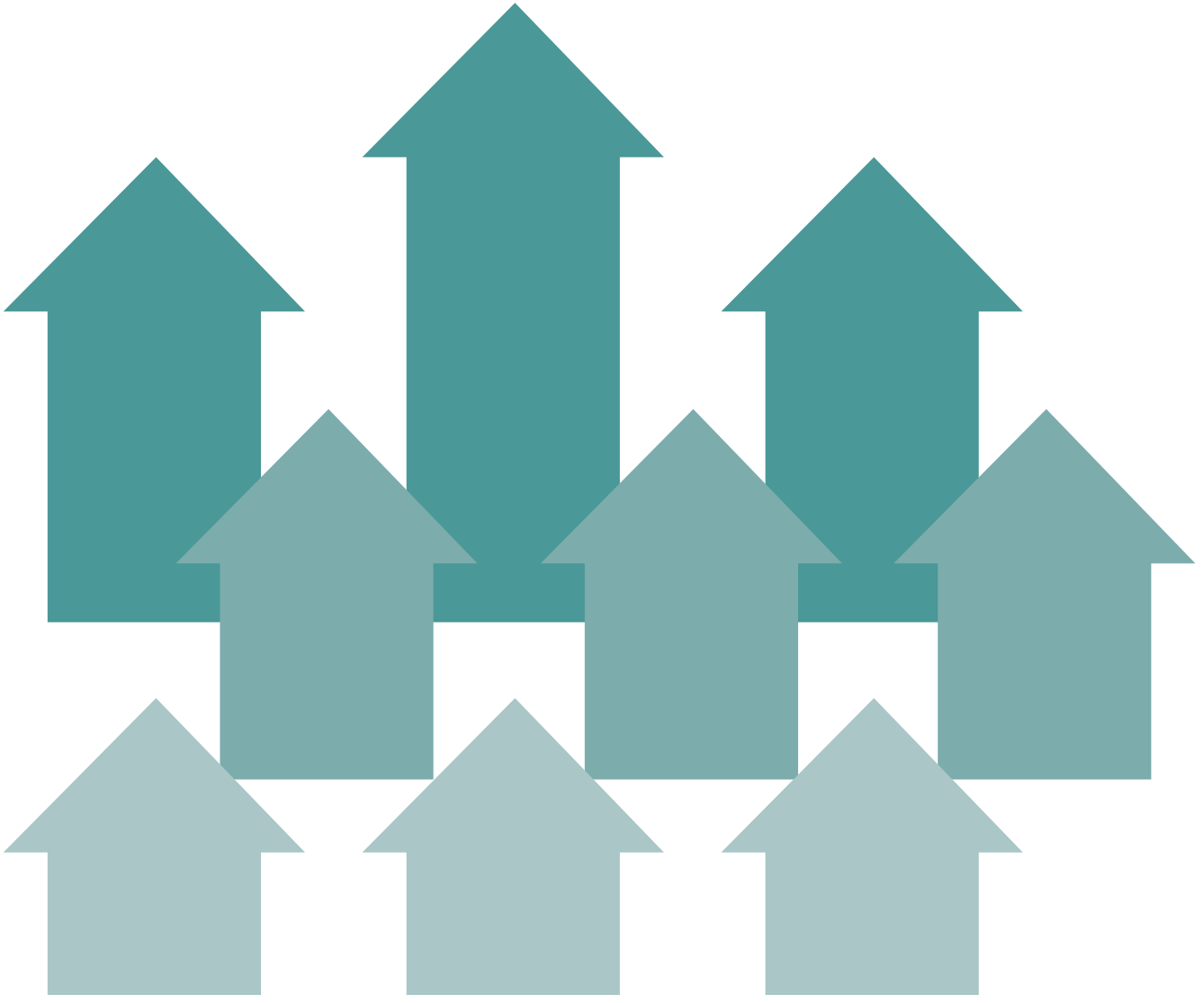
Policy challenges briefing

Resilient cities



UNIVERSITY OF CAMBRIDGE

CSaP

Cambridge Forum
for Sustainability
and the Environment

Edited by Moira V. Faul, Urša Mali and Georgia Leith

The world is changing: a rising world population, declining resources and a changing climate are all reshaping not only how we live but also where we live.

This decade is the first in history in which more people live in cities than in rural areas. It is predicted that by 2050 more than 70% of people will live in cities. Such rapid urbanisation creates tremendous opportunities and also tremendous challenges. The potential exists in cities for vibrant communities, long-term environmental sustainability, efficient transport and excellent infrastructure. At the same time, there is also the potential for increasing pollution, urban sprawl, high-carbon lifestyles and waste of resource.

Can we rethink how we design and live in cities? What measures can be taken to make them more resilient to extreme climate events and to long-term changes in climate? This policy challenges briefing brings together diverse perspectives from policy makers, technical experts and researchers to highlight some of the key issues in climate resilience in cities.

Stephen Aldridge begins this briefing by describing the important role that cities play in promoting the wellbeing of individuals, nation states, and democracy. Simin Davoudi then explains how an evolutionary framing of resilience can effectively support policy making. The traditional view of the "sustainability equation" is queried by Lawrie Robertson, while Jo da Silva makes the case for local adaptation policies alongside global mitigation. Steve Evans explains how industry can be better integrated into urban climate change resilience policies, and Alan Short discusses how carbon emissions can be reduced through changes in architecture. An international project to improve the climate resilience of the South East Mediterranean region is described by Craig Davies, before Marcial Echenique presents a case study of Cambridge. Sir Alan Wilson defines the interdependent dimensions in which policy change is required to ensure cities are resilient. Mark Kleinman closes with reflections on the importance of democratic consent and accountability in governing city systems.

Rosamunde Almond
Cambridge Forum for Sustainability and the Environment

Moira V. Faul
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Edward Glaeser has described the city as arguably mankind's greatest invention. Cities make us smarter, greener, healthier, happier and more prosperous.

Over the past 50 years, however, the UK and other nations have seen huge changes in their cities, driven by the decline in manufacturing industries and rapid growth in services; increasing returns to education and skills; and the emergence of larger city regions. Cities need to be flexible, agile and able to respond to whatever shocks and stresses come their way in the future. London powerfully illustrates the importance of the ability of a city to rejuvenate itself.

The success of cities is driven by a range of multiple interdependent factors: path dependency, economic diversity, competitive markets, the ability to attract innovative firms and high-skilled people, good universities, the right infrastructure and connectivity, a good quality of life, good governance and above all human capital.

Cities, aided by local growth policies, can play a key part in supporting investment in human and physical capital; in supporting the reshaping of the state as it responds to fiscal consolidation; and in building and maintaining the trust in government institutions needed for effective public policy. There couldn't be a more important time for taking stock of the role of cities.

Stephen Aldridge
Director, Analysis and Innovation
Department for Communities and Local Government

Simin Davoudi

The concept of resilience has become deeply embedded in policy discourses particularly in relation to climate change.

However, it is the engineering interpretation of resilience which is often promoted, which puts the emphasis on making urban systems resistant to climate change and reducing their recovery time. While this may be necessary for engineering projects, such as flood defences where stability is a key aspect of design, it is less useful for tackling radical uncertainties in complex socio-ecological systems such as cities.

In this context, an evolutionary understanding of resilience provides a more effective foundation for policy making. Evolutionary resilience is rooted in complexity theory which defines complex systems as: non-linear, self-organising and inherently unpredictable. Complex systems can change with or without external shocks, and with no linear or proportional relationship between cause and effects. An evolutionary perspective considers climate change resilience not as a fixed asset that cities either do or do not have, but as an evolving process.

Policies informed by evolutionary resilience thinking put the emphasis not so much on commanding and controlling systems, but rather on strengthening their capacity to change, adapt and, crucially, transform in response to disturbances. This requires building long-term adaptive capacity rather than merely responding to climate change emergencies. It also requires identifying not just vulnerabilities, but also transformative opportunities that emerge when cities are confronted with climate stress. Factors that contribute to the development of such capabilities include: smart technologies, intelligent institutions, vigilant governance, and active citizens.

Rooted in systems theory, resilience is often seen as a neutral concept with universal benefits. This is not the case: building urban resilience is a contested process and may lead to higher resilience for some at the cost of increased vulnerability for others. For policy to be equitable, attention should be paid to who benefits and who loses from various resilience-building projects and policies.

Four key messages for policy makers:

- Invest in long-term adaptive capacity building for climate change resilience as well as short-term emergency response.
- Capture transformative opportunities from climate change as well as identifying vulnerabilities.
- Ensure that enhancing climate change resilience for some people and places does not increase vulnerability for others.
- Encourage reflexivity and spontaneity in decision making when faced with radical uncertainties.

Professor Simin Davoudi
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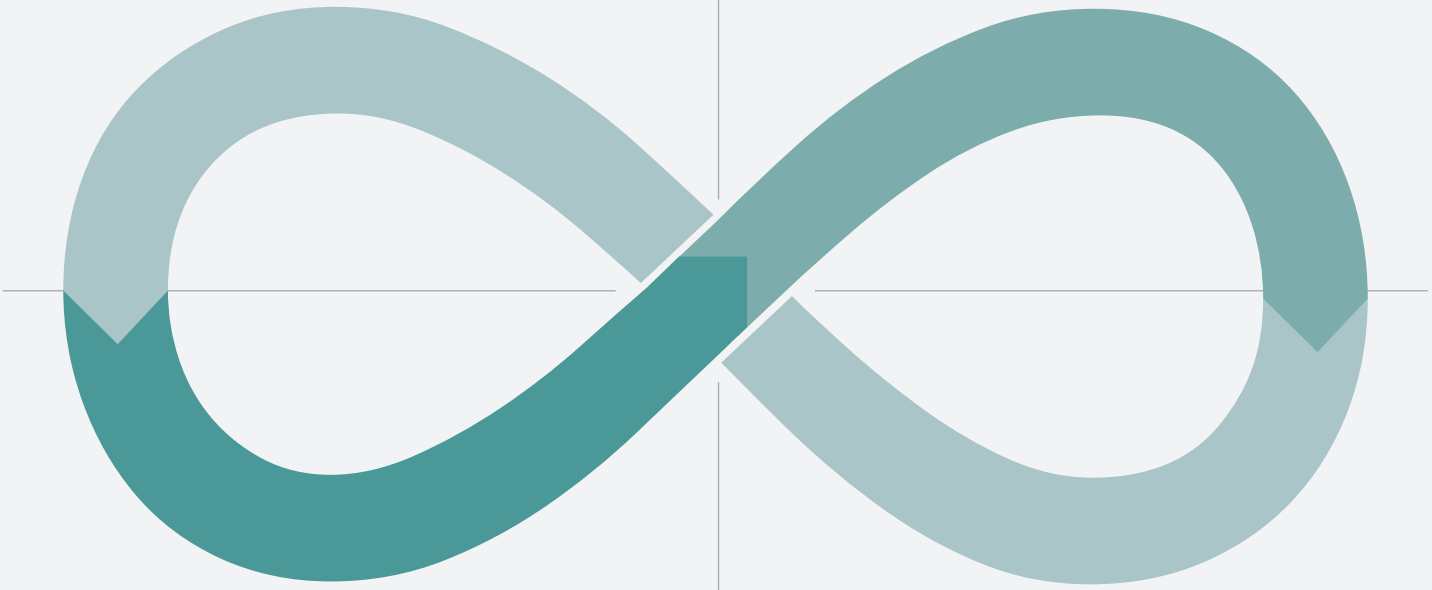
Resilience infinite loop

4 Reorganisation
The reorganisation phase is a time of innovation, restructuring and greatest uncertainty but with high resilience.

2 Conservation
At conservation phase, growth slows down as resources are stored and used largely for system maintenance. This phase is characterised by stability, certainty, reduced flexibility, and low resilience.



1 Growth
The growth phase is characterised by rapid accumulation of resources (capitals), competition, seizing of opportunities, rising level of diversity and connections, and high but decreasing resilience.

3 Creative destruction
The creative destruction phase is characterised by chaotic collapse and release of accumulated capital. This is a time of uncertainty when resilience is low but increasing.

Source: adapted from Gunderson and Holling (2013)

6 Lawrie Robertson

Cities will be where we win or lose the battle to provide a decent future for most people on the planet.

Contemporary discussion of sustainable urban development has been predominantly conceptualised in terms of an imagined attempt by city authorities at equally balancing the three pillars of social equity, economy and environment. However, such a balanced framing has proven problematic. Cities and their governments are more likely to frame the social/human outcomes as paramount, recognising that flourishing economies and healthy environments are vital subordinate contributors providing the resources to achieve these outcomes.

Financial and natural resources are channelled through multiple, interwoven city systems (from governance, infrastructure and spatial systems to natural, economic and social systems) to achieve the ultimate social outcomes. City governments are increasingly expanding their range of action to be able to manage this system of systems to enhance their chances of success.

For many cities however, this equation is sharpening: expanding urban populations hold rising expectations of the social outcomes that cities should deliver (in terms of both providing basic services, and catering to higher aspirations, such as wellbeing). And yet the economic or environmental resources with which to meet these outcomes are limited or declining.

The increasing complexity of city systems is both an advantage and a curse in addressing the dynamic of providing for rising outcomes with declining per capita resources. On the one side, new system types and approaches are emerging, which hold out the potential for enhanced impact with lower resource use; but on the other, the financial cost of delivering them is rising.

In many cities the projected cost of building and maintaining the systems required is rising far faster than the likely increase in ability to pay (whether in terms of citizen affordability or fiscal capacity).

The standard approach to rising system cost has been to search for enhanced economic growth to generate higher city revenues and alternative funding structures to spread or postpone investment cost. Increasingly, this will not be sufficient to close the gap. In future an alternative approach to system development which bears in mind long-term fiscal capacity will become increasingly important. The current assumptions that “increased infrastructure investment equals growth equals improved social outcomes” do not necessarily hold. Instead, a fundamental review of the cost-effectiveness of systems to produce specific social outcomes is required.

Our recent work with cities as diverse as Detroit and Riyadh has shown the critical issue of the long-term unaffordability of many city systems – even in the context of economic and demographic growth. In both cities, this has prompted a reassessment of their long-term strategies.

Lawrie Robertson
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Buro Happold, Cities Group.

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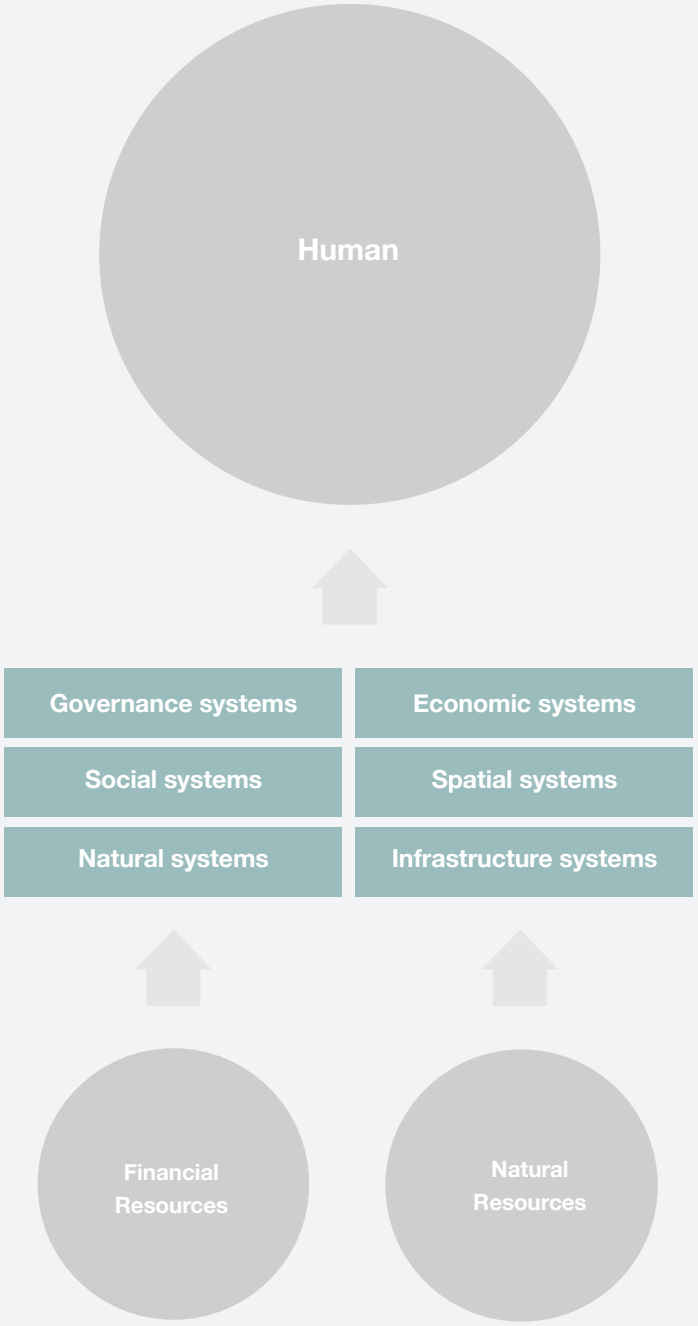
The cities sustainability equation



Aspirations
Wellbeing
Quality of life
Maximisation of human potential
Participation in decision making

Needs
Security
Sufficient food
Housing
Water
Fundamental rights
Dignity

City-region system of systems
Rigorously linking planning, operation and integration of multiple systems can achieve human goals within the resource constraints

Resources
The availability of resources, natural and financial, provides the constraints in which creative solutions must emerge

Jo da Silva

Policy makers have mainly addressed the issue of climate change through global mitigation agreements to reduce greenhouse gas emissions. We now know that this is not enough: it is imperative also to address impacts of climate change locally through adaptation responses in both rural and urban areas.

Mitigation is a singular agenda focussed on reducing greenhouse gas emissions that can be fitted into traditional sectoral planning approaches. Adaptation is more complex, as it must consider the impact of climate change on different systems, as well as the role those systems play in supporting urban life. But, adapting to the impacts of climate change needs to be addressed in the context of other catastrophic events and accumulating stresses that cities may experience. City resilience is about urban populations being able to survive and thrive no matter what happens.

Urban resilience depends on:

- People: who must be able to meet their basis needs in terms of food, water, health and shelter.
- Place: defined by infrastructure and ecosystems that protect urban assets, provide services, and enable the flow of goods, services and information.
- Organisation: of the social and financial systems that enable urban populations to live peacefully and act collectively.
- Knowledge: the governance structures and planning processes that result in informed, inclusive, integrated and iterative decision making.
- Qualities and capacities: the extent to which urban systems and institutions are robust, redundant, flexible, reflective, resourceful.

Key messages for policy makers:

Business can play an important role: Surat is one of the fastest growing cities in India, and heavily reliant on migrant labour. In 1984, extreme flooding combined with poor sanitation, and inadequate health care resulted in an outbreak of bubonic plague. Many died, whilst fled the city, crippling commence. Since then, the Chamber of Commerce has been at the forefront of efforts to tackle flooding and transform the city into one of the cleanest and healthiest cities in India.

Peer-to-peer learning: City networks such as 100 Resilient Cities, Asia Cities Climate change Network, or the C40 Cities Network, enable cities to learn from the experiences of other cities, as well as their own experiences. They play an important role in catalysing change, and accumulating knowledge of what does and does not work in a particular context.

Civil society action: Action at a household level, if supported so that it is widely replicated can help build resilience at a community or city scale. In Bangladesh, families have been able to make incremental improvements to their houses in order to adapt to increasing temperatures as a result of access to micro-finance.

Integrated resilient strategies: In Vietnam, a Climate Change Coordination Office was established in 3 cities as part of the Rockefeller Foundation's Asian Cities Climate Change Resilience Network initiative. It has created a focal point for developing and implementing a city climate change resilience strategy, and proven effective in generating innovative thinking, and involving a wide range of stakeholders.

Jo da Silva
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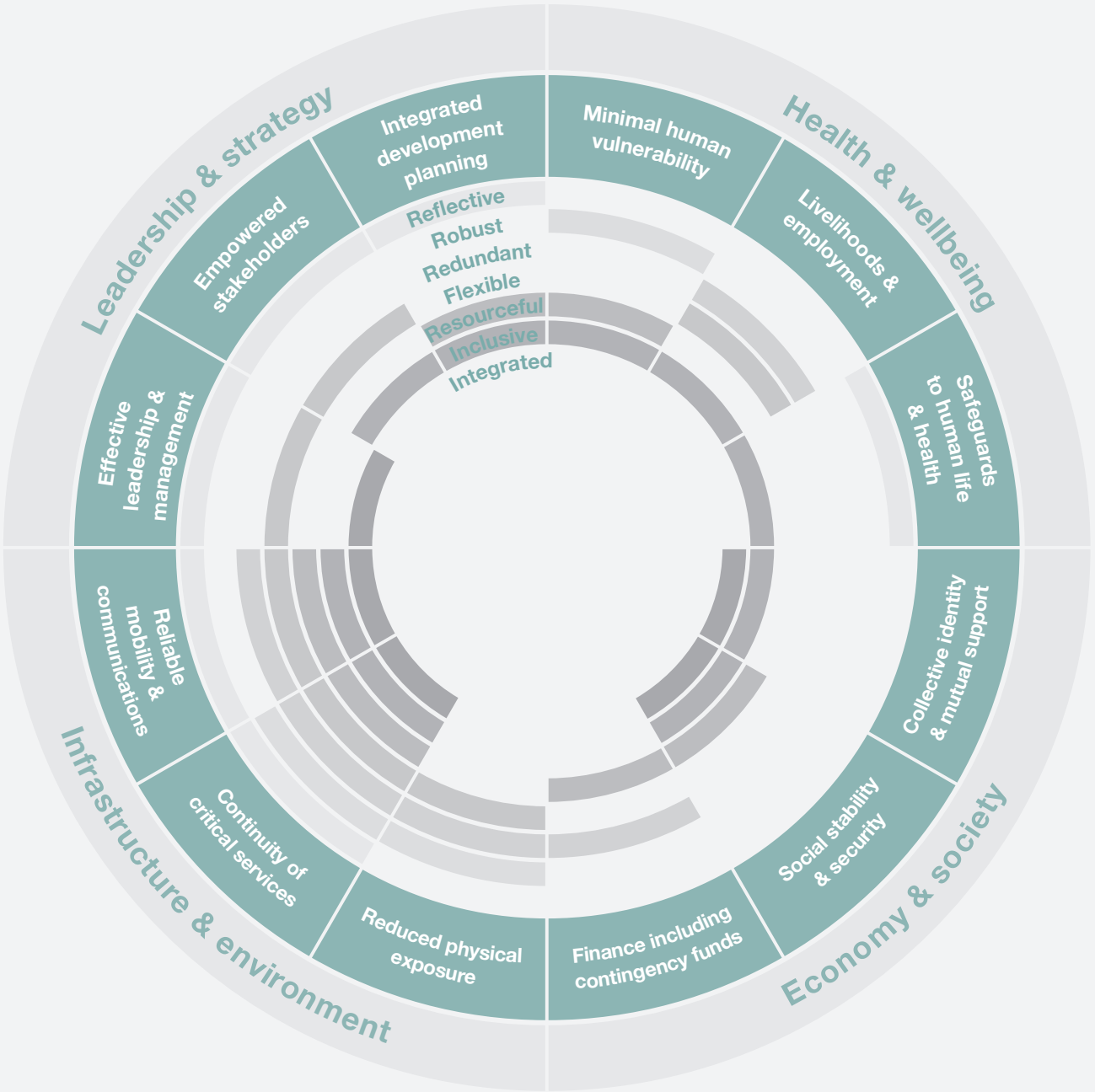
Cities resilience framework



Source: da Silva and Morera (2014)

Steve Evans

Cities can usefully be seen as complex systems within which industry is a major actor. Yet, industry seems badly integrated into the thinking about urban resilience. This is a missed opportunity, as factories can play an important role in increasing urban resilience. Often perceived as the root of the problem of sustainability, industry can instead become an integral part of the solution.

The strength of industry lies in organizing the 4Ms: men [sic], money, machines, and materials. The four may be combined in novel ways to create extraordinary value that does not destroy the planet. Take, for example, processes of industrial symbiosis in Kalundborg, Denmark: in the town, which has evolved over decades, hardly any industrially-generated energy is wasted. High heat energy used for cooling in one factory can be used to heat up an industrial process in another. The cooling of that process then generates low-grade heat, which is subsequently used for centrally heating domestic buildings.

This shows that industry should not be seen as separate, but rather as an integrated part of the urban system: it can pay for, install and maintain processes that share energy. It should do so more often and this should be valued.

A systems view of industry can teach us three things that may be of value in city systems thinking:

- The boundaries you choose to draw around a system fundamentally alter your analysis and conclusions. Cities are not independent systems, but rather are characterised by massive flows of energy, water, food and materials across their boundaries. Thus, you could draw the boundaries around cities at local, national, or global levels, and the analysis and policy solutions you arrive at will be significantly different.
- Unintended consequences arise when an intervention in one part of the system causes a hiccup elsewhere in the system. For example, building more roads to shorten journeys can lead to more cars using the excellent new roads and eventually slowing journey times. Instead seek to form win-win connections that form positive loops, such as reducing fuel consumption by manufacturing lighter cars. Lighter cars require less braking power, which causes them to use less fuel.
- In thinking about sustainable cities, we may also draw inspiration from nature: natural systems seem to follow a limited number of rules (such as variety, adaptation, change, selection, and duplication), yet remain remarkably resilient. What is the equivalent for city design? Rather than trying to come up with a single design, perhaps efforts would be better invested in designing a system that mimics certain aspects of evolution.

Professor Steve Evans
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Retrofitting existing buildings is critical to climate change resilience in cities.

Public buildings offer easy wins for retrofitting projects. NHS carbon emissions constitute 25-30% of public sector emissions. The Design and Delivery of Robust Hospital Environments in a Changing Climate (DeDeRHECC) Project revealed that reducing carbon emissions from the NHS estate would make significant advances towards reaching the national carbon reduction unit.

The DeDeRHECC architects and engineers came up with low-tech solutions for climate-proofing the NHS estate until 2050-80, calculating that their cost would be offset by the potential savings in energy bills and carbon and by patient outcomes.

The changes necessary to implement a vision of a resilient built environment are:

Modify the envelope of buildings to deliver better sustainability, finacial and user outcomes rather than rely on bolt-on gadgets. NHS buildings need to save prodigious amounts of carbon to meet new targets whilst providing safe conditions during more frequent heatwaves. However, conventional mechanical cooling – the obvious response – eats energy. The National Institute for Health Research (NIHR)-funded project, Design Strategy for Low-Energy Ventilation and Cooling of Health Buildings, modelled more naturally conditioned environments in the real context of cost, medical planning, and infection control. An order of magnitude less energy demand can be achieved where a cross section of rooms receives air from pre-cooling/ warming labyrinths and exhausts through stacks, generally without fan assistance, and where inboard rooms are vented from courtyards across circulation areas.

Build environmental concerns into the initial design spec of new buildings before they are handed over to contractors. Located at the centre of one of London's heat-islands, the School of Slavonic and Eastern European Studies is the UK's first major passive downdraught-cooled building. The very low-energy, top-down cooling system circulates pre-cooled air using both gravity and stack effect via a glass atrium, a double envelope and perimeter stacks.

Lessons from the history of architecture. Learning from the past by reconstructing and modelling late 19th century and Edwardian hospital buildings has provided clues as to how to rethink modern public buildings in this new context of climate change. Designing to achieve signigicant carbon reduction can improve outcomes in health and wellbeing by delivering less artificial environments.

Change architectural education. Architecture needs highly skilled researcher-academics – its surgeons as well as general practitioners. To achieve this, architectural education needs to be wrenched from its archaic exclusively general practice model. Higher research-based degrees should be welcomed by professional bodies as pathways to registration, or the profession will be debased and marginalised from the adult world of policy making.

Professor Alan Short
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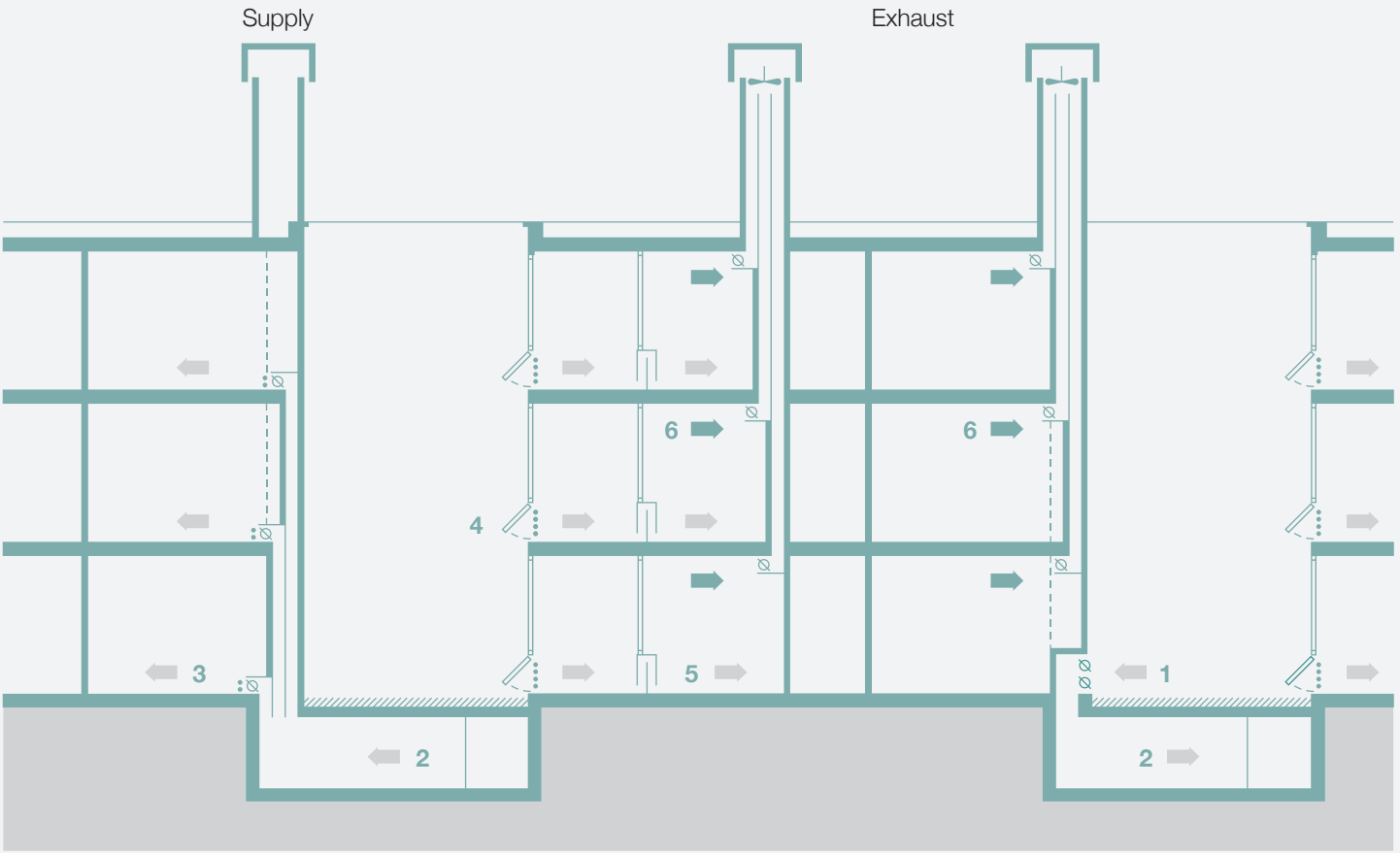
Low-energy ventilation and cooling in health buildings

Key

- Fresh air supply
- Air exhaust
- Dampers
- Heating element

1. Air inlet to labyrinth located under windows
2. Uninsulated labyrinth below courtyard
3. Pre-cooled/warmed air enters room at low level
4. Openable windows at low level allow fresh air to corridor
5. Transfer ducts allow the passage of fresh air to internal rooms
6. Exhaust air leaves rooms at high level



Source: Short (2011)

As reported by the IPCC in 2014, in urban areas of countries such as Egypt, Jordan, Morocco, Turkey and Tunisia, buildings are often poorly suited to existing climate conditions, and even more poorly suited to future conditions expected as a result of climate change.

Existing heat and water stresses in these environments pose serious threats to the built environment. Additional challenges are posed by extreme climate events such as storms and floods, which are expected to intensify as a consequence of climate change impacts, including sea-level rise in coastal areas.

Yet, building codes and standards in the region, where they exist and are applied, do not take into account current and projected future climate conditions. Unless this is done, it will not be possible to meet the challenge of improving the climate resilience and resource efficiency of buildings in this region.

Therefore, the European Bank for Reconstruction and Development (EBRD) is interested in exploring how these challenges can be met: through the adoption of appropriate new technologies and policy measures that enhance the impact of such technologies.

Some of the key questions that need to be answered include:

- What are the current and projected future climate risks that are relevant to buildings in the Southern and Eastern Mediterranean region?
- Which are the most appropriate and effective climate-resilient and resource-efficient technologies and practices that can help mitigate climate change risks to buildings?
- What is the scope for investment and policy dialogue to promote the uptake of these technologies and practices in the region?

In order to answer these questions, the EBRD intends to bring together a wide range of experts from academic institutions, central and local government, the private sector, and civil society, as well as relevant regional organisations. It is only through convening a variety of perspectives in policy, practice and research that the most appropriate routes to effecting change for climate resilience can be identified and implemented.

Dr Craig Davies
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European Bank for Reconstruction and Development

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South-east Mediterranean

1 Morocco
2 Tunisia
3 Egypt
4 Jordan
5 Turkey

Many cities face the challenge of working out how to grow without losing the qualities that make them attractive places to live and work. This was the problem investigated by Cambridge Futures, a project which aimed to move away from the policy of "no growth" that had been in place in Cambridge since World War II.

Many of the solutions proposed by the project in 1999 have been or are being realised: increasing population density around the railway station in order to increase access to the station; employing a "green swap", in which areas of green belt are developed in exchange for "green wedges" of flora and fauna that link the city with surrounding countryside; and building new villages around Cambridge.

Fifteen years since the ideas from the project were adopted, the University of Cambridge is now exploring alternatives to further expand the city in a sustainable way. Proposals include expanding low-density development in selected areas in the Cambridge sub-region and using environmentally friendly technology. This would help reduce CO_2 emissions by offering both greater availability of renewable resources (such as more solar and ground-source power, for heating houses) and a more environmentally-friendly transport system, providing private and public transport efficiently.

Such carefully planned urban development may be aided by two policy levers:

Land banking: At present, large-scale developers enter into option agreements with agricultural land owners around cities to obtain planning permission. If they get planning permission, they choose which areas to develop or retain, based on their strategic commercial reasons. However, these commercial reasons could have negative consequences for the city as a whole. In order to allow for positive public outcomes through strategic urban planning and development, local authorities could buy and urbanise the land instead (as is practised on the continent, especially in Spain). This would allow the city to grow sustainably, benefiting the community and also increasing affordable housing. Such a reduction in house prices would make cities more affordable to the very professions that are critical to urban sustainability, such as teachers and nurses.

Congestion charge: In order to de-congest the city, a congestion charge would disincentivise people from driving into Cambridge. The revenues from the charge could be utilised to improve public transport, alongside additional measures that encourage the use of energy-efficient alternatives to cars.

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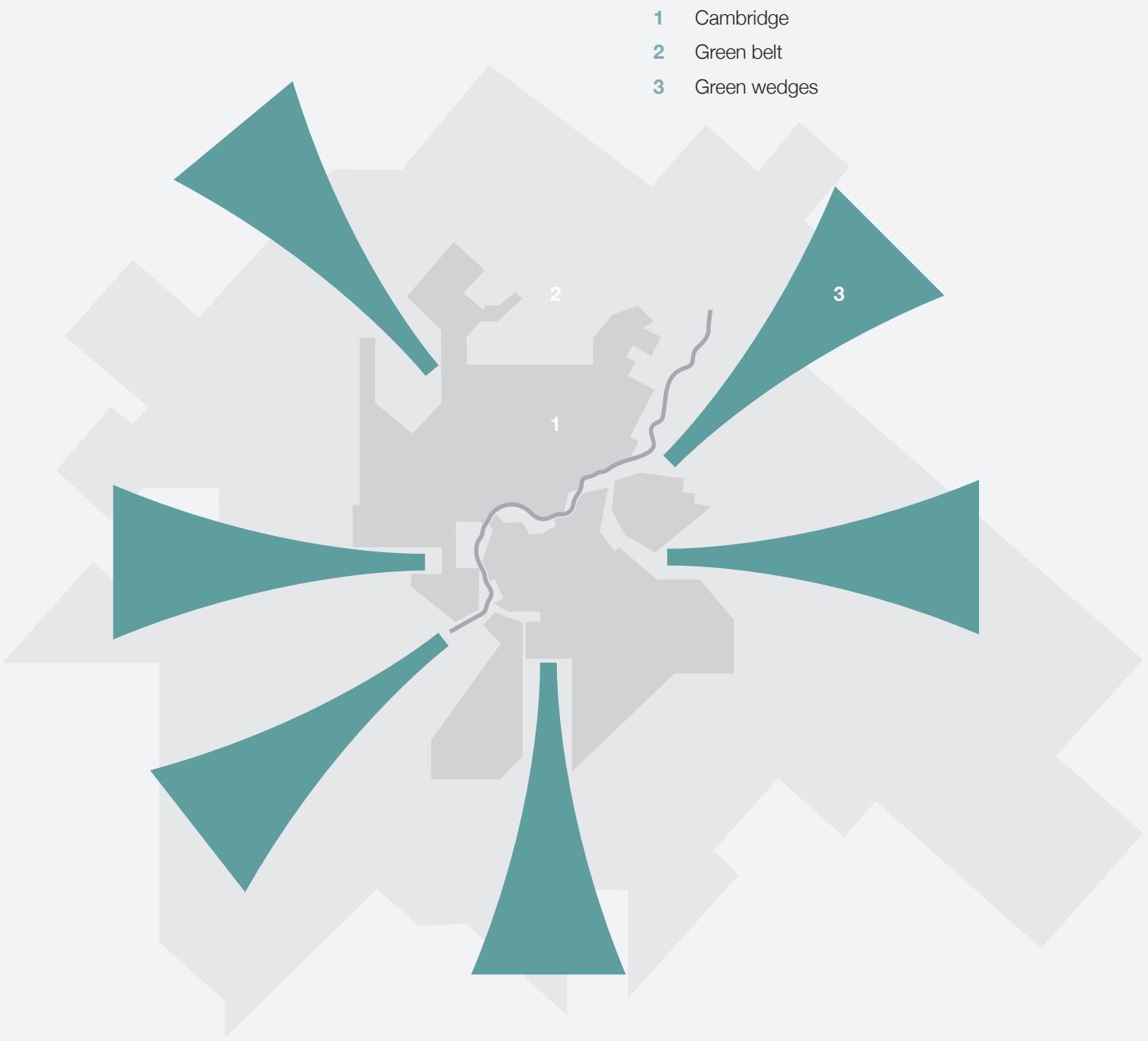
Cambridge green swap



Source: adapted from Cambridge Futures

The Foresight project on the future of cities, led by the Government Office for Science, focuses on climate change in urban areas and the corresponding need for a low-carbon agenda.

The project has identified a number of interdependent urban dimensions within which policy changes will be required:

Population change

Based on forecasting available from the Office for National Statistics, the UK population will increase by about 10 million by 2037. Such growth will need to be addressed particularly with regard to housing and employment. The rate at which housing is built will need to increase, and more than 5 million new homes will have to be built. Crucially, new housing will have to be delivered in a sustainable way: for example, increasing population density around transport hubs, which will both provide housing and shorten trip lengths.

Future of economy

The future of work needs to be rethought - what will a knowledge-based economy in future cities look like, and what skills will be required? If the economy becomes greener, will it provide a sufficient number of jobs?

Energy and material (water, waste, food) flows

This relatively under-researched area has important implications for provision of utilities for a future economy. Some policies (such as energy supply, much of which is provided by private companies) may be difficult to integrate.

Urban form and structure

This dimension includes infrastructure, maintenance of the green belt, delivering access to employment and services. Amongst many necessary changes, implementing this agenda will involve changes to travel and work patterns, reducing carbon emissions from different forms of transport, and retrofitting.

Professor Sir Alan Wilson
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Foresight Future of Cities Project

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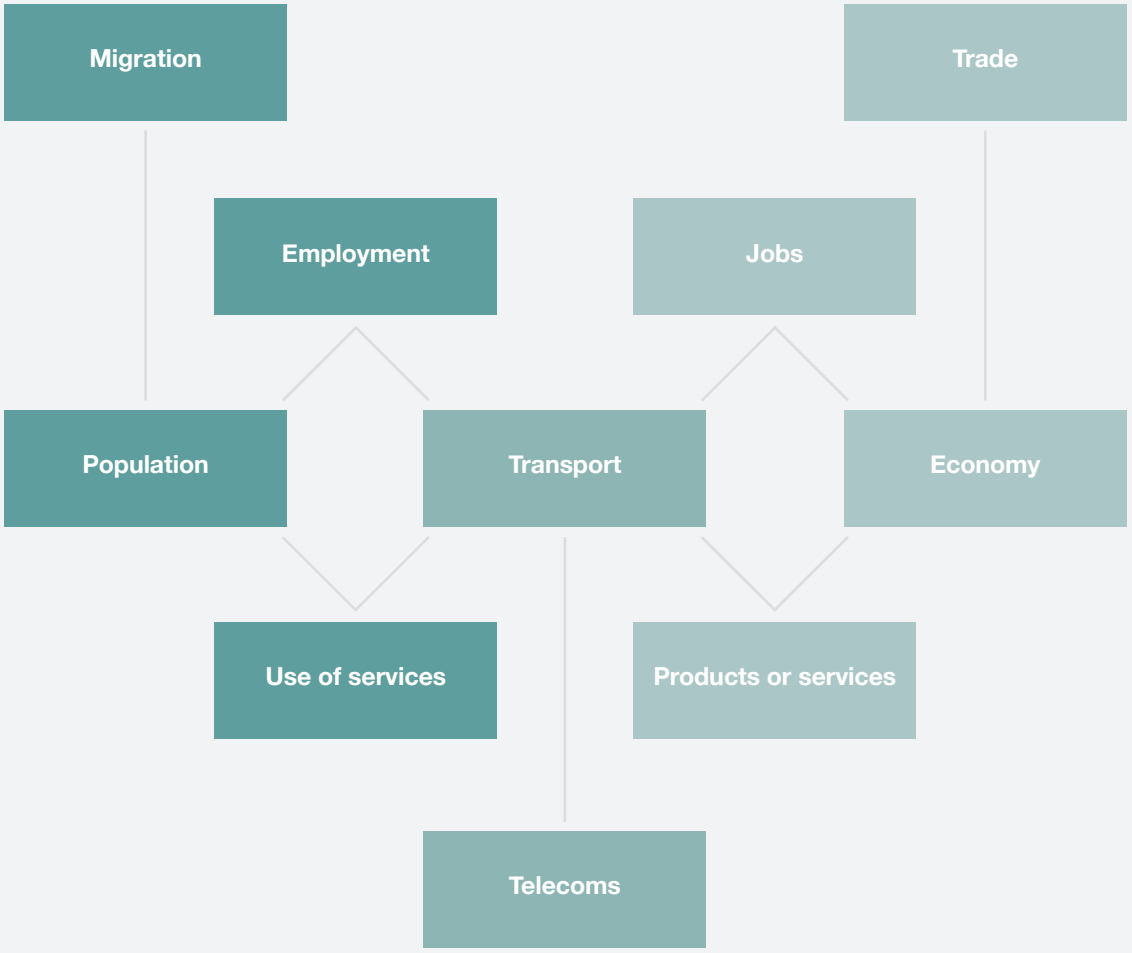
An urban system



Source: adapted from Wilson (2012)

Mark Kleinman

London is a growth machine. Its population is increasing by about 100,000 people every year, a rate unprecedented since the 19th century. Such rapid growth generates challenges and opportunities for both urban populations and policy makers.

For London to remain a sustainable city offering a good quality of life, the city has to accommodate and support growth differently from the way it did in the past. Like other cities, it has to address questions such as where we live and work and how we travel between the two, and how we use energy and deal with waste.

As a senior policy maker, I see an increasing trend away from considering sustainability and infrastructure as a series of separate, individual issues, and towards viewing them collectively, as part of a city system. Systems thinking can provide some useful insights in terms of thinking through feedback mechanisms: trying to understand what is happening, and being able to respond to that.

But we must avoid the trap of thinking of a city only as a "system of systems". Cities are where people, ideas and creativity come together. That is why, in his Smart London Plan, the Mayor of London has put Londoners at the centre of the process. We need to recognise that much of the "Smart Cities" rhetoric so far fails to connect with the concerns of city residents and city politicians. Even worse, it can be perceived negatively, as a set of top-down technocratic "fixes" in which voter-residents are at the end rather than the beginning of the process. We want to reverse this polarity.

In managing the urban system, the role of city leaders lies in promoting and supporting a smarter approach to urban growth through making use of new technologies. Such an approach is key to achieving a greater quality of life, thereby attracting and retaining people and jobs for the city.

How do we achieve this in a sustainable way, and how do we fund this huge infrastructure? In London we still rely to some extent on the investment of our Victorian forefathers, such as Brunel and Bazalgette. After 150 years, that system is showing its age across the piece from power generation and distribution to waste and water. That is why the Mayor has published London's first long-term Infrastructure Plan looking ahead to 2050. It is the first ever strategic attempt to set out London's infrastructure needs, how much it might cost to meet them, and how we pay for it.

In dealing with the urban future, resilience and adaptability are the key watchwords. We just don't know what our city or country is going to look like in 2050, but what we can do is try to build in resilience and develop systems which are adaptable to change.

Governance is crucial: sustainability needs to be achieved with and through people's consent. Dialogue and accountability are as important as technological fixes.

Mark Kleinman
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In 2013-14, the Centre for Science and Policy (CSaP) and the Cambridge Forum for Sustainability and the Environment (CFSE) worked in partnership on a Policy Challenge focused on the components of sustainable cities and the governance needed to support them.

The University of Cambridge Forum for Sustainability and the Environment aims to stimulate cross-disciplinary conversations about some of the great sustainability challenges the world faces in the future, and the research pathways which will help to prepare for and address those challenges.

The Centre for Science and Policy promotes engagement between academic research and government in order to improve the use of evidence in public policy and support academics in the public policy dimensions of their research.

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