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# Urban Resilience



## Research Prospectus

**A Resilience Alliance Initiative for Transitioning  
Urban Systems towards Sustainable Futures**

February 2007

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CSIRO, Australia — Arizona State University, USA — Stockholm University, Sweden

**A Research Prospectus for**

# **Urban Resilience**

**A Resilience Alliance Initiative for Transitioning  
Urban Systems towards Sustainable Futures**

**February 2007**

## **Cover photograph:**

C. Mayhew & R. Simmon (2000) (NASA/GSFC), NOAA/ NGDC, DMSP Digital Archive

Satellite image of global city lights prepared from a long time series of images of the Earth at night. The Eastern United States, Europe, and Japan are brightly lit by their cities while the interiors of Africa, Asia, Australia and South America remain dark and largely rural.

## **Resilience Alliance:**

The Resilience Alliance is a multidisciplinary international research consortium which aims to provide novel solutions to managing resilience and coping with change, uncertainty, and surprise in complex social-ecological systems (see [www.resalliance.org](http://www.resalliance.org)). Established in 1999, its membership includes universities, government, and non-government agencies.

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# FOREWORD

*Over the last ten years substantial progress has been made in establishing the role of resilience in sustainable development. Much of this understanding comes from case study analyses of well-known and often well-researched regional social-ecological systems in Australia, North America, Europe and Southern Africa. What this work reveals is links between attributes of resilience and the capacity of these systems to absorb disturbance while still being able to continue functioning.*

*While the RA remains committed to these regional case studies it has become increasingly aware of the need to also address urbanisation, now one of the most dominant forces in global change. Clearly there are many benefits of urbanisation – engines of economic growth, innovation, and culture. At the same time, however, they are also increasingly the location of growing social inequality, poverty, pollution, disease and political instability. The same questions arise for urban conurbation as for regional social-ecological systems: how much and which kinds of disturbances can cities absorb without shifting to alternative less desirable system regimes?*

*The problems associated with sustainable human wellbeing in urban regions call for a new research approach. One that sees cities as living systems, constantly self-organising in many and varied ways in response to both internal interactions and the influence of external factors.*

*This Research Prospectus outlines a new and exciting research effort within the Resilience Alliance aimed at generating new insights and approaches for addressing the many challenges facing urban areas around the world. Organised into four domains of inquiry – (1) metabolic flows, (2) social dynamics, (3) governance networks, and (4) built environment – this research effort will be delivered via partnerships that are grounded in a select set of urban case studies.*

*The Prospectus serves to prioritise research over the next 3-5 years and provides a framework for science organisation and delivery that will connect different research groups and expertise both within the Resilience Alliance and beyond. It will be used to guide the preparation of integrated and coordinated new research proposals, attract doctoral and post-doctoral support, and will act as an umbrella initiative for engaging with related global research activity, such as the recently established Stockholm Resilience Centre's focus on urban social-ecological systems.*

*The RA looks forward to the involvement of funding and case study partners in this project.*

*Brian Walker*

*Science Program Director and  
Chair, Board of Members  
The Resilience Alliance*



# Urban Resilience Research Prospectus

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# 1.0 INTRODUCTION

Urbanisation is a complex dynamic process playing out over multiple scales of space and time (Alberti et al 2003). It is both a social phenomenon and physical transformation of landscapes that is now clearly at the forefront of defining humanity's relationship with the biosphere (IHDP 2005). Urban landscapes represent probably the most complex mosaic of land cover and multiple land uses of any landscape and as such provide important large-scale probing experiments of the effects of global change on ecosystems (e.g. global warming and increased nitrogen deposition). Urbanisation and urban landscapes have recently been identified by the Millennium Ecosystem Assessment as research areas where significant knowledge gaps exist (McGranahan et al. 2005).

This Research Prospectus provides our response to this opportunity for integrated urban science, outlining a new and exciting research effort within the Resilience Alliance that will generate the scientific basis needed by urban managers to formulate positive strategies for their urban futures. Organised around four core themes of research – metabolic flows, social dynamics, governance networks, and built environment – our approach will be informed by selected urban case studies.

**The aim of the Research Prospectus is to prioritise urban resilience research over the next 3-5 years on the major challenges facing urban systems.** It provides a framework for science organisation and delivery that will help us to connect with different urban research groups and expertise, as well as provide a platform for engaging with related global initiatives. It represents the product of several opportunistic meetings of like-minded urban researchers over the past three years – Stockholm, Sweden (2003), Canberra, Australia (2004), and Gothenburg, Sweden (2005) – and a vehicle for moving these emerging urban resilience concepts and research ideas forward.

## 1.1 *The Problem and the Opportunity*

Virtually all of the world's future population growth is predicted to take place in cities and their urban landscapes – the UN estimates a global increase from the current 2.9 billion urban residents to a staggering 5.0 billion by 2030. Most of this growth will occur in the developing countries of Africa and Asia, mainly in small and medium sized cities rather than mega-cities. As engines of economic growth, cities offer opportunities for sustainability, but at the same time they also present many challenges, such as poverty, pollution and disease.

Several major initiatives attempt to meet these challenges, such as the IHDP Urbanisation Science Project, Diversitas Science Plan on Urbanisation, the IUSSP Urbanisations and Health Working Group, the U.S. National Academies' Panel on Urban Population Dynamics, the U.S. National Academies' Roundtable on Science and Technology for Sustainability's Task Force on Rapid Urbanisation, UNESCO's initiative on Urban Biospheres, The Millennium Ecosystem Assessment, the World Bank's Cities Alliance and Cities in Transition, and several other related integrative initiatives (Redman and Jones 2005). There is, however, still a need for examining urban systems in terms of their resilience.

Recent natural disasters (e.g. Hurricane Katrina and the Asian Tsunami) and social disturbances (e.g. London Bombings and September 11) have highlighted the need for urban systems to cope with unexpected shocks. While there is an emerging research focus on sustainable cities (urban landscapes), there remains a poor scientific understanding of the processes and factors that make some cities vulnerable to shocks and others resilient. This may be due in part to the fragmented

nature of urban science and policy, a problem being addressed as one of several foci in the newly formed Stockholm Resilience Centre (see [http://www.ctm.su.se/index.php?group\\_ID=1033](http://www.ctm.su.se/index.php?group_ID=1033)). Through collaboration with the Resilience Alliance, this Centre will draw on the perspective of cities as complex adaptive social-ecological systems, developing ways of assessing urban vulnerability and identifying principles and opportunities for building resilience in urban systems.

Building resilience is particularly important in areas such as coastlines, cities, agricultural land and industrial zones which are often the most impacted by humans. It is these same areas that people value highly, both economically and aesthetically, and upon which society often depends.

## ***1.2 The Benefits of a Resilience Approach***

Based on the definition of Holling (2001), Alberti et al (2003) have defined urban resilience as the degree to which cities are able to tolerate alteration before reorganising around a new set of structures and processes. They assert that urban resilience can be measured by how well a city can simultaneously balance ecosystem and human functions. When most people think of urban resilience, it is generally in the context of response to impacts (e.g. hazard or disaster recovery), however what we learn from our understanding of resilience in regional social-ecological systems is a society that is flexible and able to adjust in the face of uncertainty and surprise is also able to capitalise on positive opportunities the future may bring (Berkes and Folke 1998; Barnett 2001).

The abruptness of change in cities depends on spatial and temporal perspectives. As illustrated by Batty et al (2004), urban traffic jams occur over minutes, stock market crashes over days and weeks, market cycles in housing prices over months and sometimes years, while the process of urban gentrification can take decades. The point is, what might appear abrupt change through one system perspective may be gradual and insignificant from another. Reducing resilience increases vulnerability, exposing urban systems to greater risk of the vagaries of uncertainty and surprise (ICSU 2002). Often as resilience declines, it takes progressively smaller shocks to cause system crises or chaos. This process is cumulative and tends to shift a system towards criticality.

We live in yesterday's cities in an idealised dichotomy of rural and urban landscapes. Many of the urban patterns that we see today – such as buildings, roads and land ownership – are legacies of past urban policy and decision-making. The way we think about regional differences is conditioned by an early 20th Century vision of distinctiveness of rural and urban locales. Tomorrow's cities and their closely interdependent regions will be shaped by the decisions we make today that transform the legacies from the past. While there is much that is uncertain about this urban future, history shows that some urbanisation pathways are more desirable than others.

Generally speaking cities are getting larger and denser, but they are balancing processes of out-migration, suburbanisation, and the creation of 'extended urban landscapes' that combine cities, towns, and interspersed rural landscapes into a functioning whole. Other cities are decreasing or only maintaining their population, but even they are engaged in efforts at transforming their structure and function in order to maintain their vitality. Whether they are growing or not, cities and their associated regions are competing to be regional, national, and international hubs. Hence, they are all part of networks. All of this is occurring at multiple geographic scales each with associated boundaries that direct activities and flows. In addition, urbanisation is driven by processes that take place at varying temporal scales from slow (e.g., fertility decline, rising water demand) to fast (e.g., changes in regulations, monetary system). Speed definitely counts in a variety of ways from the lags in the development of some aspects of the city to overall lag of



particular cities or entire regions when compared with the cities in other regions. To some it appears that for a system to be sustainable it must be rapidly urbanising, to others it must grow slowly, while others argue it must not grow at all, but transform via new structures and processes.

These attributes – of self-organisation, of adaptation and demise, and of dynamics playing out on multiple spatial and temporal scales – lead us to conclude that studies of sustainable urbanisation could benefit from the employment of a resilience approach which we now outline in more detail.

## 2.0 APPROACH AND GUIDING QUESTIONS

Cities are the quintessential example of a complex adaptive system (Batty et al. 2004). Cities are ‘living’ systems – dynamic, connected, and open – constantly evolving in many and varied ways to both internal interactions and the influence of external factors (Bai 2003). For instance, in the developing world, cities are often changing faster than we can understand the diverse factors conditioning these changes, and to complicate matters further, many of the driving forces are also operating in contradictory directions and at differing scales and therefore do not lend themselves to simple solutions (Redman and Jones 2005). As noted by Batty et al (2004), we have barely scratched the surface when it comes to understanding the complexity of cities as evidenced by the many signals that indicate surprise, novelty, innovation, and emergence in the way cities develop.

At the heart of this Prospectus are four priorities for research – metabolic flows, social dynamics, governance networks, and built environment – which we aim to investigate through the lens of complexity and resilience thinking. In keeping with the approach that has proved most useful in Resilience Alliance studies thus far, the program of work will be iterative in nature. **The first phase, to be undertaken over the next 3-5 years, will develop and explore a set of robust propositions or working hypotheses about the dynamics and resilience of urban landscapes.**

Informed through a series of comparative urban social-ecological case studies, the work will be led and undertaken by an established network of urban resilience researchers from three institutions – CSIRO, Australia; Arizona State University, USA; Stockholm University, Sweden.

Several overarching questions will inform this inquiry:

1. What are the key drivers of change and threats to cities at global, regional and local scales?
2. Can we develop typologies of cities and their developmental trajectories based on social, economic, and ecological resilience to help decision-makers avoid common traps/pitfalls?
3. How does the emergence of a new type of social-ecological system – the extended urban region or ‘megapolitan’, comprised of one or more core cities, nearby interdependent towns, and interspersed rural landscapes – influence system resilience at multiple scales?
4. How could further urbanisation and urban transformation be re-directed so that cities can be harnessed as generators of innovation and solutions to issues of global sustainability and thereby contribute to delivery of the UN’s Millennium Development Goals for 2015?

### 3.0 THEMES FOR RESEARCH AND INNOVATION

Viewing cities as complex adaptive systems, a recent workshop of the Resilience Alliance held in 2005 in Gothenburg Sweden identified four main themes that were of particular significance for the resilience of urban systems and landscapes. These interconnected themes are presented in Figure 1. Our interest is in both the general resilience of an urban system as a whole, as well as the specific resilience of components of the urban system within each of these respective themes.

What this focus provides is a multi-level understanding of the resilience of urban systems which recognises the role of **metabolic flows** in sustaining urban functions, human well-being and quality of life; **governance networks** and the ability of society to learn, adapt and reorganise to meet urban challenges; and the **social dynamics** of people as citizens, members of communities, users of services, consumers of products, etc, and their relationship with the **built environment** which defines the physical patterns of urban form and their spatial relations and interconnections.

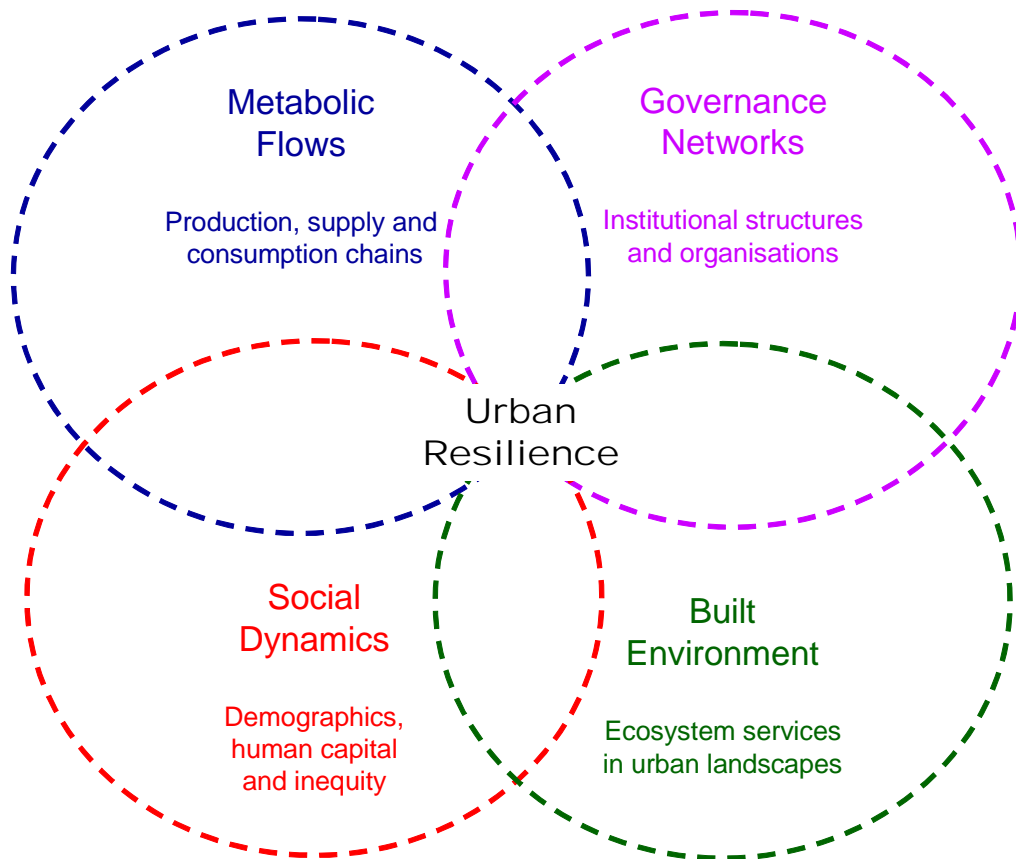


Figure 1: Four interconnected research themes for prioritising urban resilience research

## 3.1 METABOLIC FLOWS

### Production, supply and consumption chains

Consumption – in its broadest sense – is a fundamental driver of urban change (Jayne 2006). All urban inhabitants depend on the productive capacity of ecosystems located well beyond their city boundaries to produce the various flows of energy, material goods, and non-material services that sustain human well-being and urban quality of life (Folke et al 1997). These flows enter an urban system either *actively* through human effort (transport) or *passively* via natural processes such as solar radiation, precipitation and various other hydrological and meteorological means (Decker et al 2000). A number of ‘budgetary’ approaches have been developed to account for the flows that sustain the resource and waste processing requirements of cities, including biogeochemical (Odum and Odum 1980), urban metabolism (Wolman 1965, Boyden et al 1981) and ecological footprint (Rees 1996, Folke et al 1997, Luck et al 2001). Most are based on input-output models of accounting and on energy and material fluxes for which there are ready sources of information.

Our concern here is not so much with tracking change in the ‘stocks’ of resources and services required by cities, but rather to understand the critical interconnections and interdependencies along this chain of production, supply and consumption. For instance, production systems that rely on one fuel type as their energy source can be highly vulnerable if the particular fuel is in short supply or suffers some form of catastrophic disruption (see Box 3-1). Diversifying fuel sources means allowing coexistence of different suppliers, which strengthens competition and moves the system to a highly efficient and optimised state. It is important to note that there is often an inherent contradiction between efficiency and resilience that requires analysis of trade-offs. Efficiency can help build resilience, but excessive levels also act to undermine resilience.

A feature of production, supply and consumption chains is they neither start nor are complete within the city. Cities are highly dependent, open systems. The *resilience of cities* is contingent on the *resilience of other places*.

Strengthening linkages between both upstream and downstream components of the chain, e.g. linking producer with end-user through extended producer responsibility and consumer

feedback is hypothesised to enhance the resilience of the system. Nonetheless, the capacity of ecosystems to sustain urban development is being increasingly tested (Folke et al 1997). Urban air and water pollution are examples of undesirable externalities that generate from production, supply and consumption processes. An important goal of the emerging field of industrial ecology is to increase the flow from production and consumption processes to recycling (see Box 3-2) and

#### Box 3-1 Longford Explosion: Pushing efficiency can lower resilience



In 1998, several explosions at Esso Australia's gas plant at Longford in Victoria killed two people and halted natural gas supplies to Melbourne and regional Victoria for almost two weeks.

The Victorian Dairy Industry was one production system to suffer. Machinery in the milk pasteurisation process relies on gas, so when gas supply was halted, companies could not accept the farmers' milk and, as a result, 25 million litres ran to waste. Several major factories and processing plants were forced to close.

The drive for efficiency at Longford was seen as a major contributing factor. The number of supervisors at the gas plant had been reduced from four to one, all the engineers had been relocated back to head office in Melbourne, resulting in the single manning of the control panel.

Efficiency looks for standardisation and predictable solutions, whereas resilience emphasises redundancy and sensitising people to deal with uncertainty/surprise.

Source: Hopkins (2000).

from recyclers back to the producers. In order to minimise the use of energy (for transportation) and maximise use of local labour, all of these interlinked activities of production, supply, consumption and recycling need to be located close to each other. The goal is to achieve an industrial ecology in which industry produces no waste at all – i.e. byproducts from various processes are used as inputs into other industrial processes and/or recycled. The growing

**Box 3-2 Closing material cycles in urban systems is rare**



In ecological parlance, urban systems are considered 'heterotrophic' – that is, consumption far outweighs production. However, unlike most natural systems there are few processes for the reuse and recycling of the large flows of waste that are generated in cities. Urban waste management is thus a serious problem in the typically space-limited metropolis. Recycling processes appear to shift from informal systems of scavenging to formal municipal programs as cities develop. In many mega-cities, so-called 'rag-pickers' recycle substantial amounts of waste. An estimated army of 6,000 scavengers (see photo inset) work the mountains of garbage in the massive landfill at Bantar Gebang, Jakarta, Indonesia, searching for things they can either recycle or sell.

Source: Marshall (2005)

literature on recycling networks, industrial metabolism and industrial ecology stresses the need to identify a certain key actor or key organisation in a region, one around which a sustainable recycling network of industrial actors could emerge. Interestingly, this idea parallels our understanding of the role of key individuals/organisations in social and community resilience.

The message that emerges is that virtually every city and its urban landscape depend for its survival

on an integrated global network of production, supply and consumption. This reliance on distant zones renders cities vulnerable to ecological change and geopolitical instability as well as the tyrannies of distance. Without massive increases in material and energy efficiency, the present consumption patterns cannot be sustained. But that alone is not enough – efficiency on its own can lead to declines in functional diversity. Pathways of inflow and processing need to be able to cope with a variety of shocks. Regional self-reliance and material recycling can foster resilience.

## Research questions

**Diversity** – How does diversity and distance influence resilience of a city's production, supply and consumptions chains? Why is a production system with multiple sources of raw materials more resilient than one with a single source? Does choice in the consumer market 'system' increase resilience of the chain or act to undermine it? How important is regional self-sufficiency to the resilience of a city and its urban landscapes and what is the impact on economic efficiency?

**Disturbance** – How resilient are urban production, supply, consumption chains to various shocks and surprise such as a decline in the productive/assimilative capacity of ecosystems, through to geopolitical instability of distant zones, and the vagaries of consumer preferences and choices?

**Metabolism** – How does the nature and rate of urban metabolism impact on resilience? Does a higher rate of recycling within the consumption system result in greater resilience through less dependency on outside resources for raw materials? And how do we compare one system with high consumption and high recycle to another system with lower consumption and lower recycle?

**Connectivity** – Are systems with high connectivity between components in the chain (e.g. production-supply and supply-consumption) and strong feedback (e.g. consumption-production) more resilient? Does reducing the impact of a product over its lifecycle via product stewardship, extended producer responsibility and corporate/social responsibility, enhance system resilience?

## 3.2 – SOCIAL DYNAMICS

### Demographics, human capital, and inequity

Towards the end of this decade the world is expected to cross an unprecedented threshold, for the first time in history more people will live in urban areas than outside them (UN 2004). This transition is profound and most likely irreversible (Crane and Kinzig 2005). Future population growth is expected to be almost solely urban, principally in the developing countries of Africa, Asia and Latin America, increasing the current urban population of 3 billion to 5 billion by 2030 with more than two billion people living in urban slums with limited access to basic services, limited participation in decision making processes and facing extreme vulnerability to natural disasters. While mega-cities are implicated in this growth, it is the medium-sized cities (1 to 5 million) that will host the fastest rates of growth over the next 25 years, and in fact most of the world's urban population will live in small cities of less than 1 million (Redman and Jones 2005).

Urban populations grow in three primary ways – natural increase, rural-to-urban migration, and incorporation of surrounding rural areas. There is considerable regional differentiation as to the relative importance of each of these. Rates of growth are related to levels of social and economic development. In some countries, particularly in the developing world, populations are growing faster than the cities' economies can manage, thereby deepening persistent problems of poverty, unemployment and underemployment, inadequate infrastructure and housing, deficient social and human services, as well as degradation of ecosystem services. Yet in other more developed cities in Japan and Western Europe (e.g. Italy and Germany) changing value sets, beliefs and attitudes are resulting in 'shrinking' populations (see Box 3-3).

Another common urban phenomenon is emergence of the extended urban region or the 'megapolitan' region as coined by US researcher Robert Lang.

Defined as cities swallowing towns and their surrounding rural and non-urban landscapes they represent massive social-ecological systems linked by common geography, culture and ecology. Thinking in terms of megapolitan regions might lead to different conclusions about key planning issues such as sprawl and transport than does the traditional core-periphery metropolitan model?

People within cities take on a wide variety of roles, as citizens, members of various communities, users of services, consumers of products, and the list goes on. Urban individuals and their interactions with urban landscapes as groups or communities are influenced by a set of cultural patterns referred to as the social order (Force and Machlis 1997). The social order commonly includes three main mechanisms for ordering behaviour: personal identities (such as age or gender), norms (rules for behaving) and hierarchies (for example, wealth or power). Links between social order, the functioning of social systems, and stocks of social capital are beginning

#### Box 3-3 Social dynamics and negative population growth in Italy



Over the next 45 years, the UN projects Italy's population will fall by 12% from 58 million in 2005 to 51 million in 2050 and this is despite assumed immigration. The problem is the negative balance between births and deaths, a trend that has been linked to social and economic factors, as well as the availability of family planning.

This situation is particularly prevalent in the affluent areas of northern and central Italy, where lifestyle aspirations and cost of living require dual incomes to sustain.

With ever increasing costs of raising a child, fertility is no longer seen as a way to gain social status. Parenthood is put off until later in life when couples feel financially secure or completely ignored.

Changing sets of values and beliefs can thus have an impact on reproduction and parenting affecting population dynamics and in turn the national economy via workforce and social security flow-on impacts.

Source: United Nations (2005) and Guy Barnett (pers comm).

to emerge with implications for social dynamics and resilience. For instance, communities with dense social networks are thought to have greater capacity for both responding and adapting to environmental change (Olsson et al 2004). In recent years, several social commentators have reported on the erosion of civic engagement and mutual trust in urban areas (Frumkin 2002). For instance, Putnam (2000) argues in his book *Bowling Alone* that more time spent commuting to and from work in urban areas means less time with family and friends, and less time for engaging in community, resulting in increasing reductions of social capital.

What we also see in urban areas is considerable social stratification and inequity. Many housing developments these days are built to specific price ranges, creating income homogeneity within neighbourhoods, and fostering income inequality across metropolitan areas.

These patterns are reinforced or broken down by the dynamics of social composition, with residential neighbourhoods becoming gentrified or ghettoized, based on preferential differences among their populations (see Box 3-4). Often for very mild preferential bias, dramatic segregation can take place. This is a good example of how cities restructure themselves with the result that cities often look more segregated around race and class than the attitudes of their residents suggest (Batty et al 2004). Collectively, these trends imply that certain features of urbanisation tend toward greater social stratification and declining social capital, resulting in systems vulnerable to shocks and surprise.

## Research questions

**Demography** – How do demographic processes contribute to patterns of urban diversity and to a city’s resilience? How do differences in rates of immigration, social change and turnover in the urban population contribute to the resilience of urban sub-regions and the system as a whole?

**Distribution** – How does the degree of modularity versus connectivity and the associated degree of social inequity influence resilience of the system as a whole? Are the poorest always the most vulnerable to shocks and surprise? Are responses by urban populations scale-dependent and are they different depending on where people live and what resources are available to them? For instance, are populations living at the edge of urban environmental boundaries (coasts, rivers, cliffs, mountain slopes, forests, industrial areas) more or less resilient to shocks and surprise than those living near the urban core? How do these ecotones in the urban landscape influence social networks and the flows of information/knowledge required to build social capital and resilience?

**Diversity** – Where is the adaptive capacity and social capital likely to come from when an urban population is exposed to rapid shocks from within and outside the urban system? Do populations with a mix of cultures, age groups and education levels, for example, have a higher level of social capital in terms of organisational knowledge and life experience to withstand rapid-onset shocks?

### Box 3-4 Violent Protests Shake Paris’s Suburbs



In late 2005, violence in Paris, primarily the burning of cars, was sparked by the death of two North African youths who were electrocuted when jumping a fence surrounding a transformer as they were allegedly running from the police. The violence and social unrest that ensued took the world by surprise and highlighted the failure of the French government to integrate immigrants into the country’s broader society, a problem that is continuing to grow in urgency as unemployment rates climb.

Most of the country’s immigrants are housed in government-subsidised apartments on the outskirts of industrial cities. They benefit from generous welfare programs, but the governments failure to provide jobs has created a sense of disenfranchisement.

Source: Smith (2005)

### 3.3 GOVERNANCE NETWORKS

#### Institutional structures and organisations

Human institutions and social organisations are highly dynamic. As the world's cities continue to grow in size and complexity, we increasingly lay witness to the unintended consequences of poor urban design and management, the rise and fall of urban institutions, and shifting seats of power and influence (Pickett et al 1997). In fact, the very notion of urban governance is currently being redefined by the emerging dominance of the market and globalisation forces, the decentralisation of service delivery and revenue raising to lower tiers of government, and privatisation of many traditional functions of government (NRC 2003, IHDP 2005). Barriers to trade and investment are being reduced or removed by many nations, encouraging greater flows of goods, capital, and information across boundaries, and signalling a shift in power from national governments to transnational corporations or to regional centres of power. While many local authorities are acquiring more autonomy on land use and the environment, others are now having this autonomy revoked by higher levels of governments due to concerns over the conversion of agricultural land to urban. Urban decision-making, institutions, and land use practices are increasingly shaped by civil society represented by NGOs, universities, research centres, industry and informed citizens.

The challenges posed by the rapid pace of urbanisation and related impacts on the environment require networks and institutions that are able to capture and share knowledge in a transparent fashion, adapt to social-ecological changes, and build the capacity for long term observation, monitoring and perspective. The role of local, regional and international networks in defining common grounds on institutions and governance systems required for sustainable management of urban landscapes need to be better understood and utilised by various levels of governments. Governance and institutional structures need to increasingly take account of collaborative participatory approaches e.g. through development of arenas for adaptive co-management and community-managed areas, including the development of transdisciplinary academic initiatives.

Cities with 'good governance' have mechanisms for redistributing services and benefits to large proportions of their population, such as water, energy, sewer, health, education, law and order. Without equitable mechanisms for effective redistribution, the urban poor and disadvantaged often tend to miss out (Pirez 2002, see Box 3-5).

Scale mismatch is often the source of maladapted land use decisions in urban landscapes. Competing or overlapping jurisdiction between local, regional and national levels often leads to a lack of power or financial resources where and when they are most needed. When this occurs informal institutions are often left to provide the infrastructure needs of the poor and disadvantaged.

#### Box 3-5 Buenos Aires: Privatisation of the Metropolitan City



*Puerto Madero and downtown Buenos Aires, Argentina. Source: Wikipedia.*

During the 1990's, Buenos Aires was affected by changes in political structure and economic orientation that are linked to forces of globalisation, privatisation as well as the 'reduced' role of government.

The city has a plurality of governments, including federal, two autonomous units at the provincial level, and twenty-four municipalities with very little autonomy.

The absence of any democratic decision making at the metropolitan level, means key decisions are left to market forces and powerful economic actors, including developers and private companies which now control privatized 'public' services.

The only true 'planning' occurs within large private developments, including the gated communities in which half a million people now live. The city is thus shaped by a number of private enclaves, where the market logic provides a guide to the private production and operation of the city. This has led to growing spatial fragmentation and levels of social inequality. The city fails to represent the majority of its citizens and thus public interest is lost as the built environment is shaped by private interests.

Source: Pirez (2002).

The USA's National Academy of Science's Panel on Urban Population Dynamics has identified five key dimensions of urban governance – (1) *capacity* to provide adequate service, (2) ability to raise and manage sufficient *financial* revenue, (3) skill to deal with issues of urban *diversity*, fragmentation and inequality; (4) capacity to respond to rising urban *security* threats, and (5) the

**Box 3-6 Cross-Scale Effects: Oil Palm, El Nino and Singapore**



Oil Palm Plantation, Sumatra.  
© WWF-Canon / Alain Compost

Singapore has emerged as a model of sustainable urbanisation and good environmental management. Its air quality, however, cannot be controlled locally.

In 1997-98, Indonesian oil palm plantation owners took advantage of a severe El Nino drought to expand their plantation areas, burning at least 9.8 million hectares. The smoke and haze from these fires choked neighbouring countries, affecting about 70 million people. Schools, airports and businesses were shut down as a result. The economic damage to the region was estimated at around \$9.3 billion.

These fires have recurred in Indonesia over recent years, resulting in a region-wide haze and major air pollution. In August 2005, millions of Malaysians living in Kuala Lumpur suffered haze pollution so thick that a national emergency was declared.

The regional organization, ASEAN, has negotiated a treaty to deal with the issue. But Indonesia, the epicentre of the fires and where oil palm is most rapidly expanding, has not heeded its obligations.

The irony is that some of the technologies and investments in the new oil palm, industry were from Singaporean companies, and much of the oil itself destined for fast-food and other cooking purposes in the urban areas of Singapore and elsewhere.

Source: Abramovitz (2001) and Louis Lebel (pers comm).

increasing complexity of *authority* and managing across jurisdictions (NRC 2003). Placing these dimensions within a resilience framework, our interest is how institutions and organisations are able to shift from rigid to more fluid and responsive patterns of governance.

Lessons from complex systems science suggest urban decision makers should become less concerned with prediction and control, and more concerned with organic, adaptable and flexible urban management (Lister 1998) to be implemented in the spirit of experimentation and learning-by-doing (ICSU 2002, Felson and Pickett 2005). Unfortunately, few urban governments are equipped with the technical and

managerial expertise they need to take on this new mode of governance. Urban decision-makers often have limited ability to influence the management of the foreign ecosystems on which their cities depend (see Box 3-7). Conversely some cities, especially those in developing countries, are pushing their environmental problems on others. Industrial relocation, a widely accepted strategy by Asian cities to address inner city environmental problems, is such an example (see Bai 2002).

## Research questions

**Evolution** – In old cities and their urban landscapes what patterns of sequential and/or phasic dynamics in governance emerge and what can we learn from these patterns to enhance resilience?

**Components** – What components of urban governance most influence the resilience of urban systems? How do social networks connect urban institutions and organisations across levels and scales? What role does leadership, trust, social capital, rigidity, class stratification, and the life-cycle of physical capital renewal (construction vs heritage retention) play in urban governance?

**Cross-scale effects** – What kinds of cross-scale effects influence urban governance, positively and negatively? What are the implications of high or low levels of cross-scale interactions for effective urban governance? How does the political context of scale shift as previously agricultural or forested landscapes are consumed/transformed into cities and new landscapes?

**Lock-in and change** – Many social trends act to reinforce existing inequalities and some types of social capital are exclusionary in nature. So what role do social-ecological shocks and surprise (e.g. natural disasters, health epidemics, financial crises, etc) play in casting opportunities for governance? How are institutional responses to shocks and surprise influenced by the inertia of prior investment and the political/financial influence of underwriting of recovery from outsiders?



### 3.4 BUILT ENVIRONMENT

#### Ecosystem services in urban landscapes

Urbanisation creates new types of landscapes, which are often diverse mosaics of different land-uses and habitats. Urban green spaces in all their manifestations (e.g. parks, gardens, green roofs, urban farms) are by their very nature highly patchy and also highly dynamic, influenced by both biophysical and ecological drivers on the one hand and social and economic drivers on the other. Urban landscapes are often subject to a rapid rate of change, chronic disturbances, a high ratio of exotic species, and complex interactions between patterns and processes. This together with fragmentation affects the capacity of urban ecosystems to continue to generate the ecosystem services that sustain urban quality of life (Bolund and Hunhammar 1999, Elmqvist et al 2004).

Urban landscapes everywhere are changing faster than we can understand the diverse forces that are conditioning these changes – they are dynamic. Urban planning on the other hand is relatively static. It is the code by which development decisions are made and therefore by definition an exercise in deciding a city’s future form and in so doing giving certainty to ‘actors’ in that future. Urban planning occurs within a political ideology that informs the decision making process of the time. Thus to a large extent, we live in ‘yesterday’s cities’ in the sense that many of the urban patterns we see today – roads, buildings, land ownership, etc – reflect decision making periods of the past. As the prevailing ideology changes so does the planning of our cities. Understanding the role of time and the way it conditions future urban options is a crucial part of urban resilience.

The spatial organisation of a city and its infrastructure is also important (Alberti et al 2003). For instance, the physical location of roads, railways, airports, etc, has a significant influence on the flow of commerce and people in and out of cities (Garmestani et al 2005). The spatial pattern of the built environment is created through both chance and necessity (Batten 2001). Geographical endowments, transport possibilities, and economic prospects, all act to produce a locational landscape for attracting industry and employment to a city. The amount of development required to support a given number of people will vary according to decisions on the density of housing, infrastructure requirements, and the influence of any biophysical or other constraints.

Urban planning can be thought of as an expression of hypotheses about the effects of urban development on society (Corry and Nassauer 2005). As outlined in Box 3-7 there is a history of interactions between urban planning and public health officials regarding human health outcomes, but it would seem that in the face of the growing epidemics of obesity, diabetes, cardiovascular and other

so-called lifestyle diseases, that it is time to take a another look at the role of urban planning and its influence on the quality of human-environment interactions and impact on human well-being.

#### Box 3-7 The Link Between Urban Sprawl and Human Health



In the 1800s, health epidemics such as infectious disease and respiratory illness prompted an urban planning response which began the ‘garden city’ movement.


A similar response is now required from urban planners to address the modern lifestyle epidemics of obesity, heart disease, and mental health. Urban sprawl is a type of built form characterised by poor infrastructure and connectivity and thus high dependence on the car.

If land uses are separated or if the distances between them are great, and if roads are more available than sidewalks and paths, then people shift from walking and bicycling to driving. Accordingly the US is a nation of drivers, in which only 1% of trips are on bicycle and 9% on foot, compared to the Netherlands 30% on bicycles and 18% on foot. Approximately 25% of all trips in the US are shorter than one mile; of these 75% are by car. While not the entire story, urban sprawl contributes to physical inactivity and therefore to obesity and other associated health problems.

Source: Frumkin (2002)

By analysing urban form, we suggest opportunities will arise for investigating new ways of changing the built environment in line with the changing needs and requirements of urban populations. This is not a quest to discover the utopian urban form, but rather a challenge to view urban areas as complex and dynamic ‘spaces’. Because the dynamics of cities are non-linear, their problems cannot be solved by linear planning methodologies. New innovative means of planning that deal with urban complexity are needed. The implications of such a focus are profound. Change is essential, adaptation is crucial, and the past is the past (see Box 3-8).

There is growing interest in expanding concepts of patch dynamics from ecology for use in urban areas to address spatial heterogeneity (Grimm et al 2000, Band et al 2005). Urban primacy and modality in city size distributions are evidence of discontinuities (Bessey 2002).

<p><b>Box 3-8</b></p>	<p><b>The Transition of Wollongong – A Regime Shift?</b></p>
	<p>The city of Wollongong in eastern Australia, is a city in transition. Founded on the exploitation of natural resources, a decision by steel-maker BHP to donate land for the establishment of a local university has had an unexpected impact on development of the city. Opened in 1958 to provide training in metallurgy, the university provided a major employment buffer in the 1980's, when manufacturing jobs dropped from 20,000 to 8,000. During this time the university was diversifying and expanding, assisting in the creation of around 20,000 new jobs in the service and support sectors. This transformed the focus of the city from almost exclusively manufacturing to a base of knowledge and tourism for which the city is now known.</p>
<p>Wollongong, the view from the top of an escarpment.</p>	
<p>Source: Michael Doherty and Guy Barnett (pers comm).</p>	

Increased scientific understanding through evaluation of urban ecosystem dynamics has the potential to contribute to urban land use plans that are proactive rather than reactive (i.e. providing environmental stewardship before restoration is necessary). Such proactive approaches to urban planning include testing and evaluating urban design scenarios for their role in creating landscape patterns and ecological processes that build resilience in urban ecosystems (e.g. Felson and Pickett 2005). However, successful design and management of urban ecosystems will ultimately rest on a scientific, social and political capacity to not only understand but respond positively to the many diverse forces conditioning urban environmental change in time and space.

## Research questions

**Pattern and diversity** – What is the role of ‘greenspace’ or ‘semi-natural ecosystems’ (kinds, amounts, patterns) in promoting sustainability, reducing vulnerabilities, and building resilience?

**Path dependency** – With the many examples of path dependant dangers in urban systems, could irreversible changes have been identified in advance, and are there particular attributes of the systems that identify or suggest such non-return points? Can resilience theory on regime shifts and thresholds help identify key attributes of the system to monitor and inform decision making?

**Rates of change** – How can urban planning ‘blueprints’ be made compatible with the speed of urban system change and can self-organisation be specifically addressed and included? When faced with difficulties or failures in the urban environment, what structural or social responses emerge and how do we learn from these so as to guide rather than control urban development?

**Sizes and patterns** – Can the world’s mega-cities keep growing? How does the emergence of extended urban regions (megapolitan regions) influence urban resilience? Is there an optimal density and/or optimal layout for cities and how might this vary according to social-ecological context? And how does the regional pattern of other city sizes influence urban growth trends?

### 3.5 INTEGRATION AND SYNTHESIS

The overarching urban resilience questions raised in Section 2.0 will be informed by the four more detailed domains of inquiry – metabolic flows, social dynamics, governance networks, and built environment – just described. Integration and synthesis of this understanding is a key focus of this research program, involving a range of activities (see Section 5.0) for developing integrated models of cities as coupled social-ecological systems and for revealing the emergent and interdependent system properties that are influential in the building of resilient urban futures.

## 4.0 PROPOSED STRUCTURE AND DELIVERY

The project will be implemented according to the lines of management and accountability that are summarised in Figure 2 below. A **Steering Group**, Chaired by Brian Walker and comprising several internationally recognised urban researchers will ensure overall scientific integrity. Guy Barnett and Xuemei Bai will fulfil the role of **Research Leaders**. They will share responsibility for leadership of the emerging portfolio of urban resilience research, coordinating input and the collaboration of project scientists, students and partners on a day-to-day basis. The **Core Research Team** consists of an international multidisciplinary group of over a dozen scientists with existing relationships established through the Resilience Alliance. As the program of research develops it will draw an increasingly larger network of ‘experts’ and urban case studies.

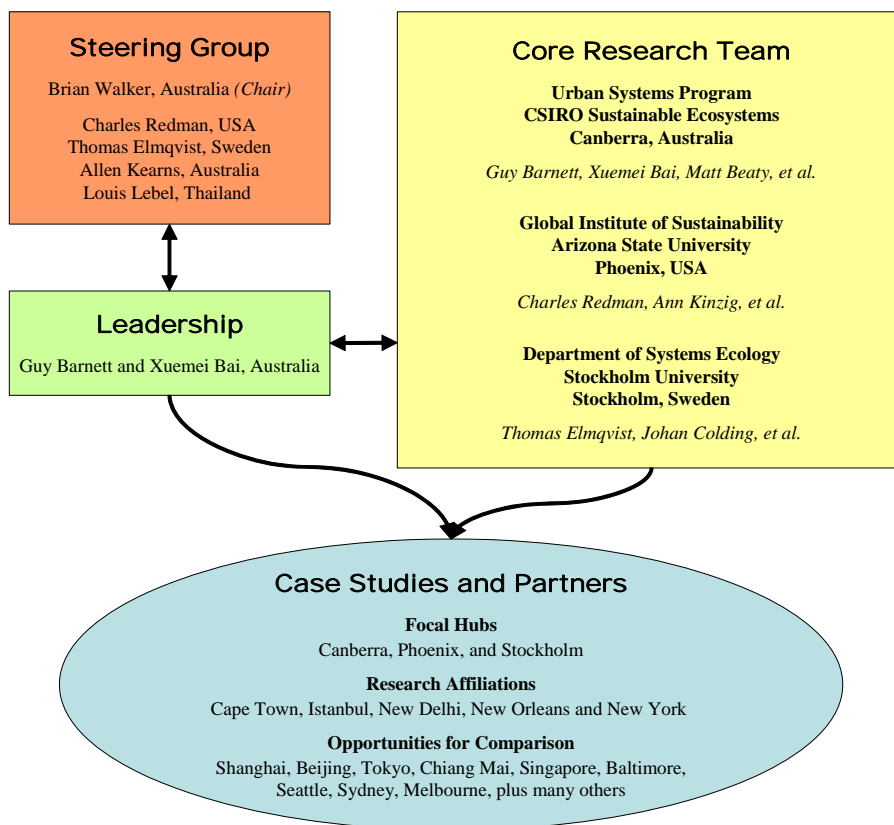


Figure 2: Proposed Lines of Management and Accountability for the Project

## 5.0 RESEARCH OUTPUTS AND OUTCOMES

The aim of this Research Prospectus is to prioritise research within the emerging area of urban resilience over the next 3-5 years. It provides a framework for science structure and delivery that will connect different research groups and expertise within the Resilience Alliance and beyond. It will also be used as a guide for the preparation of integrated and coordinated new research proposals, to attract doctoral and post-doctoral researchers, as well as a platform for engaging with related international research initiatives such as the Stockholm Resilience Centre.

### 5.1 Key Activities in the Short Term (First 12 Months)

- **Urban resilience paper** – To be undertaken in the first half of 2007, the goal of this activity is to establish a small collaborative writing team to develop a paper on urban resilience for publication in a high impact international journal. The paper would be leveraged off the material developed for this Prospectus and other Resilience Alliance documents, presenting new and novel insights from ‘resilience thinking’ on pathways for a sustainable urban future.
- **Strategic planning workshop** – To be held in mid-to-late 2007, this 3-4 day workshop will bring together 10-15 of the key players in this initiative (the *Steering Group*, *Leadership* and select members of the *Core Research Team*). The goal of the workshop is to develop a strategy for converting this Research Prospectus into an active Research Program. This will involve the mapping of existing urban resilience research into the Prospectus; identifying key knowledge gaps and bias; identifying the skills, capacity, and new projects that are needed to round-out the initiative; as well as coordinating doctoral and post-doctoral research activities.
- **Initiation of collaborative research** – Priority projects commenced with research partners.

The anticipated outcomes of this first 12 months of activity are:

- Fostering greater awareness of ‘resilience thinking’ for urban development and planning,
- Building research partnerships for meeting urban challenges and promoting resilient cities,
- Developing the RA to become a leading international research group on urban resilience.

### 5.2 Proposed Activities for the Longer Term (Next 3-5 years)

- **Framework for comparative analysis of urban case studies** – The ability to compare and contrast urban case studies is essential for generating robust understanding of urban systems. This activity will define common methods, protocols and frameworks for urban comparisons.
- **Researcher/Practitioner Workbook for Assessing Urban Resilience** – The Resilience Alliance is currently developing a set of workbooks for assessing resilience. This activity would produce a domain-specific version for researchers and practitioners in urban systems.
- **Workshops, publication of papers, and other interactions/collaborations** – The success of the Resilience Alliance has been due to a vibrant program of collaboration in the form of joint analyses of case studies and publications stemming from small working groups and occasional larger meetings. Such activities will also be a core part of this long term initiative.

- **Organise International Symposium on Urban Resilience (year 5)** – Communicating more widely, understanding of the requirements, constraints and opportunities for urban resilience.

## 6.0 BENEFITS OF PARTNERING

Adequate investment in urban research and innovation is critical to addressing both existing and emerging issues facing urban managers around the world. This Research Prospectus provides a framework for coordinating an international research effort to explore vulnerability, adaptability, and transformability in urban areas around four key themes of inquiry – metabolic flows, social dynamics, governance networks, and built environment – that together define urban system resilience. This area of research has received little or fragmented attention to date, but is vital for urban managers responsible for directing their cities’ transition towards sustainable urban futures.

The benefits of partnering in this new research program include the following:

- ***Accessing a range of expertise.*** The *Core Research Team* will comprise an international multidisciplinary team of a dozen scientists from the world’s leading research institutions. Coupled with access to the Resilience Alliance and connections with other major global urban research initiatives, partnering organisations will benefit from the range of expertise and knowledge that a cutting-edge international Urban Resilience Initiative has to offer.
- ***Capitalise on new innovations.*** With a coordinated international approach, innovations realised in a particular case study or by a particular organisation will be communicated and made available to all partners, enhancing development and utilisation of research knowledge.
- ***Reducing risk.*** By partnering with other organisations that are also contributing funding or case studies to the project, the risk and uncertainty of research is reduced by sharing it with others. It is also often inevitable that there will at times be duplication of effort as a result of different groups researching the same topic, but partnering clearly helps to reduce this risk.
- ***Synergies.*** By joining with others interested in researching a similar aspects of urban resilience, the combined investments of the participating groups allows each to be engaged in a project that is viable in terms of scales and expertise. While many urban issues are resource or sector specific, most of the management, system design, policy and institutional issues are often generic. Thus by partnering, an organisation can benefit from these synergies and ‘economies of scale’ accessing a far broader range of urban research than it could on its own.

## 7.0 CONCLUDING REMARKS

There is no panacea or silver bullet for urban sustainability, but an approach based on complex adaptive systems and resilience will allow urban planners and decision-makers to learn and adapt to the inevitable failures of urban management actions. This initiative offers a unique research opportunity. The scientists contributing to the initiative are leaders in their fields. They will spearhead an international urban research effort comprised of a comparable set of selected urban case studies that will provide a framework for urban resilience research and policy development.

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