when, where or in what form a problem might materialize. The authors feel that this approach provides a certain degree of guidance in understanding systems that may be at risk even though they appear robust on the surface. It is also a way of relating remote, distant or removed threats specifically to the urban systems that planners are responsible for. If used, therefore, this approach should be considered a way of flagging troublesome areas for careful study and analysis. However, any policy decision to address these problems will require the input of a number of administrative levels since the origin of these sorts of problems is not the responsibility of urban planners who must deal with more local issues such as infrastructure, land use, waste management and the transportation system.

This is not an attempt to predict how events on the far side of the world will affect the cities where we live. We can take it as a given that far away occurrences will impact us in strange and unpredictable ways. Rather, this is an attempt to understand the characteristics of vulnerability, so that we can pro-actively recognize communities that may be adversely affected. By identifying these characteristics, we also identify characteristics of resilience. This, therefore, should lead us to better policy: a good policy is one that moves us away from vulnerability and towards resilience.

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Notes

[1] The framework laid out here is preliminary and represents the first steps on a much longer research programme begun at the University of British Columbia, and now currently being followed through at the University of Leeds in the UK.

[2] For example the power system in rural Belize, Central America is so decentralized that everyone who can afford a diesel generator owns one (this observation was based on personal experience during fieldwork in 1997). Although this system is so diverse and unconnected that a system-wide collapse is almost impossible to imagine, this is a highly inefficient, polluting and noisy way of generating power.

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