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EDITORIAL

Green cities

More of us than ever before live and work in cities nationally and globally[1]. But cities are heavily dependent on their interaction with their surroundings for resources such as food, energy and water, access to nature, and as a final resting place for people and waste. Cities are dependent on other cities for trade, finance and knowledge exchange. They are also significantly impacted by the actions of those outside the city: air pollution, flooding, or through traffic. It is important to make cities as sustainable as practicable while at the same time ensuring the sustainability of their surroundings.

This issue of the environmental SCIENTIST seeks to address some of the questions that arise around our common urban future. The papers that follow draw on work from across the environmental sciences, exploring the challenges that cities will face over the coming decades, and the exciting and innovative environmental solutions and projects being undertaken to improve our urban areas.

Bristol is a city that aspires to be sustainable[2]. In the late 1960s and early 70s, Bristol saw the closure of the city centre docks and the decline of many local industries. There were proposals to fill in and redevelop the docks and construct a major new road network across the city. The backlash and wider environmental awareness were probably the starting point of the city-wide commitment to achieve sustainability goals.

In 2008, environmentally committed organisations and businesses and the City Council created the Bristol Green Capital Partnership, with a pledge to help Bristol become "a low carbon city with a high quality of life for all". The European Commission set up the annual competition for a European Green Capital later that year and, following major changes and improvements, Bristol won the competition to become European Green Capital for 2015. Winning cities have to have achieved high environmental standards, show commitment to ambitious goals for sustainable development, and provide a role model to inspire other cities and promote best practices and experience.

The award has encouraged the City Council and its partners to engage further with communities and organisations across and beyond the city to address local, national and international issues including transport, energy, resources, food and nature. The Bristol Green Capital Partnership has increased its membership from 65 to over 800 in two years. During 2015, over £15 million from national and local government, partners and businesses has supported green initiatives, neighbourhood projects and wider activities. Thousands of students have become more involved with sustainability and the city has hosted many debates and conferences on subjects ranging from fair trade to health. Bristol is "In it for good".

But is Bristol more sustainable? Will attitudes and actions have changed? The monitoring and evaluation of impacts will take years, but it has already started. Reports on the 'Bristol method' will show how a city can become a Green Capital, how it can build partnerships, involve volunteers, explain where the city has changed practices. Our MOOC (massive, open, online course) *Green City: Global Challenges, Bristol Solutions* will show everyone what is being done. Meanwhile Bristol is determined to deliver on the other criterion for being a sustainable city – to have fun.

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CONTENTS

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Our urban future

James Hale describes the work being done to design sustainable and liveable cities.

Thinking about the future is a messy business – any predictions we make about energy use, technology, population or climate will be wrong at some level. Thinking about the future of cities is even messier, as human settlements are highly complicated, interconnected and rapidly changing landscapes. In terms of physical structure they can vary massively within a few hundred metres. The size of land use patches such as green spaces and gardens tends to reduce towards the centre of cities, and sustainable development policy often encourages multiple land uses within the same development plot. Such compact and multi-functional places present huge problems for sustainability policy and governance. A high density of private landowners and activities makes the sources of some pollutants challenging to identify, and can act as a barrier to coordinating the delivery of city-wide sustainability goals. In spite of all of these elements, planning for the future is an essential component of sustainable development.

The structure, composition and functions of cities are changing rapidly. Many stressors are increasing, some of which are driven by the continued growth in urban areas, urban populations and individual levels of consumption. Increases in environmental problems within cities may also have less obvious drivers. For example, one of the causes of a global increase in light pollution is thought to be the rebound effect, where more energy-efficient (and therefore cheaper) lighting technology enables brighter and more extensive urban street lighting at no extra cost[1] (see **Figure 1**). Another example is the current fashion for the use of wood-burning stoves to provide secondary domestic heating. Driven in part by increases in fossil-fuel costs, the resulting increases in particulate matter (PM_{10}) emissions may be sufficient to undermine initiatives to reduce urban air pollution[2].

"Thinking about the future is a messy business"

These sustainability challenges sit within a global context of climate change, globalisation, political and economic uncertainty, and competition for resources. Cities are centres for resource consumption, yet are largely dependent upon imported energy, water and food. This raises broader questions about their long-term resource security and the scale and complexity of urban ecological footprints.

INTRODUCTION

BOX 1: LIVEABLE CITIES

Transforming the engineering of cities for global and societal wellbeing
Liveable Cities is a five-year, £6M, EPSRC-funded programme of research dedicated to transforming the engineering of cities to deliver global and societal wellbeing within the context of low carbon living and resource security by developing realistic and radical engineering that demonstrates the concept of an alternative, liveable future. It will achieve this through the creation of an holistic, integrated, truly multi-disciplinary City Analysis Methodology (CAM), which uniquely integrates wellbeing indicators, is founded on an evidence base of trials of radical interventions in cities, and delivers realistic and radical engineering solutions.

Liveable Cities is led by Professor Christopher Rogers and colleagues at the University of Birmingham in collaboration with University College London, Lancaster University and the University of Southampton. It will run from May 2012 to April 2017.

www.liveablecities.org.uk

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URBAN SUSTAINABILITY SOLUTIONS

Unsurprisingly, the challenge of developing more sustainable cities has inspired the creation of numerous solutions. Many of these make use of technological advances, with increasing interest in citizen-generated data, fine-resolution physical models, real-time pollution-monitoring networks and intelligent buildings. Other softer solutions include the use of green infrastructure to deliver ecosystem services, and the creation of economic incentives to nudge the public towards more sustainable behaviours.

Despite a clear appetite for creating more sustainable cities, there is the risk that proposed solutions may fail to deliver their intended benefits. Urban areas contain a range of wicked problems[3], which may be hard to define clearly and are often highly context dependent. A particular solution may rely upon the long-term presence of certain forms of funding, maintenance, built infrastructure and public support, yet these may all change over time. It is not always clear what problem(s) a particular solution is intended to address, whether the solutions put in place have worked, whether they would perform similarly in another context, or whether they have generated unintended consequences. The common practice of working inside disciplinary, professional and site boundaries also creates a very real risk that sustainability solutions may be unintentionally removed, or even end up undermining each other.

RESEARCH, CONCEPTUAL APPROACHES & PRACTICAL TOOLS

In an attempt to address the challenge of how to deliver more sustainable cities, a large number of related research

▲ **Figure 1. Artificial lights at Media City, Salford. One of the causes of a global increase in light pollution is thought to be the rebound effect, where more energy-efficient lighting technology enables brighter and more extensive urban lighting at no extra cost. (©adamrowley | Dreamstime)**

projects have been funded by UK research councils within recent decades. A report commissioned by the Future Cities Catapult, *Connecting Research with Cities*, identified 1,612 UK-funded projects that related to cities or urban areas, with 2,564 European Commission-funded urban projects that have had UK participants[4].

Whilst resolving discipline-specific technical problems is often key to achieving more sustainable cities, there is also much to be gained by taking a broader systems view. Some of this research has therefore sought to conceptualise cities in a way that recognises their complexity and interdependencies, whilst at the same time providing a structure that can be used to explore their future. A key theme that has emerged is the need to think about cities as nested systems of systems. Numerous conceptual models exist, such as the social–ecological or technological–political systems, although the emphasis of each model is largely a reflection of the particular research focus. The key point is that the social, technological, economic, environmental and political systems that drive high-level city performance do not function independently. Rather, they interact, and in order for improvements to the environmental sub-system (for example) to be sustained, it may be necessary to identify and intervene in specific social practices or governance processes.

This conceptual shift can facilitate collaboration between research and practice across traditional disciplinary lines. It can provide a space for comparing the ways that social and technical systems are described, and helps to give permission for people to step outside of disciplinary or professional boundaries. For example, it may help civil engineers to legitimise the inclusion of user behaviour in models of water-distribution systems. This conceptual approach can also facilitate the application of systems theory from one domain to another. For example, resilience is a concept familiar to ecologists, where resilient ecological systems are those that can reorganise/rebound when subjected to disturbance, such that they still retain essentially the same structure and function. Characteristics of resilient natural ecological systems (e.g. having high functional redundancy) might therefore be applied to improve the resilience of urban systems (e.g. by retaining a variety of options for public transport, rather than prioritising the most efficient).

This broader view of cities is also very useful when developing plausible scenarios for their future. Given the uncertainty of how global development will progress even over the next 10–20 years, scenarios are increasingly being used to define a probability space for the future, which can be used to identify risks to our current interventions[5]. The aim is to ensure that a sustainability solution put in place today will still be working far into the future, even when the future develops in ways we have not predicted or hoped for. Conceptualising cities as systems helps to ensure that these scenarios are internally consistent. For example, in a future where market forces dominate, one might expect consumerist and individualistic attitudes to be common. The implications for land use in this scenario may be that urban areas have tended to sprawl rather than becoming compact. Tools such as the Designing Resilient Cities™ methodology[6] are intended to facilitate the use of such scenarios when thinking about the future of UK cities. In addition, analyses of the opportunities and challenges facing UK cities over the next 50 years are being commissioned directly by the UK government[7].

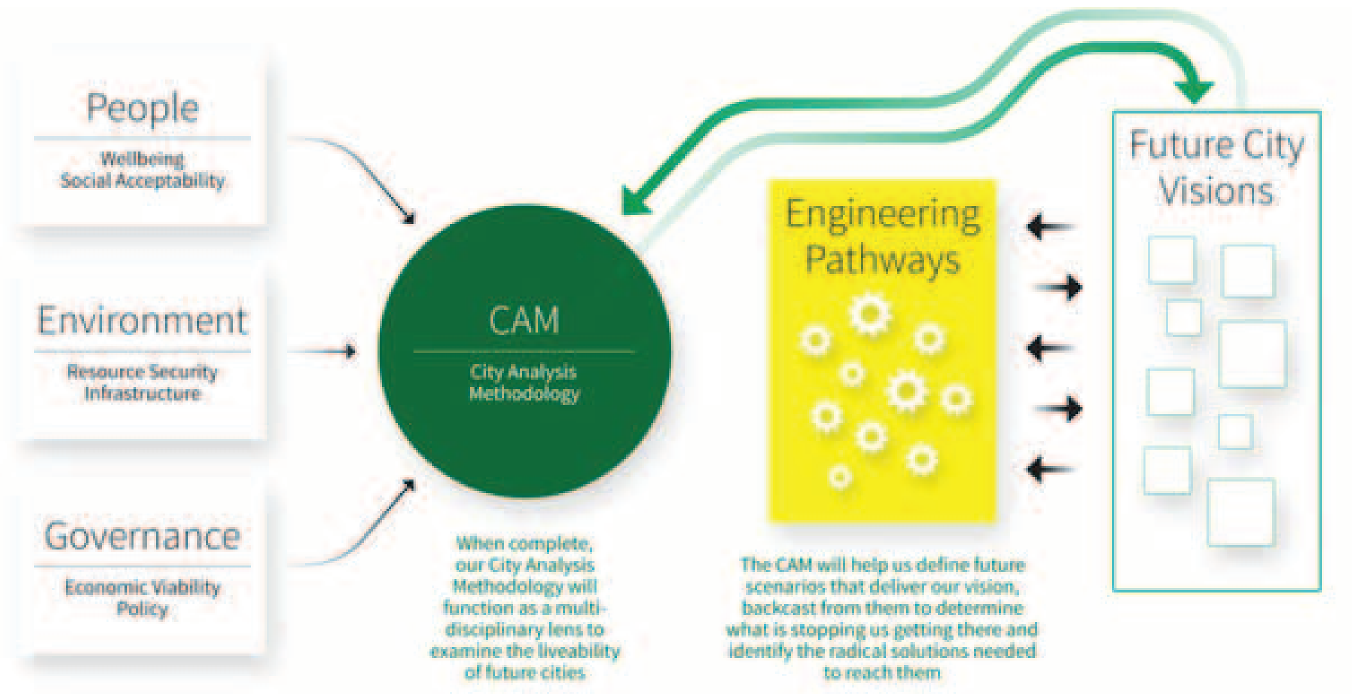
LIVEABLE CITIES

Liveable Cities (see **Box 1**) is a large multi-university research programme funded by the Engineering and Physical Sciences Research Council (EPSRC) that illustrates the type of holistic work on future cities now being supported by UK research councils. It includes research components that take a broad systems view of cities, as well as work on more narrowly focused questions. It also interprets the Brundtland definition for sustainability in a manner that helps it to be operationalised for future cities. The project has identified three key characteristics of a liveable city – low carbon emissions, high resource security and high individual and societal wellbeing. It is clear that the ability of future generations to meet their basic needs will be compromised if massive reductions in global carbon emissions are not achieved. Similarly, sustaining access to resources such as energy, water and food is a basic requirement.

The importance of citizen wellbeing is perhaps less prominent within the broad discourse on sustainable urban futures, yet within Liveable Cities wellbeing has been prioritised. The primary purpose of cities is to meet the needs of people, and the rapid urbanisation of the global population is being fuelled by the perception that cities offer a better, more secure quality of life. Despite this, cities often perform poorly according to some indicators of individual wellbeing. In addition, it is clear that many of the proposed technological and policy solutions to global climate change and resource insecurity directly threaten human wellbeing (e.g. by causing nuisance, restricting individual freedom or reducing disposable income). Attempting to impose solutions that are socially unacceptable is a self-defeating strategy. A central aim of the Liveable Cities programme is therefore to explore how our urban areas may be transformed to reduce carbon emissions and increase resource security in a manner that enhances rather than threatens the wellbeing of their citizens.

WELLBEING, ASPIRATIONS AND FUTURE URBAN VISIONS

Human wellbeing can be a difficult concept to define and measure since it includes tangible elements such as physical health along with other aspects related to people's values and aspirations. A key theme within the Liveable Cities programme has been to explore how people's values and aspirations might be incorporated into sustainable engineering strategies for future cities. This work has included studies of self-reported wellbeing and citizen aspirations in three case-study cities, and future visioning workshops with different sector groups. As can be seen within a recent study of how the future has been visualised by past generations[8], within this study there was a strong tendency for participants to reference particular urban forms, i.e. what a desirable



▲ **Figure 2. Key research themes and connections within the Liveable Cities programme. A holistic City Analysis Methodology (CAM) has been developed to measure city performance, with respect to carbon emissions, resource security and wellbeing. This supports the development of visions for future UK cities that would deliver on these aspects of city performance. From these visions, back-casting will then be used to identify (often radical) interventions that could be implemented and pathways that would be followed. (© Liveable Cities programme)** future city would look like. However, an essential outcome of this research is to distinguish between form and function, deriving a set of characteristics for a future city that maximises wellbeing and that can be realised in a variety of ways. For example, a respondent might aspire to live in a city where weekend shopping with friends is easier, yet a detailed analysis of the interview transcript might reveal that the underlying aspiration is to have greater social contact – the mechanism and venue being largely irrelevant.

UNDERSTANDING CURRENT CITY PERFORMANCE

Another major theme within this project is the development of the City Analysis Methodology (CAM; see **Figure 2**). The CAM is an innovative framework designed to assess how cities perform in terms of wellbeing, resource security and carbon emissions. It can be applied to today's cities to establish a baseline of current performance, and will also be used to test whether the interventions and strategies proposed for future liveable cities are likely to be successful. Performance measures in the form of indicators and metrics have been selected (e.g. age of usual resident, childhood obesity, satisfaction with the quality of life) that individually and in combination provide key information related to the programme's three high-level targets for future liveable cities. In some cases, the data needed for reporting was considered insufficient. It was either unavailable, available at too coarse a scale, or existed in a form that was difficult to interpret. The CAM therefore also includes models and analyses that provide information on city operation and sub-city scale performance. For example, models for material and energy flows are being developed as part of broader research on urban metabolism. In addition, predictive maps of urban ecosystem services have been developed, drawing on field measurements of urban temperature and ecological diversity.

RADICAL ENGINEERING AND TRANSITION STRATEGIES

Liveable Cities is currently in its second phase: developing radical engineering strategies. The speed and magnitude of reduction in carbon emissions that is required in order to limit future global warming to 2 °C implies that incremental changes to energy generation and demand will be insufficient. Urban systems involving large-scale built infrastructure and human behavioural patterns tend to be resilient to rapid incremental change. Similarly, the vulnerabilities in our resource supply systems are likely to be systematic, requiring fundamental changes to how cities are structured and managed. The Liveable Cities programme is therefore exploring what radical changes might be required to urban systems in order to deliver on these targets.

A variety of research themes are helping to provide evidence for how radical change might be achieved. Central to this subject is the topic of domestic energy provision and user behaviour, and part of the Liveable Cities research team is working to test assumptions about retrofitted energy efficiency measures and to assess a city's capacity to implement large-scale renewable energy solutions such as solar PV roof panels. In addition, the programme includes several research strands related to shifts in policy, governance and finance that would be needed to support a variety of radical changes. A series of cross-disciplinary research questions are being explored in order to identify specific radical changes and to make explicit the detail of what would be required to enable them. These include the role that a sharing economy could play in delivering a future Liveable City, a thought experiment on the implications of a car-free city, how a city could be reorganised to maximise the consumption of ecosystem services, how cities could be re-zoned for liveability and how flows into, within and out of cities could be redesigned to decrease carbon emissions and increase resource security without compromising citizen wellbeing.

The author would like to thank the broader Liveable Cities team for providing much of the content of this article, particularly Joanne Leach for her edits and suggestions. Funding for this project was provided by the EPSRC – Transforming the Engineering of Cities to Deliver Societal and Planetary Wellbeing, EP/J017698/1. ES

James Hale works as a researcher in urban ecology with Professor. Jon Sadler at the University of Birmingham. His work focuses on identifying relationships between urban form and biodiversity, and on the mechanisms that underpin these patterns. Recent work includes mapping outdoor artificial lighting and quantifying its impact on bat movement.

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▲ **Figure 1. Green space in cities is becoming increasingly important for city populations, but it is also under increasing pressure. (© Shutterstock - Arup)**

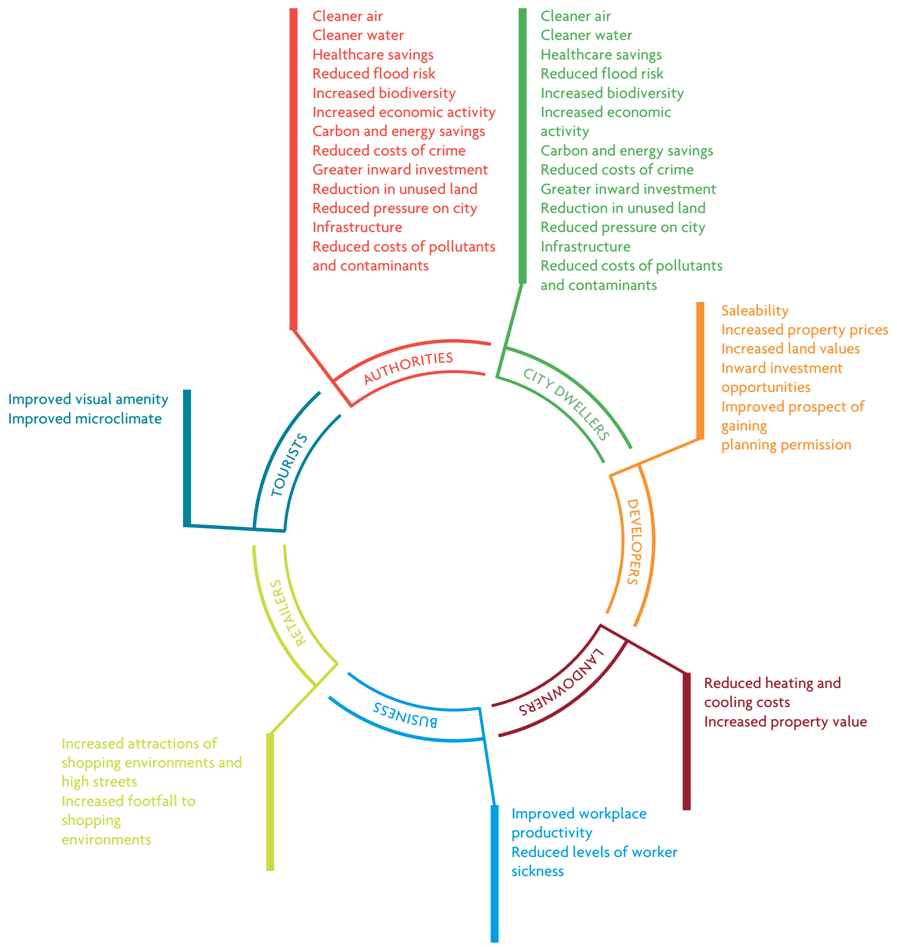
Cities alive – rethinking the cities of the future

Tom Armour asks whether nature can help restore harmony in our cities?

Cities Alive[1] is a report by Arup that looks at how we can redefine the role of the natural environment to improve urban environments for the people who live there and help to build in climate-change resilience. It draws on global research and scientific evidence that demonstrates that our urban green (and blue) infrastructure – the system of city parks, open spaces, city trees, urban woodland and waterways – perform essential ecosystem services and provide other fundamental benefits within city environments.

THE ROLE OF GREEN INFRASTRUCTURE

Ecosystem services can be defined as the processes by which the environment produces resources used by humans such as clean air, water, productive soils, food and materials[2]. Green infrastructure is defined by researchers and practitioners in different ways – Naumann *et al.*, for example, define green infrastructure as "natural or semi-natural networks of green (soil covered or vegetated) and blue (water covered) spaces and corridors that maintain and enhance ecosystem services"[3]. Urban green infrastructure can play two major roles – the first is in contributing to the quality of life for urban citizens (see **Figure 1**):



▲ **Figure 2. The benefits of green infrastructure for city stakeholders. (©Arup)**

- Enhancing residential areas and influence economic value[4];
- Enhancing visitor destinations and boosting the visitor economy;
- Conserving landscapes and the natural environment and increasing access to nature;
- Providing sustainable travel connections and promoting cycling and walking;
- Encouraging healthy living by providing land for physical activity and areas for relaxation;
- Promoting sustainable food growing.

The second major role for green infrastructure is that it can provide climate change resilience (see **Box 1**). Urban green and water systems can perform a range of functions, including buffering from extreme weather conditions, water storage and purification, urban cooling, improving air and soil quality and improving biodiversity. This is backed by the UK National Ecosystem Assessment[5] that states that climate change adaptation services provided by green infrastructure can be substantial. These findings are confirmed by other key research sources[4,6].

Contemporary research demonstrating the positive benefits of green infrastructure in urban environments is gaining wider recognition (see **Figure 2**). However, there remains a widespread lack of awareness of how extensive and important these benefits are, as demonstrated by the frequent failure to plan, design and manage them appropriately[7].

GREEN INFRASTRUCTURE – PROJECT EXAMPLES

The following section sets out the advantages under five headings supported by a selection of case studies that demonstrate inspiring initiatives to promote green infrastructure through multi-functional design.

1. IMPROVED QUALITY OF LIFE

The first public parks were created to improve the quality of life for urban citizens. Green spaces in cities where people can go to interact socially, exercise and reduce stress levels and where children can play have been shown to significantly benefit physical and mental health. This also has knock on economic benefits by

▲ **Figure 3. Madrid Río – the Salón de Pinos is a key area designed as a linear green space and located almost entirely on top of the new motorway tunnel. Featuring over 8,000 pine trees, it has quickly become an integral part of the city, offering a rich and healthy environment for citizens and visitors. (© Jeroen Musch/West 8)**

BOX 1: CLIMATE CHANGE RESILIENCE

Climate resilience in urban areas can be defined as their capacity to become more able to absorb the physical, social and economic challenges arising from our changing climate. A consideration of resilience should include not just the major shocks, such as earthquakes, fires, floods etc. but also the stresses that weaken the fabric of a city or urban environments on a day-to-day or cyclical basis. By building resilience a city becomes more able to respond to adverse events and is better able to deliver basic functions - in both good times and bad - to all populations.

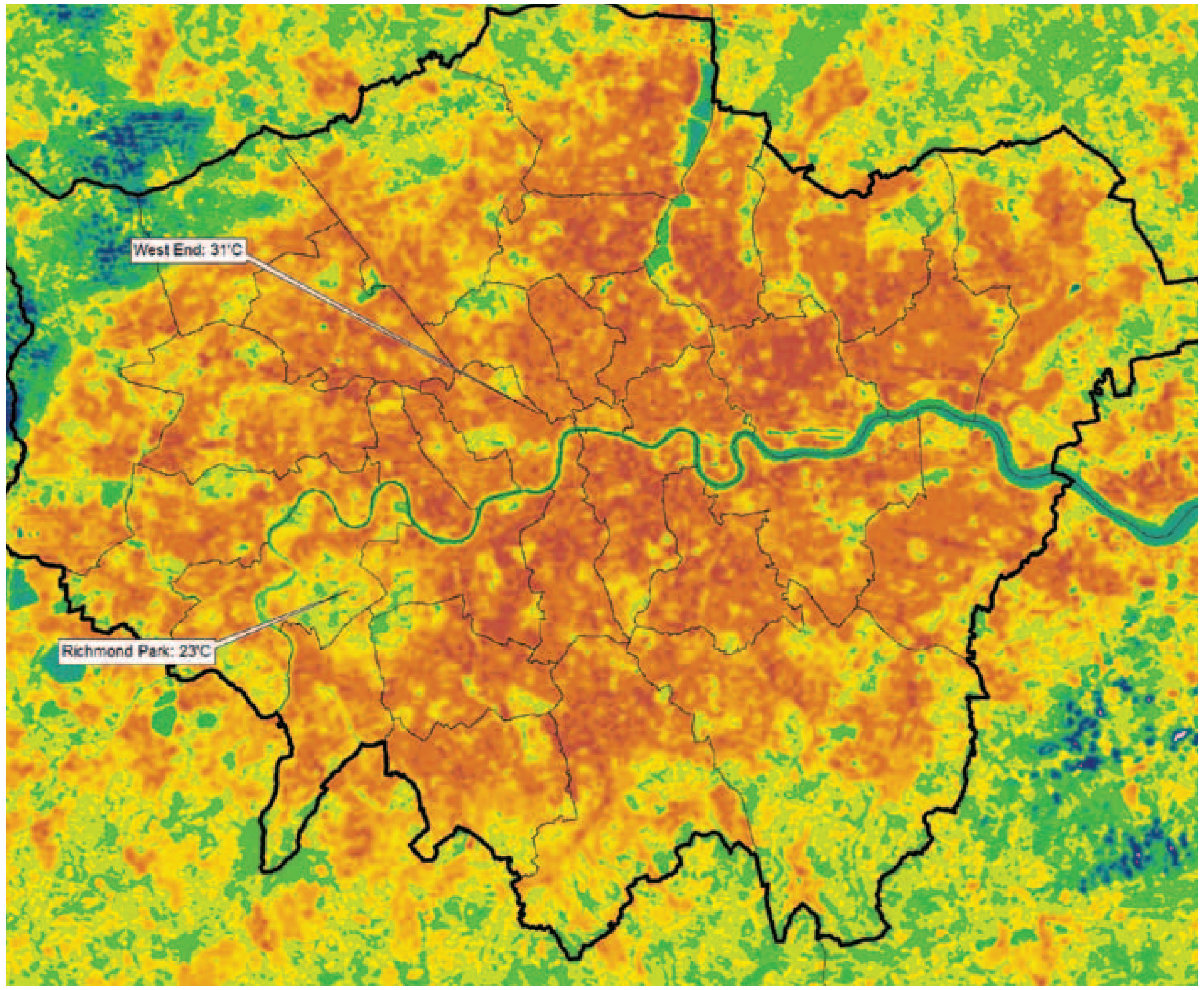
reducing health service costs[8] and can add to a city's appeal to attract businesses, workers and tourists, as well as boosting economic activity.

Space in denser urban environments with growing urban populations means that land for green space has to compete with development and 'grey' city infrastructure. The city of Madrid took a large-scale and bold approach to improving its city environment by digging 43 km of tunnels into which the exit routes and a 6 km section of the M-30 ring road motorway disappeared. They built a new green urban space over it, Madrid Río, which has become an integral part of the city, offering Madrilenians and visitors a rich and healthy parkland filled with a wide range of sports, leisure and cultural facilities (see **Figure 3**).

2. FLOOD RESILIENCE

In terms of retrofitting flood resilience, the Copenhagen Cloudburst Management Plan presents a superb example of positive adaption against future extreme rainfall events that uses the green areas within the city – parks, sports grounds and open spaces – to store storm water. These buffer areas slowly release water into the city drainage system. It is also worth noting that green infrastructure solutions are often cheaper than traditional solutions. As an example, the Cloudburst initiatives are costing DKK 3.8 billion, compared to the cost of a single flood

FEATURE



▲ **Figure 4a. Visualisation of land surface temperature across Greater London on a summer's day based on satellite data. Note that the West End with little green space is 8 °C hotter than Richmond Park. (© Arup/ UK Space Agency)**

▲ **Figure 4b. Comparing this vegetation map of London with Figure 4a, it can be seen that there is a direct correlation between cooler areas and vegetation. This suggests that better planned and more comprehensive urban greening along streets, in spaces, on roofs, façades and walls within the central areas of cities would have huge potential to cool and reduce the urban heat island effect. (© Greater London Authority)**

event in 2011 that caused damage in the city to the tune of DKK 5–6 billion[9].

3. REDUCING HEAT

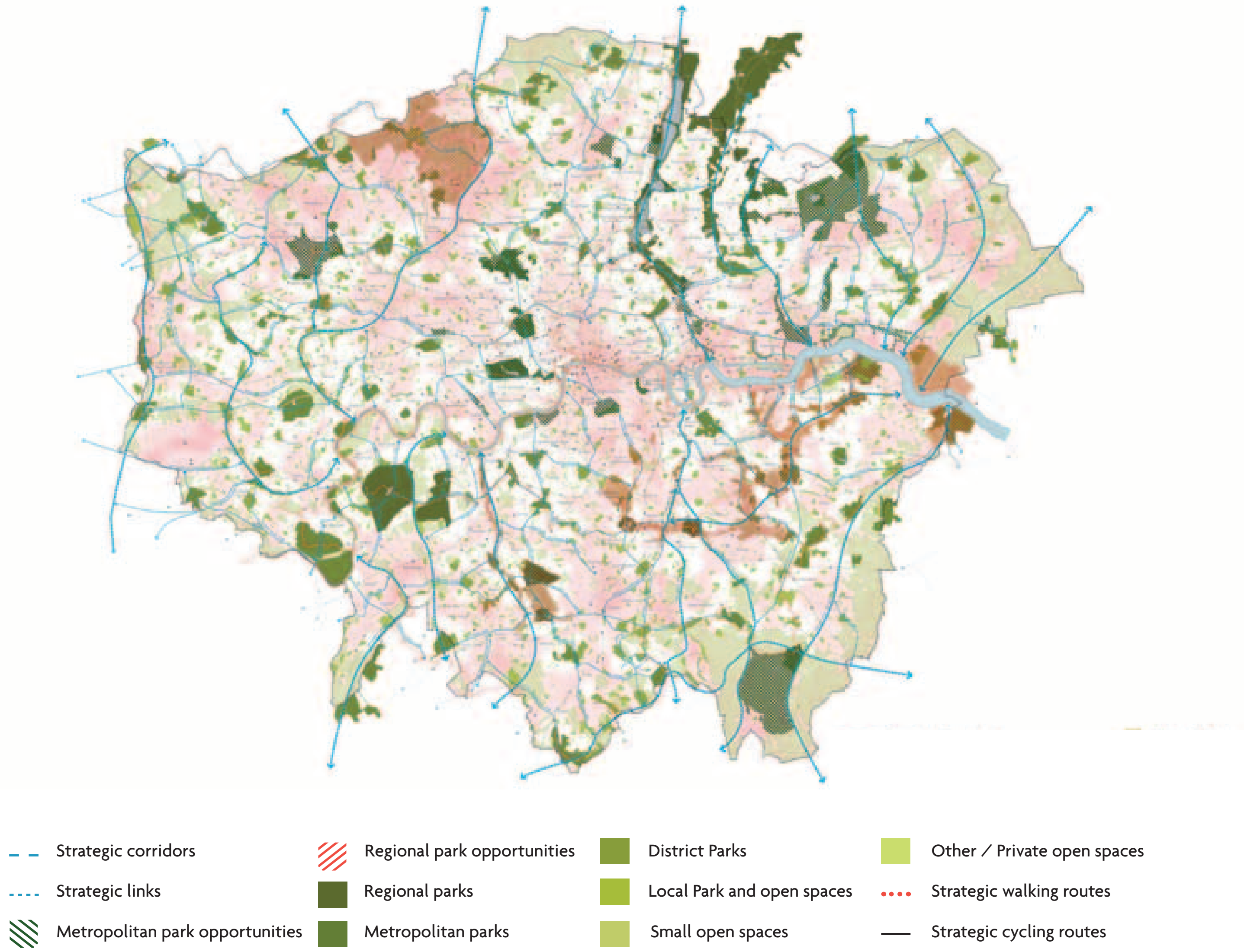
Urban centres are hotter than their surroundings through a phenomenon called the 'urban heat island effect'. All types of urban green, along with water surfaces, cool the environment through evaporation (see **Figures 4a and 4b**). Trees (especially those with large canopy spread) have the added effect of cooling by creating effective shade[10].

In response to the heatwave of 2003 the Greater London Authority developed the All London Green Grid (ALGG) (**Figure 5**). It supports London Plan policies on urban greening by encouraging the establishment of a multifunctional network of high-quality open spaces connecting town centres, public transport hubs, major employment and residential areas with parks and open spaces.

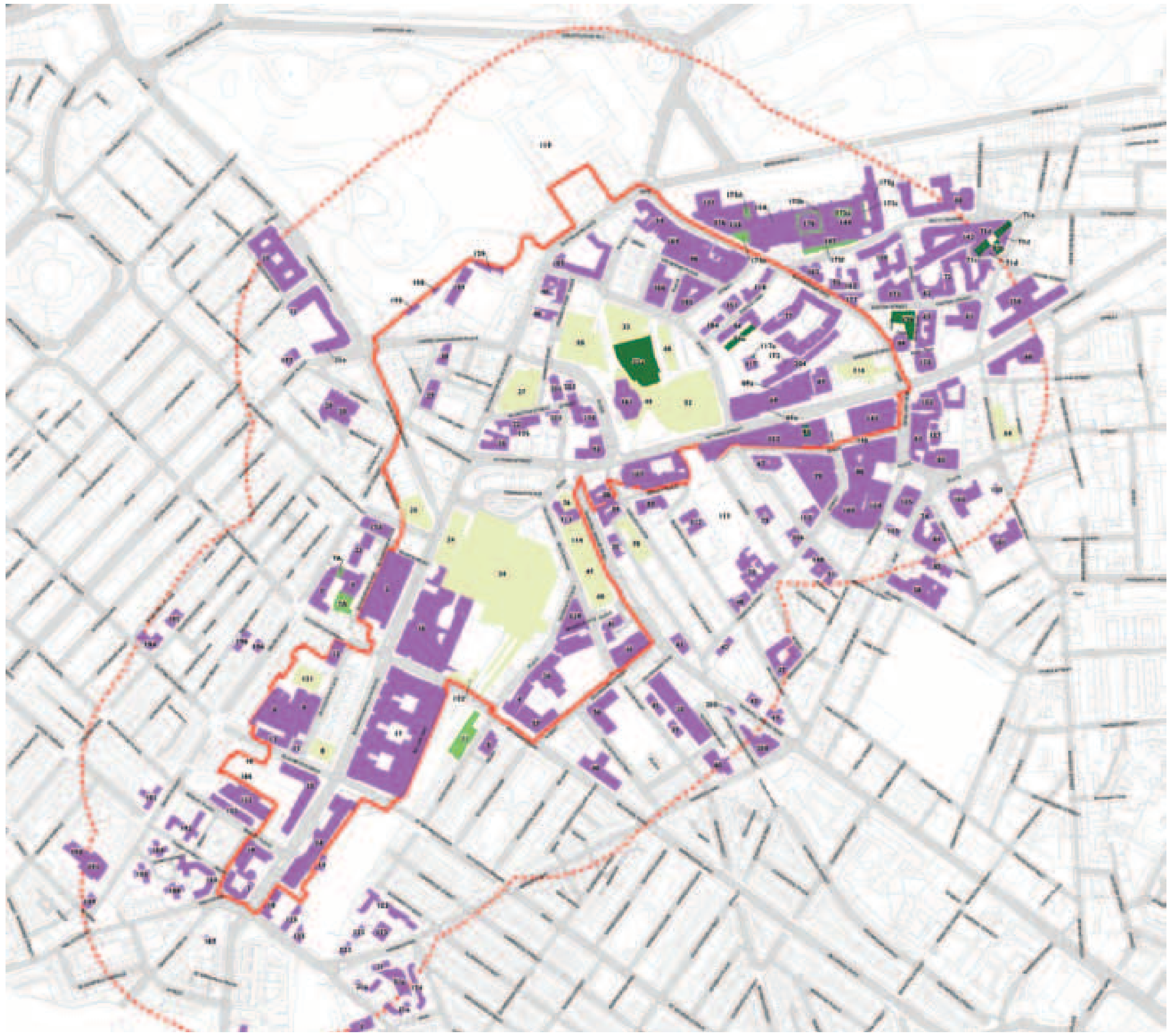
4. IMPROVED AIR QUALITY

Whilst green areas cannot compensate for all air pollution created by human activity, green infrastructure can capture carbon dioxide, sulphur dioxide and microscopic pollutants known as particulate matter (PM_{10}s), high levels of which have been shown to cause respiratory illnesses, to deliver air quality improvement in urban areas.

In 2010 the Victoria BID[12] undertook a green infrastructure audit to identify new locations for green space in a part of London largely characterised by hard surfaces (see **Figure 6**). As a result the Rubens at the Palace Hotel



▲ **Figure 5. The All London Green Grid. This strategic planning of green infrastructure at policy level is important in that it provides an overall vision for green infrastructure whilst supporting policies for delivery by boroughs, developers and communities to promote sustainable travel, flood management, healthy living and the economic and social uplift that these support[11]. (© Greater London Authority)**



Key

Victoria BID zone (Core area) 200m buffer around Victoria BID

▲ **Figure 6. Victoria BID: analysis of potential for 25 hectares of green roofs (roofs with potential shown in purple) – an ambitious green infrastructure proposal. Natural England reports that this could amount to around £12,000 in averted CO_2 emissions, £17,500 in energy savings per year and a 5 °C decrease in peak surface temperatures during summer months[13,14]. (© Victoria BID/ Land Use Consultants/ Green Roof Consultancy)**

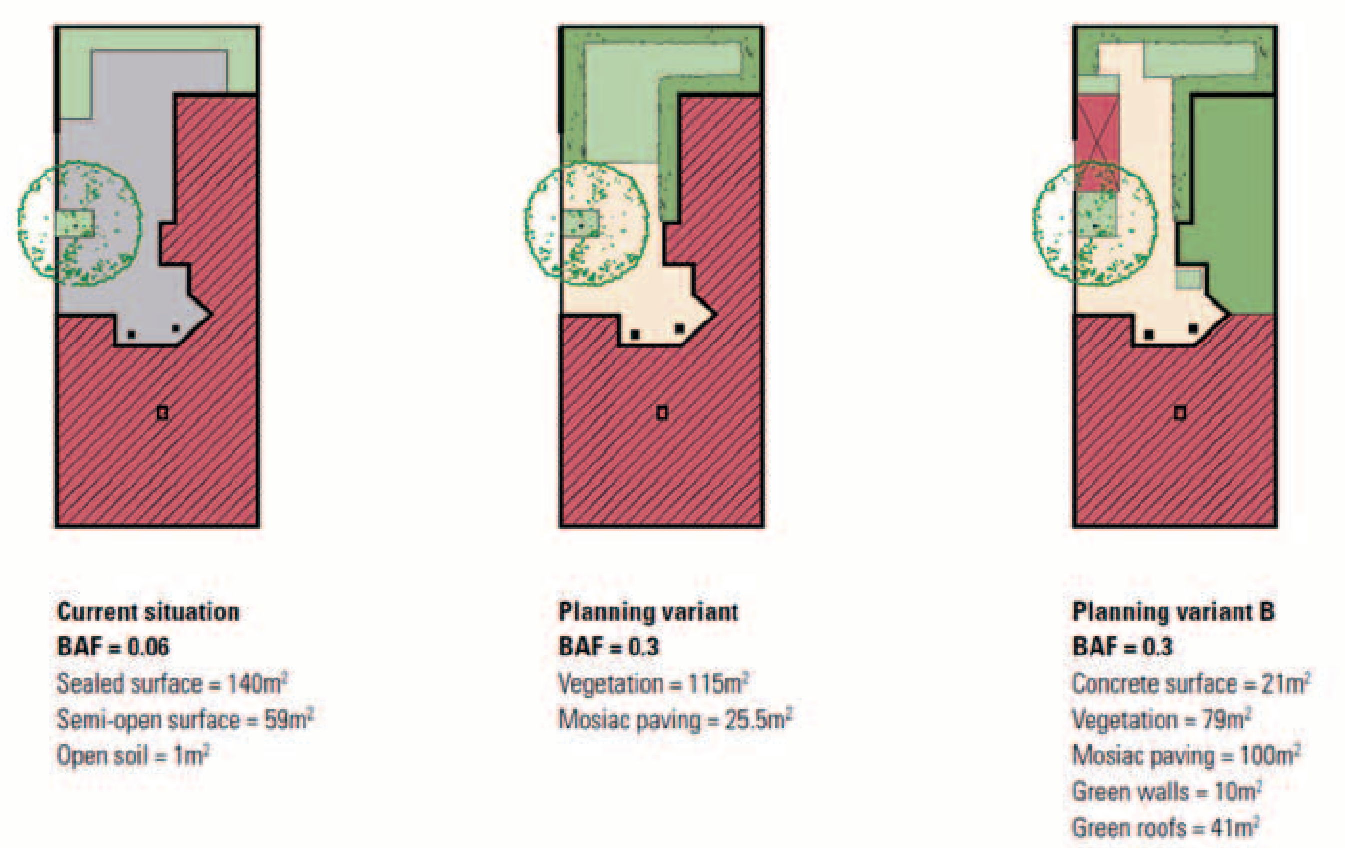
commissioned a green wall (**Figure 7**). At 350 m² and over 21 m high, this is London's largest green wall. It will be effective in trapping PM_{10}s, and will help deaden noise and keep the hotel cooler in the summer and warmer in the winter.

5. IMPROVED BIODIVERSITY

Cities provide habitats for many types of flora and fauna. The viability and health of ecological systems can be greatly enhanced through a green infrastructure approach, by better linking and optimising the city's many surfaces – using roofs, walls and façades.

Following the reunification of Germany and in response to the severe shortage of green space in the east of Berlin, the city developed the Biotope Area Factor (BAF; see **Figure 8**) which was formulated for inner-city districts to retain high development densities whilst also developing the city's green infrastructure[15]. Whilst the BAF has been introduced principally as a nature conservation measure, it also improves the quality of life for the city – its microclimate, air quality and resilience to climate change (see **Box 1**).

▲ **Figure 7. Improving air quality: London's largest green wall at the Rubens at the Palace Hotel. In addition to air quality benefits, water collected by tanks is channelled slowly through the wall, helping to reduce the risk of surface water flooding by storing up to 10,000 litres at any time. (©www.greenbiz.com)**



▲ **Figure 8. Berlin's Biotope Area Factor (BAF). The objective of the regulation is to achieve the BAF target values for different types of development using standard tables. The developer can choose different solutions to achieve the required BAF target, which allows creativity and flexibility. The ease of use of the system has made it popular with developers, architects and the public. (© Aleksandra Kazmierczak and Jeremy Carter/University of Manchester)**

CONCLUSION

Courageous environmental projects – like Madrid Río or the Olympic Park in London deliver at a scale that realise substantial city-wide environmental and social benefits. Other cities focus on providing multifunctional spaces, which can offer flood risk management along with recreation, amenity and habitat creation. Where urban space is under pressure, projects like the Promenade Plantée in Paris which in turn inspired the High Line in New York effectively reuse obsolete city infrastructure, in these cases disused railways, to create valuable new community space. In some cases success is down to enlightened individuals, city mayors or city officials. In others it is driven by large-scale political or natural events – the unification of Germany encouraged Berlin to regulate the Biotope Area Factor to address climate change and loss of biodiversity; a series of heatwaves encouraged the Greater London Council to adopt the All London Green Grid.

There appears to be no consistent global approach or uptake in the delivery of green infrastructure. However, approaches to implementing new green infrastructure should always use the resources, delivery mechanisms and policy context available. Moving forward, we should not expect that investment will be aimed at green infrastructure in its own right, but that it will have to compete with and should be integrated with other priorities.

Space in our cities is at an increasing premium, but planning for green can no longer be an afterthought; it needs to be a fundamental aspect in the city planning and design.

It is suggested that there are three areas of focus for researchers, policy-makers, planners and designers to help achieve this objective. The main focus is to engender a general understanding of the potential of green infrastructure, and bring it into a more influential role, whilst understanding how it can be integrated with other urban systems like energy, transport and resource management.

1. All stakeholders need to understand that urban green is far more than an aesthetic consideration, given the array of benefits it can deliver.

2. Design creativity is needed to deliver a green city ecosystem at all scales – from city-wide strategic infrastructure and regeneration projects through to smaller interventions that optimise the use of the city's many surfaces (including roofs, walls and façades).

3. By capitalising on advances in technology it is possible to measure the value that the natural environment delivers through ecosystems services. Through this we can better justify green infrastructure design and optimise the planning and design of urban space to meet future demands.

Cities Alive *is a study by Arup, an independent firm of designers, planners, engineers, consultants and technical specialists offering a broad range of professional services.* **ES**

Tom Armour is a landscape architect and Director at Arup, and leads the firm's award-winning Arup landscape architectural practice which he founded in 1990. He works with clients around the world to deliver landscape design from concept to implementation. He has worked on a wide variety of development projects at all scales, including the Queen Elizabeth Olympic Park, the Garden Bridge and High Speed 1. Tom has been instrumental in promoting the importance of green infrastructure in urban environments through research and publications.

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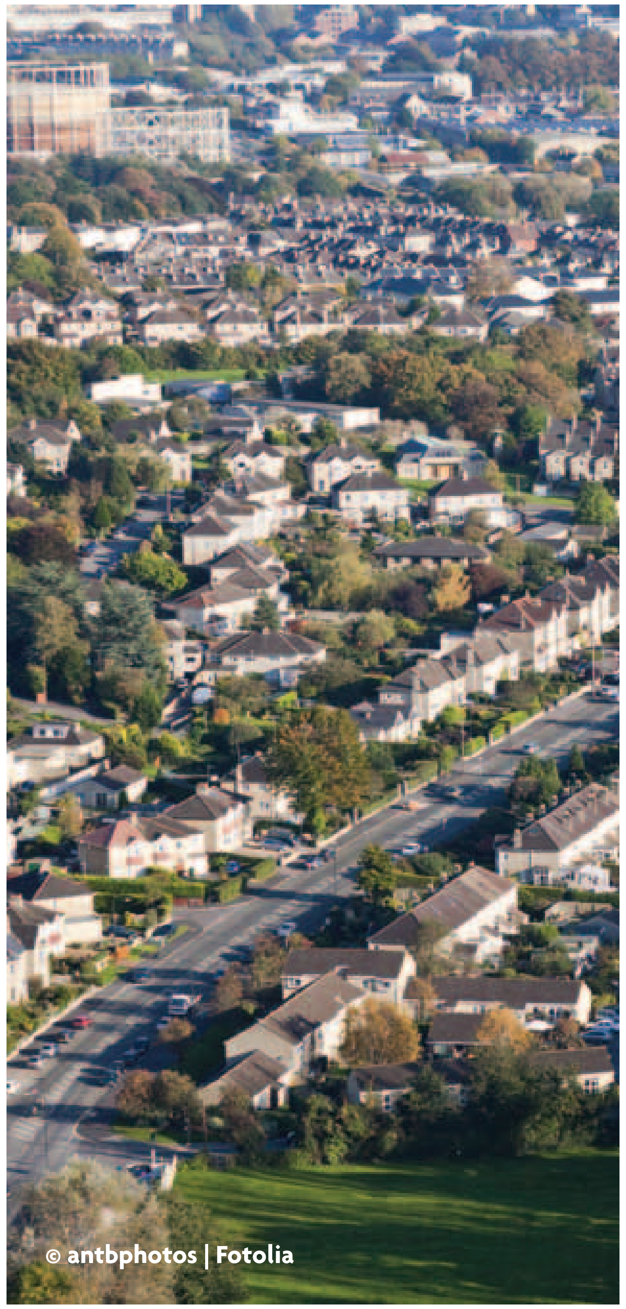
Eco-urban systems in the UK: what lies ahead?

Joe Ravetz explores different futures for UK urban ecosystems services.



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I regularly find myself in the middle of heated debates on ecosystems services. Many are strongly for the idea, arguing it's the only way to get natural assets balanced with human demands. Others are strongly against, on the basis that it dumbs down both the ecosystems and the human systems: producing some kind of fictional shopping list, where in theory the entire planet is worth only '$33 trillion per year'[1].

Servicization – turning complex relationships into simple exchanges – could be useful as a simple cross-section of a more complex reality. My concern is that urban systems (at least in the UK) are apparently at least as complex, and as powerful as ecosystems. So to make real progress we need ways to understand the inter-connections in a combined urban-eco-systems services model.

This article draws on the *Future of Urban Ecosystems Services and Environment in the UK* report, prepared for the Foresight Future of Cities programme[2]. This Foresight programme looks ahead 25 and 50 years, and is linked to a network of 22 cities with various kinds of futures activities. One example is *Greater Manchester 2040*, a demonstration of the aspirational approach to Foresight. This article tests the notion of urban ecosystems services by looking ahead and exploring ways in which the future might be different to a continuation of the present. Starting with baseline mapping, we look at future scenarios, and possible opportunities, which point to action pathways which are future-proofed. Ultimately we raise a question: if ecosystems and urban systems are each complex, should we follow the servicization approach, or is there an alternative?

WHAT IS AN URBAN ECOSYSTEM SERVICE?

The first issue here is: what is urban? The simple understanding of urban as the physical built-up area covers only part of a wider 'gravity field' of economic and social activities associated with towns and cities.

The UK overall has 80 per cent of its population on 9 per cent of its land area[3], but much of the rural hinterland is predominantly urban in social and economic structure (even in rural areas only 3 per cent of the population work in farming). The study of urban-related ecosystems services confirms the interdependency of built areas with their fringes, catchments, peri-urban and rural hinterlands. But such categories may be changing rapidly. For instance the European project PLUREL defined the peri-urban as areas with a density threshold of over 35 people per hectare, on which basis most of England and large parts of western and central Europe, are effectively peri-urban areas of low- to medium-density urbanisation[4,5]. The implication is that to understand urban ecosystems services we need to look beyond the built-up boundary to a wider view of urban activity systems and their hinterlands.

The second issue is: what is an urban ecosystem, and what are its services?[6] According to Defra, "Ecosystem services can be defined as services provided by the natural environment that benefit people"[7]. We can look at the interface of ecosystems with other domains and policy agendas, as in **Figure 1**: extending from typical foresight studies, this shows a multi-layered landscape, with social, technical, economic, environmental, policy, cultural and urban components 'Special Report Emissions (SRES)'. Each of the circles overlaps or interconnects, with possible tensions or conflicts, but also with potential for synergy and added value.

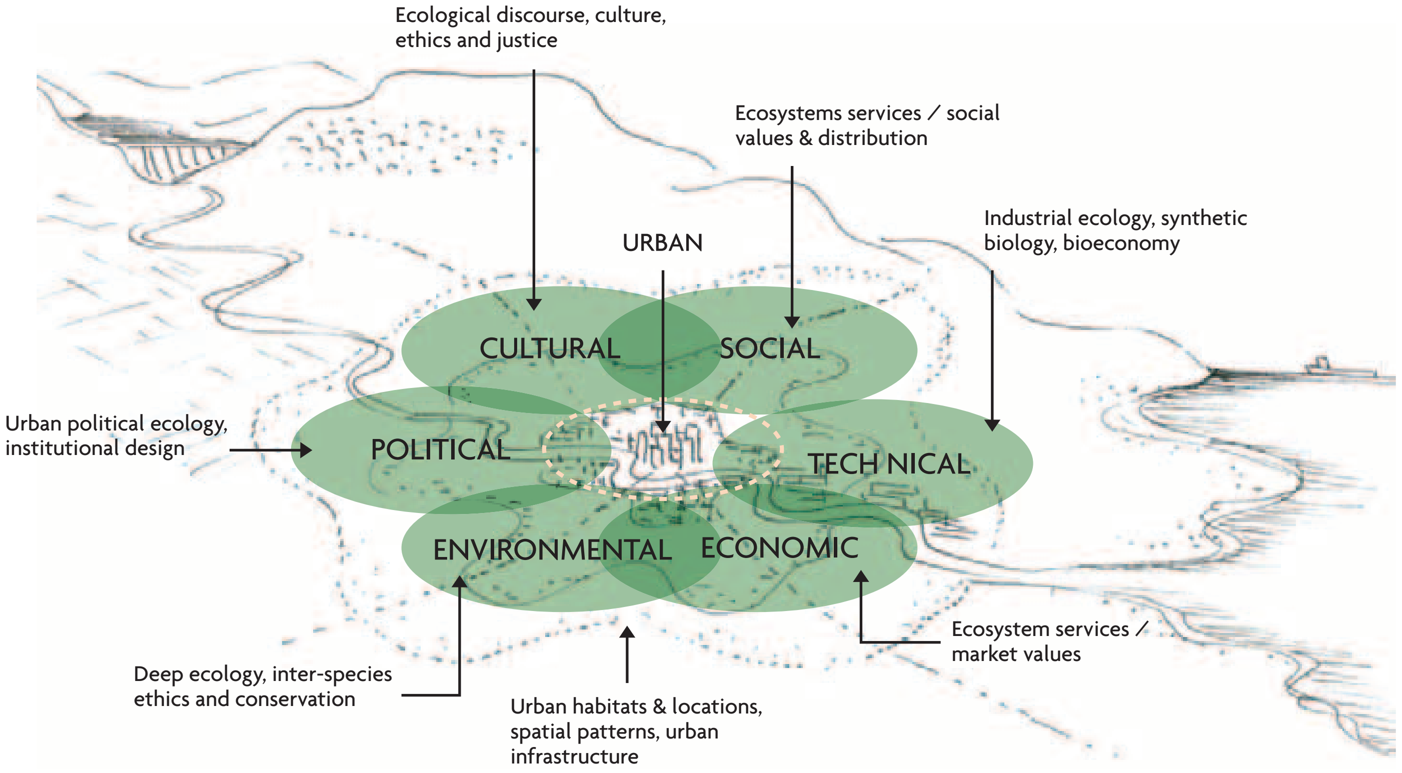
Putting these together we can see urban ecosystems services interactions in four broad domains (see **Figure 2**):

- Ecosystems services **within** the city;
- Spatial ecosystems services patterns **around** the wider city–region;
- Ecosystems services and physical flows **through** the city, such as food, water, energy and materials; and
- Ecology-related human systems **for** the city, including wider applications in industrial ecology, political ecology, eco-design and others.

STATE OF THE ART: A BASELINE MAPPING

This is a very brief summary of a wide range of studies, 'drawing largely on the urban chapter of the of the UK National Ecosystems Assessment[3].

Most ecosystems **within** the typical UK city have improved over the last 50 years – including habitats and



▲ **Figure 1. Urban ecosystems domains, or human perspectives, shown as overlapping fields. (© Joe Ravetz)**

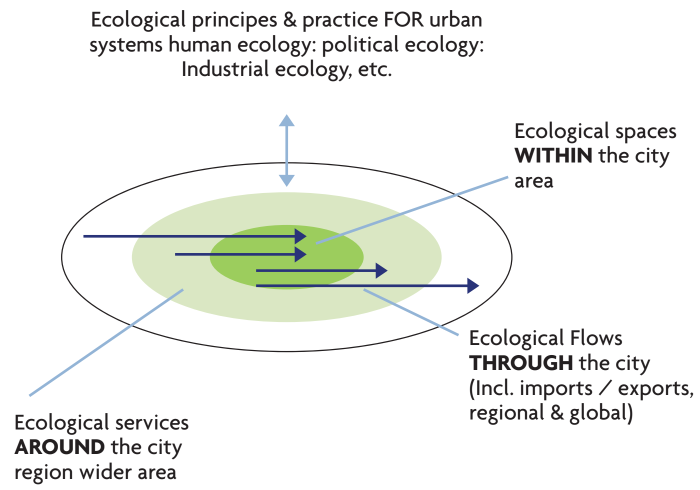
micro-climates, greenspace and green infrastructure, air quality, water quality and land contamination. However, there are continuing risks generated by urban development and infrastructure, increased urban densities, exotic and invasive species, soil degradation, and climate-related flood, storm, heat and drought. Air pollution and waste generation each continue at levels that are deemed unacceptable. There are economic risks in the lack of public funding for investment and maintenance, and political risks in reduced public access to privatised space.

Around the city, i.e. in the various spatial layers between city centres and the rural areas around them, there are recent improvements with access to rights of way, country parks etc. There are also increasing risks from climate change-related flood, heat, storm, drought and sea-level rise. Green belts are seen as the primary defence against urban development and speculation on land values, but are under pressure from housing and commercial development. Intensive agriculture in some areas also undermines the 'green' qualities of the belt. Meanwhile large areas of hinterland are now effectively urbanising in social and economic functions, and it is arguable how far these should be included in the picture.

For ecological flows **through** the city, i.e. energy and material resources, the picture is mixed. Improvements in the efficiency of buildings, transport and industry are often outweighed by growing demand for energy, water, construction materials, and the general flow of globalised consumer goods. While most of these provisioning services are external to urban areas, responses such as local recycling, food cultivation or energy efficiency can be very localised. In practice many cities have low-carbon or climate-proof strategies, but lack the resources, know-how and political powers to achieve them. For many organisations and citizens, their low-carbon aspirations seem to conflict with high-carbon activities such as travel and shopping.

Regarding **ecosystems for the city**, the UK is on a learning curve. Integrated systems for industrial ecology are making progress with schemes such as the National Industrial Symbiosis Programme, but these are still in the minority. Eco-design and eco-investment are slowly gaining ground. Political ecology and social ecology principles are often not well formed, but show up in *ad-hoc* protest movements such as the opposition to hydraulic rock fracturing.

The context here is the national-level 'system of cities', in both the spatial arrangement of settlements and the underlying socio-economic interactions. The first issue is the dominance of London and the greater southeast: continuing urbanisation right across southern England



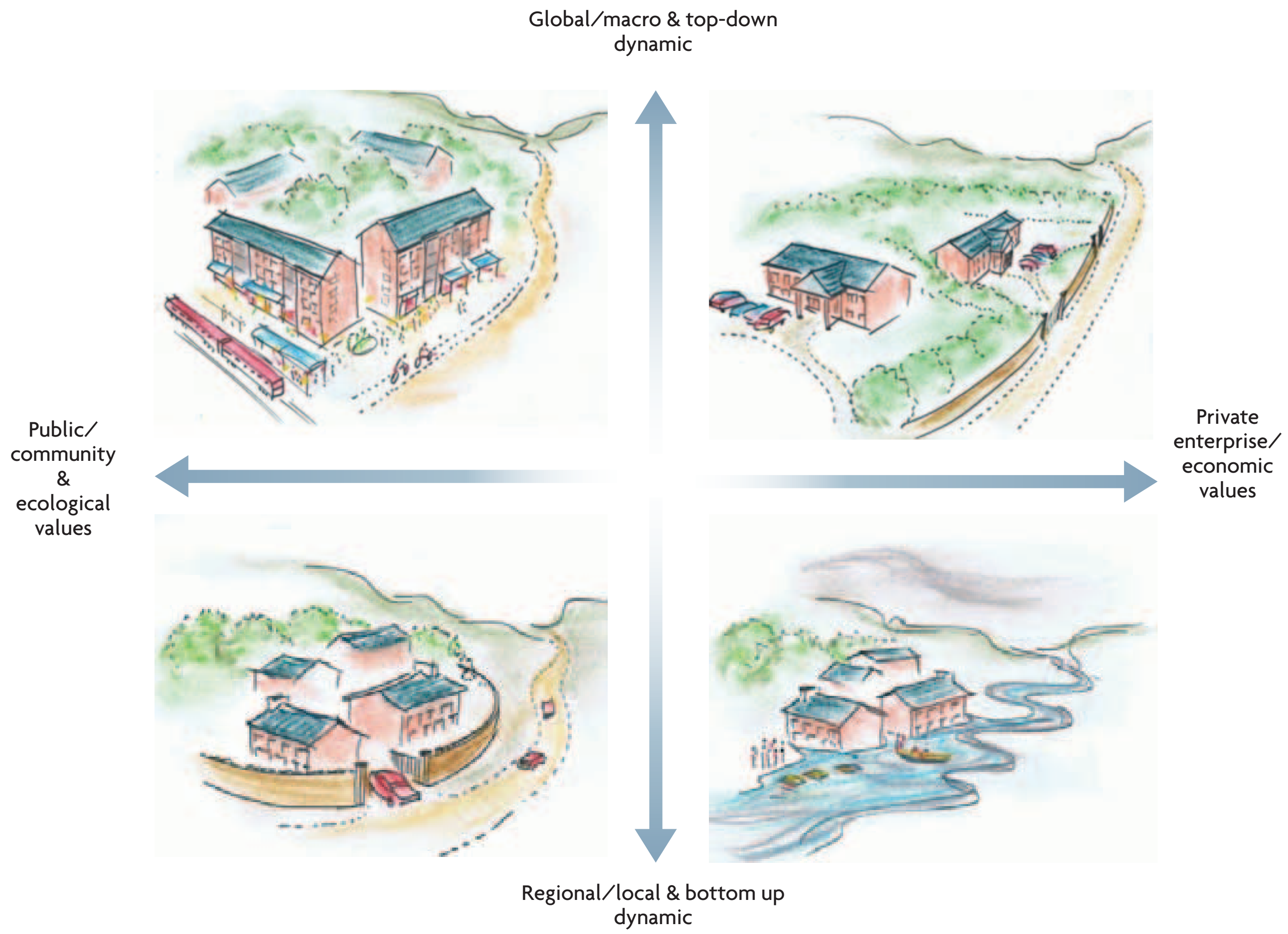
▲ **Figure 2. The links between urban systems and ecosystems. This diagram shows a simplified 'urban systems', with four different kinds of interaction with ecosystems. (Source: Joe Ravetz)**

would have major effects on urban ecosystems. Urban growth areas would see intensification (building on all available land), densification (increasing residential or activity densities), gentrification and over-development, with landscape frangmentation and degradation likely to result in further habitat loss and more extended supply chains for energy, water, waste, biomass and minerals. In contrast, areas of urban decline could see increases in derelict and vacant land, which raises social and economic problems but also provides opportunities for ecosystems and biodiversity.

FUTURE SCENARIOS: CHANGE MAPPING

There are many alternative possibilities, for both 25- and 50-year horizons: here summed up in a set of urban ecosystems scenarios (adapted from the IPCC global 'Special Report Emissions Scenarios; SRES[8]). Note there is no central forecast or business as usual (BAU) scenario: the four alternatives shown here are simple caricatures, and reality would of course be more complex. Each scenario can be illustrated with a different urban model from around the world (see **Figure 3**):

- **Technology urbanist scenario – Singapore model:** smart, climate-controlled, sealed buildings are the norm, as environmental hazards and social divisions increase. Food, water and energy come through hi-tech centralised systems. Urban greenspace that is not developed is generally privatised and intensively managed.
- **Technology hinterland scenario – Los Angeles model:** car-based urban sprawl; many local ecosystems are destroyed or degraded, or turned



▲ Figure 3. Alternative futures for urban eco-system. Four different directions for urban and ecological development are shown: The scenario axes are based on the SRES scenarios of IPCC, 2000[8]. (© Joe Ravetz)

into private leisure, golf courses and high-value tourism. Food, energy and water are imported over large distances by privatised utilities according to the global market logic.

- **Ecological urbanist scenario – Freiburg model:** this can be low-tech or hi-tech/smart, and is the classic sustainable urban model with dense, mixed-use urban neighbourhoods. Greenspace is used and managed intensively to increase resilience to climate and other environmental hazards. Urban ecosystems are designed around quality-of-life factors.

- **Ecological hinterland scenario – Greater Stockholm model:** many households relocate to peri-urban and rural areas to be in closer contact with nature and to produce local food, energy and natural materials. Local economies are revitalised and better connected with local ecosystems, with alternative forms of ownership and management.

CHALLENGES AND TRANSITIONS: SYNERGY MAPPING

This stage is more exploratory of critical perspectives and bigger pictures. First we look for ecosystems-services-related socio-economic challenges, such as demographic change, the changing nature of work and new patterns of physical and mental health. There are political and cultural challenges, such as the privatisation of space, distrust in governance, and conflicts on environmental justice. Turning such challenges into opportunities is where 'discourses' come in: combined bundles of vision, aspiration, values, evidence, synergies and opportunities. The overarching discourse for urban ecosystems is 'sustainability', but this can be interpreted in many ways. Here are some of the most topical discourses:

- Resilient city: urban ecosystems services will aim at capacity to withstand or adapt to physical pressures;

- Liveable city: urban ecosystems services will aim towards social and cultural benefits;

- Eco smart city: urban ecosystems services can be enabled by digital technology;

- Transition towns: urban ecosystems services can enable movement towards low or zero-carbon performance;
- Circular economy: urban ecosystems services will be geared to material recirculation and zero waste; and

- Sustainable community or neighbourhood: urban ecosystems services will aim to meet the needs of both the present and the future, locally. How far in practice, is a matter for great debate.

Each of these discourses can then be tested, not only against current environmental policies, but against wider trends and problems. At the top of this list could be the widening gap between rich and poor, and the projected increase in child poverty[9]. As projected by 2020, nearly one in four of children will be in both relative and absolute poverty, and so their participation in the above discourses or as users of urban ecosystem services, is likely to be much impaired. The wider effect fragmentation of social structures can only be guessed, but there are implications for the pathways below.

RESPONSES: PATHWAY MAPPING

From these challenges, transitions, opportunities and discourses future-proofed action pathways (also called success scenarios) begin to emerge[8]. Again these can be tracked to each of the four ecosystems services domains. For ecosystems services **within** the city, there are opportunities in community greenspace, food cultivation, and benefits in health, education and local enterprise. Creative adaptation to climate change is a whole new agenda for the interactions of humans and ecosystems. The principal threat may be the privatisation and enclosure of public and ecosystems services space. The response might be in new social models for access, stewardship and crowd-sourced investment for such spaces.

For ecosystems services **around** the city, there are opportunities in wider patterns of green infrastructure, local food supply chains, and climate change adaptation to flood, heat and drought. New settlement forms may see new kinds of interaction between people and ecosystems, as in eco-belts, forest gardens, water parks, outdoor schools, community orchards, co-eco-housing and 'incredible edible' type food schemes. The main threats to ecosystems services may be direct pressure for development (see **Figure 4**), or related problems caused by policy restrictions.

For ecosystems services **through** the city, there are growing policy pressures to move towards the low-carbon, zero-waste type of city system. Achieving these physical goals is technically feasible for the most part, but is likely to involve similar

▲ Figure 4. Allotments in Edinburgh. Ecosystem services may be under threat by the privatisation or development of such spaces. (© JoannaTkaczuk | Fotolia)

changes in economic, social and political systems. The current direction is towards smart, digitally enabled cities, though this may bring its own risks and unintended consequences.

In ecosystems services for the city, there are many opportunities in industrial, social and political ecological thinking. Industrial ecology aims towards a circular economy or bio-economy: for instance integrated systems of algal biomass, materials recycling, ecological habitat and microclimate management. There are opportunities in social ecology: urban food growing, for instance can promote education and health, community cohesion, social enterprise and resilience. For urban political ecology, ecosystems services can enhance social empowerment, inclusion and public participation.

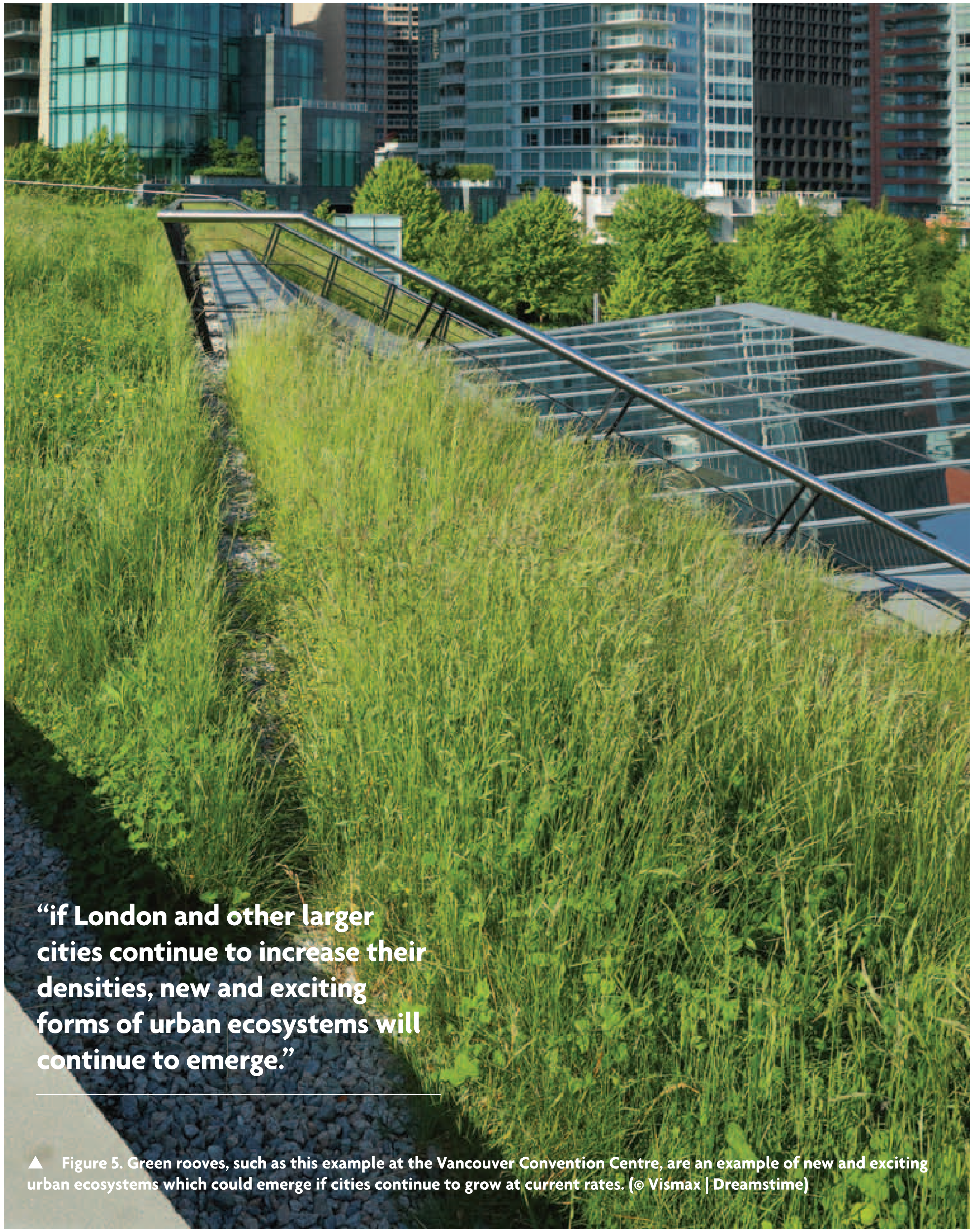
For the UK system of cities, if London and other larger cities continue to increase their densities, new and exciting forms of urban ecosystems might continue to emerge. Some possibilities include green roofs (see **Figure 5**) and living walls, elevated walkways and cycleways, vertical gardening and aquaponics, semi-enclosed microclimates in public spaces and atriums, biomimicry on urban rivers and waterfronts and creative landscapes for climate adaptation[10]. In many urban forms there is potential for ordinary dwellings to host diverse ecological habitats, with integrated breathing walls, passivhaus-type dwellings with solar conservatories, rare species nests, with eco-design embedded in the low-carbon re-engineering of the building stock.

Schools could be designed around greenspace and ecological habitats, and subject curricula should enable outdoor activity in school gardens, walking tours and so on. Leisure activities and meeting points for children and youth can be in outdoor or semi-outdoor spaces, with facilities for cycling, woodland activities, self-help shelters or creative arts. The 'incredible edible'[11] principles of urban cultivation as a community development involving all social groups, is a powerful statement of the potential[12].

CONCLUSIONS AND THE NEXT CHALLENGE

This article highlights some topical issues for the future of urban ecosystems services in the UK. In terms of global urbanisation, with 300,000 new city dwellers per day, the UK is changing relatively slowly, although with many local pressures of growth or decline. So we could anticipate more change on the human side than on the physical urban environment; current social, economic, technology and political trends all raise problems and opportunities.

This comes back to the question raised at the start: is it possible to understand and assess the complexity of urban ecosystems services, so that scarce resources can be used more wisely? My article , 'The complexity of ecosystems services', also in this issue, explores this question and proposes a method and toolkit. ES



"if London and other larger cities continue to increase their densities, new and exciting forms of urban ecosystems will continue to emerge."

▲ **Figure 5.** Green rooves, such as this example at the Vancouver Convention Centre, are an example of new and exciting urban ecosystems which could emerge if cities continue to grow at current rates. (© Vismax | Dreamstime)

ANALYSIS

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ANALYSIS

How to work with joined up eco-urban-systems

Joe Ravetz outlines a synergistic way of working with complex systems.

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The previous article in this issue looked at the future of urban ecosystem services's, drawing on the Government Office of Science Foresight study[1]. The backdrop is the Ecosystems Approach, a general way of looking at the interconnected whole rather than the sum of parts[2]. The article ended with a question: if the reality of urban systems and ecosystems is complex and interconnected, how can we understand and work with them?

So here we set out a new method, known as the synergistic approach. This works well with urban ecosystems services; these are often the kinds of systems that are complex, cognitive and coevolutionary ('3C'), shaped not only by biological forces, but, also human factors such as collaboration and social learning. When it is used for assessment, valuation or evaluation, the synergistic approach does not replace existing methods, but it helps them with a more realistic joined-up view of problems and opportunities[3,4].

QUESTION: WHAT IS THIS PARK WORTH?

Work is in progress on ways to measure or assess urban ecosystems services. One example is now a UK best practice: the Mayesbrook Climate Change Park Project in London[5,6].

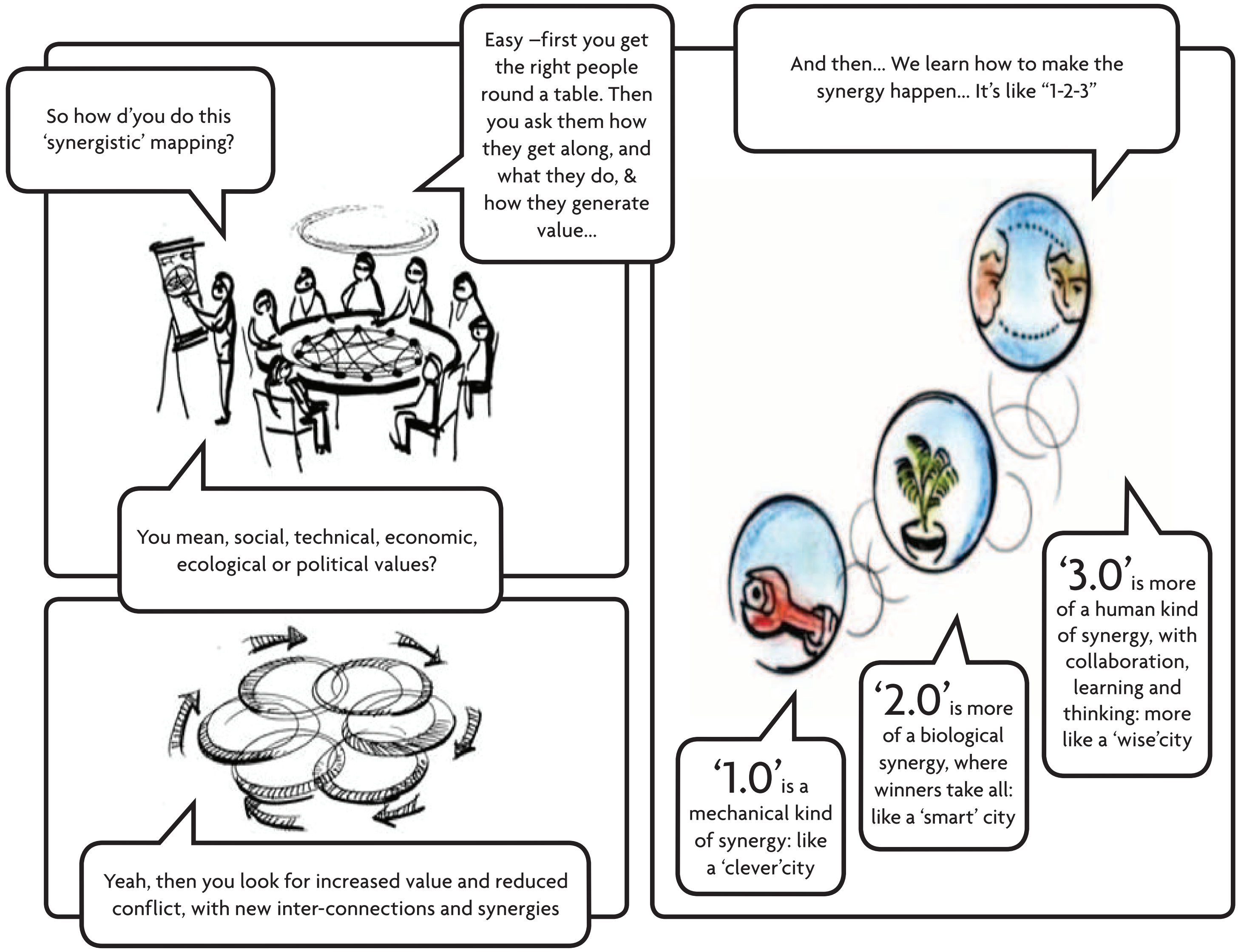
"This is the largest river restoration project in London and the flagship project for the London Rivers Action Plan. The 48 hectare park, one of the largest in east London, used to be mostly short mown grass and lacking amenities, and was used little by people. An Ecosystem Services Assessment quantified the benefits from the proposed work… showing benefits worth up to seven times the estimated £4 million cost."[5]

This ecosystems services valuation was one of the first of its kind in the UK. From the estimated urban-ESS benefits, 65 per cent of the total benefit is in recreation and tourism, and another 30 per cent is due to property value uplift in the surrounding area. It seems a bit problematic that the regulatory services of climate, flood, soil erosion, nutrients and habitats are less than five per cent of the total, and these come with large bands of uncertainty. A policy-maker might look at this summary list of values, and decide to replace the outdoor park with an indoor leisure centre or industrial food complex. It seems that Mayesbrook and many other cases would benefit from a more synergistic approach, which is more grounded, in both ecosystems and urban systems.

> **"the synergistic approach doesn't replace existing methods, but it helps them with a more realistic joined-up view of problems and opportunities"**

TOWARDS A SUITABLE METHOD

Urban ecosystems – even the humblest pocket park – have a physical aspect, but also a tangle of social, technological, economic, political and cultural issues. There are interconnections between global and local levels, or between the short term and the long term. And most importantly, much depends on the cognitive human factors, as to whether creative thinking, synergy and collaboration, social learning and intelligence can coevolve. It seems that the ecosystems approach aspire sto this holistic level of integration, but often lacks the tools and resources. All this suggests the possibility of new ways to work with highly interconnected problems with 3C complexity.



▲ **Figure 1. Synergistic mapping and the coevolutionary '1-2-3.0'. The basics of the synergistic mapping method are shown on the left, starting with a group of actors. On the right, the three main levels of coevolutionary change are shown. (© Joe Ravetz)**

So what can be done? A method has taken shape over the last decade – the Synergistic approach – so called as it is focused on the human factors of creative synergy[7]. As applied with synergistic mapping, the method begins with drawing the problem, with its main components and inter-connections, with as much detail as needed, starting from a flipchart (**Figure 1** left side). Then it works through a four-stage cycle of questions:

a) **Scoping / landscape mapping:** (questions – what is our problem: who / what is involved, how does the system work: what are the inter-connections?).

b) **Scenario / change mapping:** (questions – what are the drivers of change, trends, alternatives?).

c) **Synergy / idea mapping:** (questions – which are the most creative synergies and opportunities?).

d) **Strategy / pathway / road-mapping:** (questions – which direction to follow, and what to do next?).

Working through these questions, we can sum up different kinds of systems order and change with three main levels, so titled '1-2-3.0'. For each there is an image of a certain kind of city (**Figure 1,** right side):

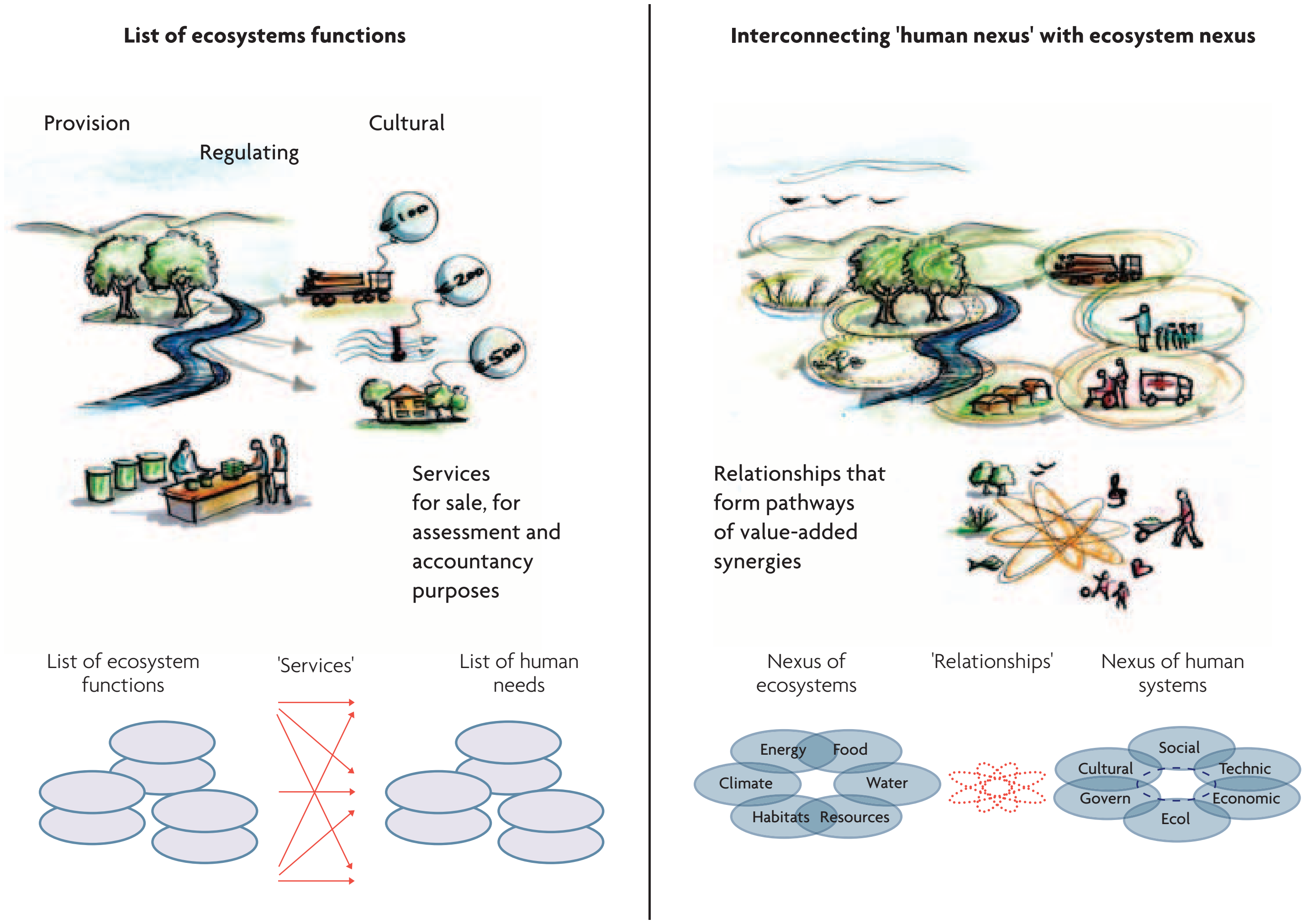
1) **1.0: linear change:** 'functional systems' that respond to direct short-term change: (i.e. an image of a large and complex *machine*). For instance, a car engine is complex and quite clever, but it changes only with speed, power, fuel mix and so on; it could not reproduce itself or evolve into a different kind of engine. A successful city in this model would be a *clever city*.

2) **2.0: evolutionary change in 'adaptive systems':** evolving with longer-term changes and transitions, but with an evolutionary model of 'winner-takes-all' (with an image of biological jungle). A successful city in this model would be a *smart city*.

3) **3.0: coevolutionary change in 'synergistic systems':** these are shaped by human qualities such as thinking, learning, questioning, strategy, self-awareness, intelligence (an image of a human situation). This is like a coevolutionary model of 'winners-are-all', via a learning process for synergy and social intelligence. A successful city in this model would be a *wise city*.

The third model – 3.0 synergistic change – helps to understand many kinds of human system, where there are both technical and cognitive dimensions, and where there is potential for creative synergy and social learning. For example:

- Urban 3.0: a self-organising, responsive city or region that provides livelihoods for all, takes responsibility for its ecological effects and builds a just and equitable society;
- Economy 3.0: systems of livelihood, production, finance and overall prosperity that include social and ecological values, respect global limits, and are creative, resilient, inclusive and self-organising; and
- Governance 3.0: structures for participative decision-making and collective resource management, with citizen empowerment via collaboration, based on social learning and intelligence.



▲ **Figure 2. Urban ecosystems services: from linear to coevolutionary. On the left is the current approach to ecosystems services, as lists of items for exchange. On the right are some ways to visualize relationships between a nexus of ecosystems and a nexus of human systems (© Joe Ravetz)**

TOWARDS URBAN ECOLOGICAL INTELLIGENCE

Here the focus is an urban ecology 3.0 model. Broadly this is about mobilising human learning and synergy to organise energy, food, resources and ecosystems, for lower impact and increased value, with enhanced resilience and capacity. Experience shows that understanding and working with urban ecosystems services is more than a 1.0 linear system of cause and effect, and more than a 2.0 competition and 'winner takes all'. The Ecosystems Approach calls for a more 3.0 synergistic model, but there are problems: often, a 3.0-type response does not fit well in a 1.0 or 2.0 type organisation, or policies facing 3.0-type problems can only offer 1.0- or 2.0-type responses.

IRWELL COUNTRY PARK

One example is the Irwell Country Park in a run-down area of North Manchester[8]. The ecosystems services it provides include amenity, health, flood alleviation, and local microclimate. In social terms it is a problem area of stolen cars, drug dealing and illegal waste tipping, needing costly remediation to recover negative economic values. There are conflicts between dog walkers, bird-watchers, cyclists, land managers, security, the youth and the elderly. An extended participation programme with local residents showed that creative social innovation has the potential to turn conflicts into collaboration, for schemes in local food, education, health, ecology, events, markets, cafes, or play schemes. The implication is that the urban ecosystems services and their socio-economic values are not fixed or objective at all – they are more like spaces of opportunity, that reflect the potential for creative collaboration, learning and innovation.

This case and many others raise questions on the application of urban ecosystems services. The concept provides a first take on human–ecosystem interactions, but it could also squeeze both sides into an over-simplistic frame. This is particularly topical for economic valuation of ecosystems: for example, the UK NEA seems to present monetary valuations without bands of uncertainty or confidence[5]. By contrast, the Ecosystems Approach raises the possibility of working with the complexity of human and natural systems: in this case, services are not so much one-way transactions, rather more like processes of social learning and coevolution. For instance, farmers learn how to work the land, and land use patterns are in coevolution with markets and technologies. Or, food chain managers learn how to match supply and demand, and the technologies are in coevolution with the markets, and so on[7]. The point is that value is created by complex socio-economic systems, and these are not generally given on a plate or in a formula, rather they can only emerge through social learning and a coevolution process.

"Urban ecosystems – even the humblest pocket park – have a physical aspect, but also a tangle of social, technological, economic, political and cultural issues."

▲ **Figure 3a. Urban ecosystems, adaptation and resilience: Linear-evolutionary (1-2.0) model. A typical approach to adaptation and resilience (reactive, short-term, silo thinking). (© Joe Ravetz)**

We can visualise the shift from a linear concept of urban ecosystems services, towards a more synergistic model (see **Figure 2**). On the left-hand side is a diagram based on the Millennium Ecosystems Assessment, with checklists of human and ecological systems[9]; the cartoon shows 'services for sale', where prices can be checked for assessment and accountancy purposes. On the right-hand side, a more interconnected picture reflects the complexity and dynamic nature of both human and ecosystems services. Rather than services, this is more about relationships between actors and factors, with potential for value through interconnections. In our country park example, examples of such positive interconnections included:

(a) outdoor lessons for schoolkids;
(b) space for youth to build sheds;
(c) effects on social inclusion and reciprocity;
(d) reduced pollution and damage to the woodland.

Such examples highlight the economic valuation of urban ecosystems services, as seen in the economics of ecosystems and biodiversity (TEEB), payment for ecosystem services (PES) and other variations[10]. If there are ecosystems services with human or urban benefits that are specific and tangible, tradeable and substitutable, then standard methods of economic valuation and marketisation can be useful. If other kinds of interconnections are more significant, as in the example above, then a purely economic focus is not enough: we have to include other human factors, such as the capacity to learn, deliberate, collaborate or innovate. In that way the assessment of value added, valuation and evaluation is not so much a fixed answer, rather a space for opportunities to be explored[11].

"the Ecosystems Approach raises the possibility of working with the complexity of human and natural systems"

The implications are very topical. To protect and enhance our urban ecosystems services in an uncertain future is more than a linear type of calculation of costs and benefits, and more than a 'winner-takes-all' calculation of market forces. The greater added value is in potential for learning and synergy of all involved. It seems this is already the aspiration of the Ecosystems Approach,

which provides the backdrop to ecosystems service assessment; the question is how to turn it into reality, not only for ecosystems, but for urban systems too.

AN 'URBAN ECOSYSTEM SERVICES' ASSESSMENT METHOD

We can now sketch out a next-generation model for urban ecosystems services valuation, assessment and evaluation, based on the synergistic method of mapping and design. The basic principle is that urban ecosystems services interactions are not static but dynamic, under conditions of change and potential. If a town has lived next to a river for 500 years, it will be difficult to assess this relation in any meaningful way; but if conditions change on either side, then the value of the relationship will be much more in focus and relevant to action. The synergistic approach enables a way of exploring such dynamic change and potential risks and opportunities, keeping in mind the interconnections and complexity on either side. The four main steps would therefore include both flow-chart mapping and a matrix analysis to track the detail (some example matrices are in Ravetz, 2015[1]):

1. Scoping/landscape mapping: this would show the combined linkages of urban ecosystems, framed as capabilities and affordances of the main actors or stakeholders, which might be economic, social, technical or cultural. For example, an urban park should be integral to quality of life, which includes the capability of outdoor experience, in general and for particular activities such as pets, children, sport, etc. Value-added generated by combinations of stakeholders can be mapped in terms of relationships or linkages between them: as can the possible dysfunctions or conflicts. In the park example above, it appears there are social-ecology-cultural linkages which suit animal lovers: technology-ecology-policy linkages for infrastructure: urban-ecology-economy linkages for property values: or, cultural-ecology-social linkages which promote outdoor education.

2. Scenario/change mapping: this would show a systematic review of drivers and the possible outcomes of potential change. For example, gentrification is a key driver of change both in the usage of the park and in the surrounding property market. A full investigation

▲ **Figure 4. Urban ecosystems, adaptation and resilience: coevolutionary (3.0) model. A more synergistic approach that is proactive systems thinking, based on social learning and collaboration. (© Joe Ravetz)** would look at the drivers of change, the dynamics of change and the results in alternative scenarios.

3. Synergy/idea mapping: this would be a systematic review of the potential for shared learning and creative collaboration. For the urban park, an intractable social problem with ecological effects (e.g. wrecked cars), might be transformed into a win–win opportunity (e.g. socio-eco community enterprise). Possible pathways of interconnecting potentials, include:

- Multi-functional infrastructure pathway: a collaboration of government, finance, land managers, infrastructure providers and public services; the added value is via advance procurement, multi-functional design and fiscal channels for costs and benefits from integrated catchment investment;

- Social eco-crowd-source pathway: this is more about the socio-cultural value of ecosystems, where a social media strategy can mobilise investment both of money and social activity; and

- Community farming pathway: social enterprise innovation for urban farming, with new models of linking niche production with social markets and distribution networks.

4. Strategy/road mapping: here the point is that by looking for potential synergies and practical pathways on the urban ecosystems services interface, we can explore the possibility of a very different kind of assessment or evaluation. If necessary, the assessments could be reduced to monetary values with large bands, but it is generally more useful to keep them as synergistic opportunities. The whole calculation can be shown in matrix form, which sets out in detail the tangible and intangible values, the probabilities and contingent factors, the uncertainties on all sides, and the practical realities of collaboration and mobilisation. The assessment can also be turned around for the 'null' case, i.e. not working on a pathway, thereby bringing into focus the added value of action, either for the ecosystems or the urban systems.

Overall there is a shift from valuation models (which tend to assume clear and tangible concepts of value) towards evaluation models (which are more about deliberation on potential values or priorities, for multiple actors, with multiple justifications). An evaluation approach tends to call for a wider view. In this case we look not only at the urban ecosystem services in that specific park location: but more widely at the prospects for climate change adaptation, and the potential for resilience at various levels on the right (both of these are major questions for another paper). **Figure 3** shows a linear model in, and **Figure 4** shows a more coevolutionary model of adaptation and resilience.

CONCLUSIONS

Overall, the synergistic approach is a logical extension of the Ecosystems Approach, and the building of relationships between natural assets/flows, and human needs/demands. The notion of complex adaptive systems is now recognized in ecology. We can now link this more clearly with the dynamic and coevolutionary potential in human systems. With this, we can go back to tricky joined-up questions of climate adaptation, local biodiversity, flood risk and similar, keeping in the picture the interconnectedness of ecosystems and urban systems, while working towards a practical outcome. ES

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Belfast: back to the future

Joseph Martin and **Mary Maguire** outline the way that Belfast is embracing a sustainable future.

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In 2013[1] and 2014, two conferences were held in Belfast, both of which focused upon Belfast as a future city. In Belfast's flagship Waterfront Hall in 2014, Joe Berridge from Urban Strategies Inc., who was integral in designing cities in the USA, the UK and Canada, gave a fantastic insight into a future Belfast[2]. Workshops were conducted on city-centre regeneration, digital-city progression, low-carbon drivers and inclusive city neighbourhoods. His speech brought to the fore the opportunities on offer for a once-divided city. After the event was over, it was clear the path ahead for Belfast was in sight.

THE PATH TO A FUTURE CITY

In the late 20th century, Belfast was a changing city. The old industries of linen and engineering had declined, replaced by a burgeoning shipbuilding industry. Flagship developments such as the Waterfront Hall and Odyssey Complex in the 20th century signalled a city rebuilding its image at home and abroad[3].

> **"One of Belfast's strategic advantages is its geographic position as a maritime city with exceptionally strong links to the renewable energy sector "**

At the beginning of the 21st century, Belfast began to reinvent itself, developing from the River Lagan inwards towards the city centre. A new phase of prosperity had begun, and the message was simple: Belfast was open for business. In November 2012, Belfast City Council prepared a report entitled *Back to the Future: Future cities and urban empowerment for resilient, low carbon communities* for the Technology Strategy Board[4].

Belfast City Council's submission to the Technology Strategy Board (TSB) contains a portfolio of projects that focus on the particular economic and environmental sustainability challenges the city faces in the future. The studies show how, by adopting an integrated approach and applying innovative technologies to issues of renewable energy generation, food production and waste management, the city can develop unique solutions on post-industrial sites. The concept developed in the studies is of a sustainable, low-carbon, connected city:

"The aim of the projects is to create pilot small scale energy plants in neighbourhoods that are linked together to power homes and businesses, and also tie in IT facilities, and community food production. The result being a new connected community for the 21st Century." (McKeown, 2012, p10)[4].

▲ **Figure 1. Cranes at Harland and Wolff shipyard, Belfast, where the Titanic was built. One of Belfast's strategic advantages has always been its position as a maritime city, and as links to the renewable energy sector have developed this has remained key to the city's economy. (© Dazb75 | Dreamstime)**

CASE STUDY

BELFAST HARBOUR

One of Belfast's strategic advantages is its geographic position as a maritime city with exceptionally strong links to the renewable energy sector within Northern Ireland, which has one of the greatest wind resources in Europe. It is important that this natural resource is fully harnessed. Belfast Harbour is a key driver in the development of wind, wave and tidal energies.

"Belfast Harbour is at the forefront of developing its port infrastructure and land bank on the renewable energy sector, as increasing energy costs and green government policies combine to drive growth in this area. Ports are strategically important to the success of the sector, with offshore wind, wave and tidal and biomass all requiring access to appropriate port infrastructure, and in the case of offshore wind, highly specialised infrastructure"[5].

▲ **Figure 2. A wind turbine at Ormonde offshore wind farm in the Irish Sea, assembled at Harland and Wolff in Belfast Port. (Davagh, Creative Commons[6])**

Belfast Harbour has been so successful that an offshore wind terminal for DONG Energy was built and completed in 2013[7]. The facility is the UK's first dedicated port for the offshore wind sector, and has secured Belfast's reputation has an innovator in exciting and profitable renewable energy technologies. The DONG terminal has ensured that Belfast has positioned itself in the same bracket as leading European ports such as Bremerhaven in Germany and Esberg in Denmark. As well as the offshore wind market, Belfast Harbour sees great potential in the wind farm supply chain – to manufacture wind turbine structures for wind farms across the UK and beyond. Belfast is therefore able to promote itself as a forward-thinking city that encompasses new technologies to not just survive but to thrive within a niche marketplace.

▲ **Figure 3. Completed biomass district heating system at Glencraig Camphill Community. (© Camphill Communities Trust NI)**

One of the latest projects has seen more than 100 turbines, each with a rotor diameter of 120 m, being shipped from the new terminal to the West of Duddon Sands project. It is one of the world's largest offshore wind farms, located approximately 15 km off Cumbria's Walney Island. The West of Duddon Sands wind farm began generating power in January 2014 (almost 400 MW) and is a joint venture between ScottishPower Renewables and DONG Energy[8]. The Pacific Orca ship[9] was used to assist in the transport of the turbines to their respective destinations. The Pacific Orca is the world's largest wind farm installation vessel (WIV), and it can carry up to 12 wind turbine generators (WTG) and is self-elevating and self-propelled, making it ideal for offshore activities at Belfast's state-of-the-art port.

Another successful project completed has been the Ormonde offshore wind farm, located 10 km from the coast at Barrow-in-Furness. The world-class facilities at Belfast's Harbour provided logistics and assembly services for the client Vattenfall (see **Figure 2**). The operations for Belfast were completed in 2011, with over 30 turbines transported and installed for the completed scheme[10]. The project's successful delivery is evidence that Belfast Harbour is able to contribute significantly to the transition to offshore energy technologies. As a city, Belfast can only benefit from how the harbour is transforming the energy sector and how it is leading the way for other seaboard cities to follow its example.

▲ **Figure 4. Woodchip at Glencraig Camphill Community is sourced locally. (© Camphill Communities Trust NI)**

"As a city, Belfast can only benefit from how the harbour is transforming the energy sector"

BIOMASS IN BELFAST

Glencraig Camphill Community, located a few miles outside the city of Belfast, is one of four Camphill community charities located in Northern Ireland. These communities provide care, support and education for children, young people and adults of all abilities (including those with a learning disability) who live, learn, and work together in an extended family setting. The focus is very much on self-sustainability.

Glencraig Camphill Community has always embraced new sustainability ideas ever since its inception as a charity. The latest development is the installation of a 1 MW Urbas wood biomass district heating system to supply hot water and heating to 27 different units within the community (see **Figure 3**). The project involved the construction of a purpose-built boiler house and 3.2 km of steel pre-insulated heating pipes.

The project was completed in 2011 and has helped to substantially lower carbon emissions for the charity and reduce its fuel costs. In its first year of operation, 800 tonnes of locally sourced low-grade wood biomass (on-site coppice and hedge cuttings, virgin wood waste from local tree surgeons, butt chip from local sawmills and high-bark-content chip from sawmills; see **Figure 4**) was used to replace 270,000 litres of oil and prevent the emission of 600–700 tonnes of carbon[11]. This is a significant carbon saving, and at the 7th Annual British Renewable Energy Awards, Glencraig Camphill Community received first prize for best community project of the year 2011.

Glencraig is proof that this idea of social cohesion and environmentally sustainability can succeed – it has shown that a community-based approach to renewable energy can thrive on the periphery of a large urban centre. Glencraig is an example of how Belfast and its neighbouring areas are cities that are symbiotic in their development with the surrounding landscape and environment.

CONNECTED CITY

Belfast Rapid Transit (BRT) low-carbon transport will provide fast and reliable services to link communities to jobs, retail and health and education services for the people of Belfast (see **Figure 5**). The rapid-transit vehicles will run on the latest hybrid diesel technology, emitting low noise, low vibrations and low emissions[12]. The rapid transit system construction is now well underway, with a completion date set for 2017. The Department of the Environment (DOE) in 2015 produced a sensitivity analysis examining the effects that various economic and policy impacts will have on greenhouse gas emissions in Northern Ireland[13]. The report estimated that 92,000 tonnes of carbon will be saved as a result of the BRT over the 60-year appraisal period of the study. The rapid transit network is expected to link into the Belfast Transport Hub, which is set to transform Belfast into a modern world-class connected city.

ELECTRIC TRAVEL

The title of the visionary 2012 report *Back to the Future* by Belfast City Council was deliberately evocative of the famous DeLorean car, which was manufactured in the wider Belfast area from the late 1970s into the early 1980s. The car plant produced some 9,000 vehicles and helped to shape Belfast's economy and image in more difficult times. The idea of building a futuristic car primarily for the US market within the midst of the troubles was a risky endeavour for the manufacturers. An endeavour that symbolised the city as an innovator, not content to subsume within itself socially and economically – the spirit of a future city perhaps?

In 2013, Queen's University students in cooperation with Northern Ireland Electricity (NIE) sought to bring back to life a DeLorean Car used in the *Back to the Future* film

▲ **Figure 5. Dublin Luas light rail system is an example of a Rapid Transit scheme operational in another city (Ave Maria Mõistlik, Creative Commons[14]).**

▲ **Figure 6. The DeLorean DMC 12, which was built in Dunmurry, a suburb west of Belfast. (Georg Sander, Creative Commons[15]).**

franchise (see **Figure 6**). The new project involves local students creating an electric vehicle using the car's iconic body[16]. The project should be completed in October 2015, and signifies the progressive use of alternative technologies employed by both education authorities and the business/government sector in Belfast today.

LOOKING AHEAD

In its recent history Belfast has transformed itself from a city in economic and political strife to a city embracing science, sustainability, cultural diversity and world class education. Most importantly, there seems to be a desire from the government and the wider business community to continue growth into emerging markets such as renewable energy and low-carbon transport initiatives. Belfast Harbour, sustainable communities and low-carbon transport are radicalising Belfast's image. A truly post-modern city is developing. **ES**

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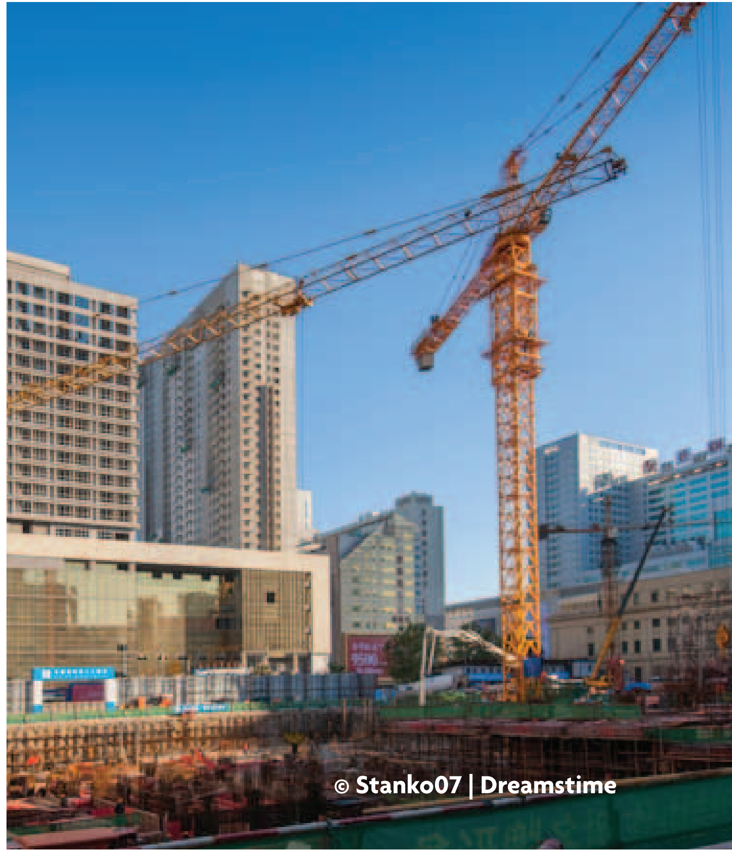
Designing the cities of the future



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Emilia Plotka shows the need for new ways of thinking about urban design.

In 2008, for the first time in human history, more people were living in cities than in rural areas, and while the global population is doubling, urban dwellers are trebling. The growth of mega-cities in Africa, Asia and South America, and the rebirth of post-industrial cities in Europe and North America, are set to increase the number of people living in cities to nearly 70 per cent[1] by 2050. As we enter an unprecedented era of urban expansion and city-building, we have to rethink how we plan and design for this change.

Today urban areas cover around 3 per cent of global land – this is expected to at least double by 2050[2]. That is the equivalent to adding 20,000 paved-over football fields every day for the next 20 years. Such rapid urbanization carries substantial implications for the world in terms of environmental impact, resource depletion, and climate change.

Cities already consume 75 per cent of the world's natural resources, and produce more than 60 per cent of greenhouse gas emissions[3], and areas in Asia, Africa and parts of South America, which will see urban territory grow most rapidly, tend to overlap with biodiversity hotspots[4]. Urban expansion could encroach on or displace many habitats, and as land is cleared for new cities – especially in densely forested tropics – carbon could be released into the atmosphere, contributing to climate change[5].

MANAGED URBANISATION?

The urbanisation wave cannot be stopped. But the way this transition is managed will be critical to mitigating its impact on the environment. The one thing that is clear is that we cannot build cities the way we have over the last couple of hundred years – (resource-heavy buildings springing up organically on a piecemeal basis) – the scale of the change will not allow it. If we want cities of the future to be sustainable, healthy places for people to live, the city of 2050 will need to look radically different from the city of today.

"If we want cities of the future to be sustainable, healthy places for people to live, the city of 2050 will need to look radically different from the city of today."

In the developing world, for example, many of the cities and infrastructure that are needed are not yet in existence. Take China – it has yet to build more than 50 per cent of the buildings it will need to support an extra 300 million city dwellers by 2030[6]. There is an opportunity to make these new buildings as sustainable as possible.

2015 will be crucial to the future development trajectory of cities. In September, the United Nations is expected to include an objective to make cities more sustainable in a new set of Sustainable Development Goals which will define international development objectives. In December, a new global climate change agreement is expected to be finalised in Paris. This presents a big window of opportunity to set a global aspiration for creating compact, mixed-use, transit-orientated urban centres that incorporate sustainable, low-carbon infrastructure.

Central to realising this opportunity will be bringing together urban planning, design, technology and innovative governance models. With the right focus and resources, we believe that cities can be designed for a better future for themselves and the environment.

THE SMART CITY ERA

A wide range of technologies for capturing and analysing data are supplanting pen and paper in planning and urban design departments. These electronic data devices – geographic information systems, satellite mapping and visualisation software – offer deeper insights into human behaviour as well as greater understanding of the physical attributes of sites.

This is enabling architects and planners to create place-based design approaches that, for example, increase the use of natural features to help reduce flooding and prevent cities from overheating. For example, Rotterdam's Benthemplein Water Square has been designed to accommodate surplus rain water – "its basins can go from being basketball courts to ponds"[7] (see **Figures 1 and 2**). The ponds help cool the surrounding buildings during summer, and provide a water feature for the public to enjoy, although most of the time the square will be dry and in use as recreational space. By gradually releasing collected storm water, this system also helps to maintain the ground water balance, and thus healthy urban vegetation which reduces the urban heat island effect[8]. Other examples include:

- Melbourne has a map-based tool to review elements constructed in the city to ensure that they incorporate green infrastructure for this purpose, and to promote mental wellbeing to yield savings in future health budgets[9].

- Guadalajara in Mexico is using other types of technology to help plan growth in a more integrated way. It is embracing open data, smart grids, e-health, augmented reality, and other tools. These are enabling urban designers and local councils to improve and revolutionize the city in anticipation of rapid projected population growth in the future, and to limit the impact of expansion on the local environment. By using the large amount of data which has been collected to help identify areas for future expansion that will least encroach on valuable green space, practitioners in the city are also able to experiment with and model the impact of design interventions, in order to optimise design solutions for high-density living as well as good infrastructure links[10].

- In Asia a number of emerging cities are working with partners to develop models for sustainable growth that learn from the current generation of cities through harnessing open data (see **Box 1**). These models will have to be developed further if the city of 2050 is to benefit from new approaches, particularly to ensure they incorporate public engagement in shaping future environments.

▲ **Figures 1 and 2. The Benthemplein Water Square in Rotterdam, which was conceived and designed by Dutch company De Urbanisten. This square acts as public recreational space when dry, but during heavy rainfall these areas act as ponds to store excess water, preventing flooding in the streets. (Top: ©Jeroen Musch, bottom: ©De Urbanisten)**

BOX 1: OPEN DATA

Open data is information that is freely available, and comes from a range of sources:

- government, business and academia publishing datasets;
- individuals producing and disclosing data; and
- or information that is collected through monitors and sensors (electronic devices).
- Open data is commonly collected and utilised to help identify trends and sources of problems e.g. why in certain areas there is a lot of traffic/crime/pollution, and is key to the vision of 'smarter' cities.

PUBLIC PARTICIPATION

The digital age is making the public voice easier to access and harder to suppress, and it will become increasingly difficult to generate support for new initiatives without taking public views into account. At the same time, public consultation software, online forums and social media can now increasingly be used to capture public opinion to test ideas, evolve proposals and disseminate information[11]. With this in mind, RIBA is exploring the idea of a digitised planning system that could use new technology and big data to support strategic planning of a city and help improve public engagement with the process[12].

Imagine a planning system that allowed planners and the public to view future project proposals in 3D online, and use fast-forward fly-throughs to see how schemes would develop over time and affect their local surroundings. Or being able to hold up a tablet in front of a development site to view a new scheme overlaid on it, and easily insert a comment about it.

Our idea of a digitised planning system embodies this type of thinking, with the view to create a system of continuous feedback loops that provide information about a range of social, economic and environmental changes for urban design and development decision-making. Data and modelling could allow designers and planners to save time and potentially money by testing designs on the public before they enter the construction process. This could also help identify likely objections, and model solutions, saving time in the planning process and maintaining public and political support.

"The digital age is making the public voice easier to access and harder to suppress"

The technology to make this happen already exists. Smaller-scale digital platforms have been created for a few development sites that are large and complex, to enable developers to experiment with and optimise design based on monitoring how people move through and use the space as well as public consultations. One such digital platform is being used by development staff for the redevelopment of King's Cross in London – the largest area of urban redevelopment in Europe (see **Figure 3**). Argent, DHL and London & Continental Railways Ltd have teamed up to create a digital platform to ensure the largest new street in London since 1904 and largest public square since 1845 create maximum benefits for communities with minimum impact on

▲ **Figure 3. A digital platform has been used by planners in the redevelopment of King's Cross, to model people movements and potential environmental impacts. (© Ajv123ajv | Dreamstime)** the environment. By layering various datasets (e.g. air pollution, traffic, energy and water supply grids) on a 3D computer model of the development site, project planners can visualise the potential impact of a change on a range of variables. At King's Cross this system has been used to model the movement of people through public spaces, enabling designers to encourage pedestrians into public squares and reduce anti-social behaviour.

SHIFTING MINDSETS

It will not be enough to create a digitised planning system by simply extending the scale of existing platforms. In order to take place-making into the digital age, a culture shift will be required alongside this, among those who plan, build and design our cities. Planning departments will have to apply more multi-disciplinary thinking to urban development strategies and design, to avoid unintended consequences and harness as many social economic and environmental benefits from development as possible. They will also need to foster greater participation from the public to gain deeper insights into their needs and preferences to ensure future cities meet their aspirations.

In a similar vein, the construction industry will need to adopt a circular economy that is restorative for the environment and resources. Buildings will have to be built with future changes in mind, rather than built to existing environmental conditions. One modern example of architects embracing this principle is the village of Maasbommel in the Netherlands. In 2005 houses were built here with floating foundations which can rise to a height of 12 feet, effectively waterproofing the residence. There are plans to extend this project on a much larger scale and build a floating town of 12,000 homes near Schipol airport[13]. We should also consider that the architects of tomorrow will have a range of tools available to them that we have not even dreamed of.

Exploring the potential implications and applications of a range of technologies will highlight the range of possibilities ahead of us – leaving us both prepared and in a position to better control the fate of cities. It will be crucial to retain a focus on using technology as a means to anticipate and manage change within urban areas to create and maintain good-quality sustainable environments.

If a strong global commitment to sustainable development and tackling climate change is set in 2015, and bold leadership and new technology is fostered by national and local governments, our cities can become the cornerstone of a green circular economy, supporting resilient and inclusive communities. Instead of adding to the problem, cities could begin to address climate change and environmental degradation. With the tools at their disposal today, cities have never been better equipped to rise to the challenge. Their success in 2050 and beyond will be determined by how well they do so. ES

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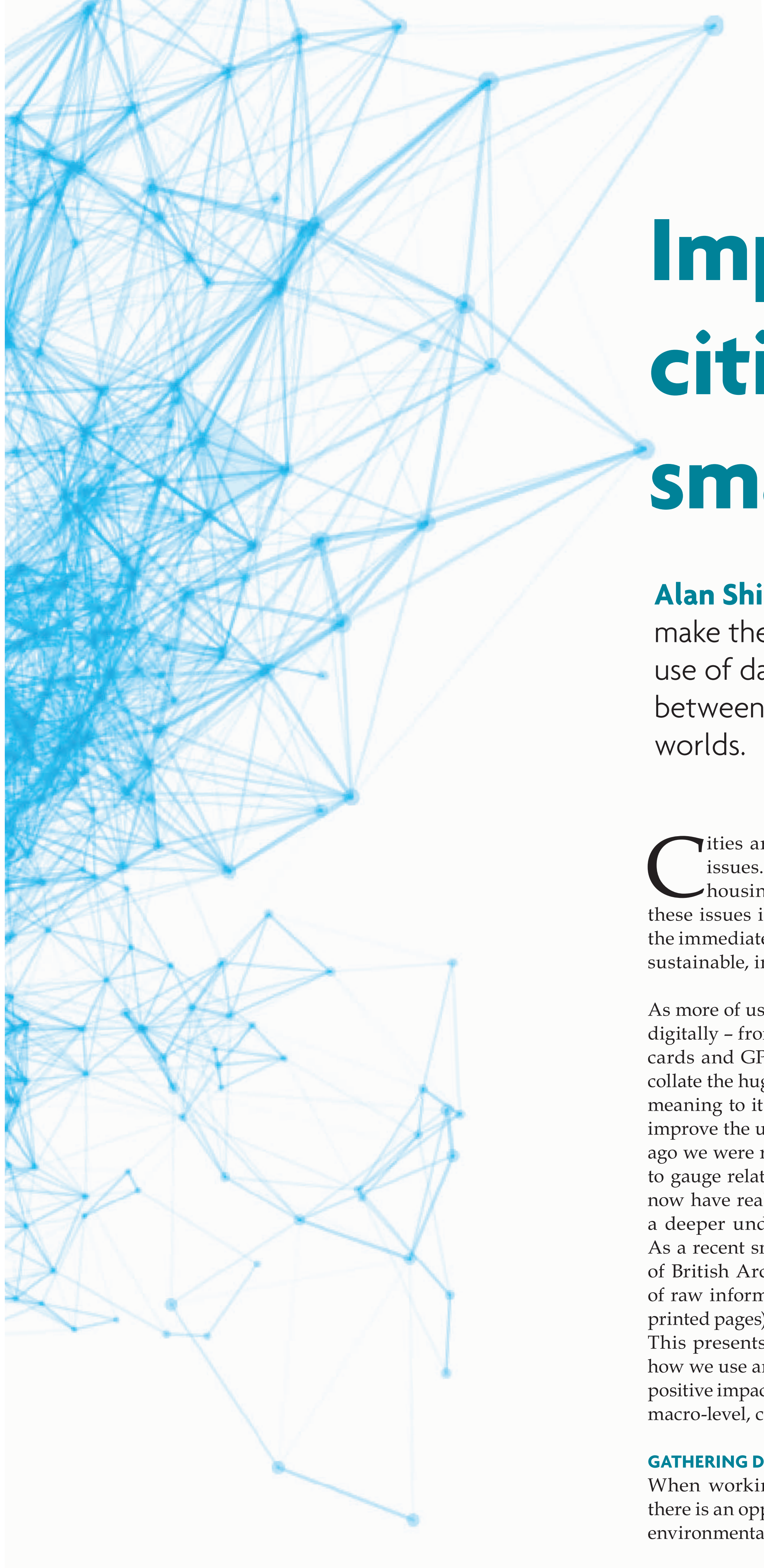

Improving cities with smart data

Alan Shingler and **Martin Sagar** make the case for the intelligent use of data to create a dialogue between the virtual and physical worlds.

Cities are a fulcrum for discussions on urban issues. Do we build taller? How do we solve housing shortages? And how do we address these issues in a responsible way that engages with the immediate urban issues whilst creating long-term, sustainable, informed solutions?

As more of us record our experiences and movements digitally – from the use of phones and tablets to travel cards and GPS devices – there is an opportunity to collate the huge amount of data that is generated, give meaning to it and find ways of using it to shape and improve the urban fabric of our cities. Whilst 15 years ago we were reliant on formal and expensive surveys to gauge relationships between people and cities, we now have real-time virtual information that gives us a deeper understanding of place than ever before. As a recent smart cities report by the Royal Institute of British Architects stated, in New York a terabyte of raw information (enough to fill nearly 143 million printed pages) passes through the Mayor's office daily[1]. This presents the opportunity and the challenge of how we use and share such a volume of data to have a positive impact on our everyday lives as well as making macro-level, city-wide improvements?

GATHERING DATA

When working in newly formed neighbourhoods, there is an opportunity to create a collective social and environmental understanding of place using data. New communities, neighbourhoods and cities can be fitted with advanced operating and monitoring systems from the start, creating a closely connected dialogue between virtual information and the physical environment.

Projects such as East Wick and Sweetwater – which involve creating a new community with 1,500 homes on the Queen Elizabeth Olympic Park site in London – have the ambition and scale to make the most of data. Although the project is in its early stages, Sheppard Robson (part of the project's design team) is looking at how smart principles can be integrated into everyday life (see **Figure 1**); for example:

- Installing real-time energy and water monitoring so that residents can compare the performance of their homes with those of other residents;
- Creating a digital forum where people can get to know their neighbours and also highlight maintenance issues; and
- Installing real-time dust and noise monitors to manage and inform mitigation of nuisance activities.

This data is also crucial to the construction industry. The sector often considers its work done soon after the official completion and opening of a building or space, with the majority of the profession remaining in the dark about how a building actually performs over its lifespan. Collecting micro-data will help the profession improve the efficiency of the development in question, whilst also feeding lessons learnt into other projects, sharing experiences and raising the bar for best practice. Architecture – when viewed as a community and not a profession – could be given a new collective power through gathering and sharing smart data.

THE LONDON HEAT MAP

An example of using data to shape the future of existing cities is the London Heat Map, created by the Greater London Authority (GLA). This digital map shows heat loss from the built environment, and ultimately led to the revision in the GLA's policy to encourage decentralised energy solutions, such as combined heat and power (CHP) and district heating networks. By presenting and visualising information that was not previously available, this digital map highlighted the amount of heat lost through existing buildings, allowing the GLA to look at efficient ways to deliver heat, leading to CHP district heating networks. This is a good example of digital analysis informing policy and encouraging change.

Data can be a particularly powerful tool for cities when a number of datasets are combined to create an interactive overview of an urban environment. A common language and accessible platform for data would enable datasets to be evaluated in relation to one another and could help designers understand and respond to dynamic

▲ **Figure 1. Diagram demonstrating how smart data can be used to improve communities, such as the East Wick and Sweetwater project in London. (© Sheppard Robson)**

▲ **Figure 2. The Queen Elizabeth Olympic Park. It is hoped that data can inform design for the East Wick and Sweetwater project. (© Sam D\'cruz | Dreamstime).**

change. For example, the London Heat Map could be combined with conservation and regeneration plans as well as data on traffic, infrastructure and retail hubs. A common platform could also be used to model the impact of renewable energy generation and could include micro-climate analysis such as daylight and sunlight. The cumulative effect of overlaying these different streams of data would be a resilient low-carbon plan for London, as it would enable designers and strategic planners to make data-informed decisions. Resilience is achieved by assessing all relevant information instead of embarking on policy revisions or masterplans that might only be informed by one data set.

If consistent data could be shared whilst protecting intellectual property, stakeholders would also be able to form partnerships beyond the boundary of an individual development. A common data platform would enable opportunities only achievable through economies of scale and collaboration. For instance, where CHP is proposed, heat could be more freely shared with neighbouring residential developments, schools and public buildings with a relatively high heat load. This would enable the optimum amount of electricity to be generated off the CHP for office and commercial uses, which typically have a low heat demand.

The London Heat Map is only one example of how big data is currently being used to develop our cities, but this only seems to be the start, with more sophisticated tools planned for next 10 years. The government-led Digital Built Britain is an initiative to create a virtual world by 2025 that forms a live digital map of London, allowing people to conduct more in-depth sustainable analysis and also to project energy use, carbon emissions, and pedestrian/traffic flow into the future.

THE CONTEXT OF DATA COLLECTION

With data-fuelled city initiatives, there is a fine balance between the irritation of feeling monitored and benefits of feeling informed. The difference between the two is the use of technology in an informed context. The smartest 'smart city' is a robust network of digital data – spanning social, economic, cultural and administrative layers of a community – that is processed and displayed intelligently.

However, the use of this data should not lose the connection with the people and community that it is helping to shape. With projects like East Wick and Sweetwater (see **Figure 2**), the collection of raw data should be complemented by qualitative findings that give meaning and direction to the data. If we are to create a digital social forum for residents, then this should encourage people to meet in person and use the local cultural and leisure facilities (or indeed inform the facilities or cultural assets that should be included in the development). Architects are not driven by creating purely digital communities that can exist anywhere, but are interested in where the virtual and physical worlds meet to create digitally informed communities that still remain focused on face-to-face relationships. **ES**

Alan Shingler is a partner at the architectural practice Sheppard Robson. He is a recognised expert in sustainable design and has chaired the RIBA Sustainable Futures Group as well as advising numerous other organisations on best practice. Alan's recent projects include designing the most efficient HQ building in the Middle East and the UK's first zero-carbon house.

Martin Sagar is a partner at Sheppard Robson and leads the practice's masterplanning team, which works internationally on a breadth of projects that vary widely in scale, geography and social contexts. His current projects include rethinking the water supply and sanitation across five African cities to, improve living conditions for 40 million people, and projects focused on improving communities and neighbourhoods in London.

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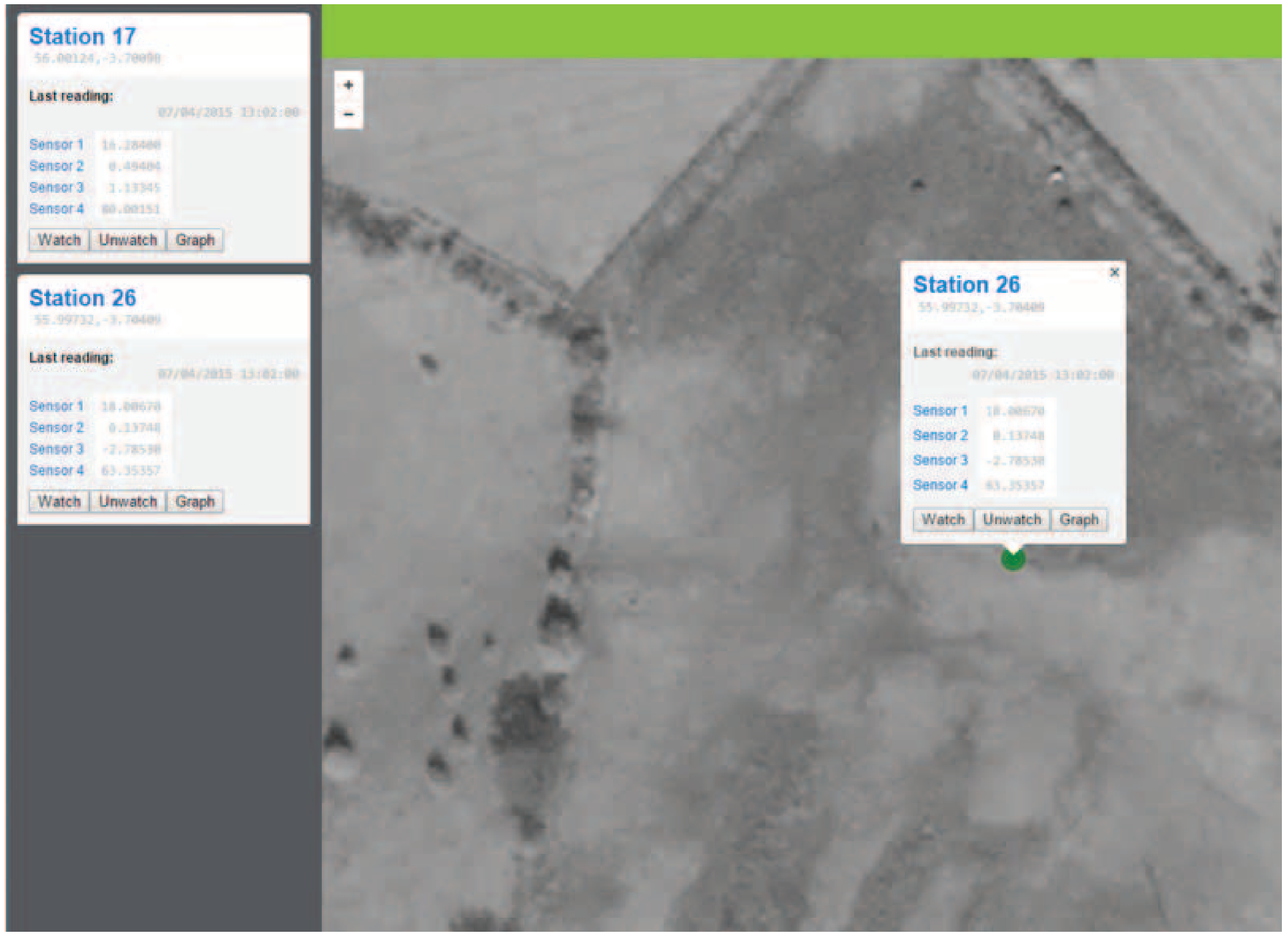
Smart cities – industry and transparency

Michael Groves describes the advances that make continuous environmental monitoring possible.



▲ **Figure 1. Environmental sensors and real-time data can now be geographically visualised using new software platforms, allowing users to make better sense of the 'industrial internet of things'. (© Topolytics)**

With cities generating around 80 per cent of global GDP, there is justifiable interest in the application of smart technologies that improve transport and urban services, resource efficiency and citizen engagement. The value of the market for these technologies and associated services has been put at £260 billion by 2020[1]. While there is a focus on municipal and utility services, businesses are key partners in smart city strategies, as well as being agents of innovation. They too are attempting to reduce environmental impacts, enhance resource efficiency and engage with employees and external stakeholders. At the same time they have to be more transparent.

THE TRANSPARENCY AGENDA

There is a growing list of demands on companies to measure and disclose information on environmental risk and performance. The regulatory picture includes the EU Non-Financial Reporting Directive, the Energy Savings Opportunity Scheme (ESOS) and specific industry standards.

> **"there is real commercial pressure on companies to take a more sophisticated approach to environmental risk management"**

For listed companies in the UK, the nature of annual reporting continues to evolve with the latest iteration of the UK Corporate Governance Code and Strategic Reporting regulation, which requires greater description of material environmental and social issues. This is also a backdrop to specific demands around greenhouse gas (GHG) emission disclosure. In parallel, there is a growing movement to combine financial and other information that is relevant to company value, such as sustainability – to produce the so-called integrated report[2].

While these reporting demands on larger listed companies garner all of the attention, the pressure mounts on companies of all shapes and sizes to disclose environmental and sustainability performance on an ongoing and informal basis. This may be through questionnaires from customers or criteria linked to bank lending or private equity investments.

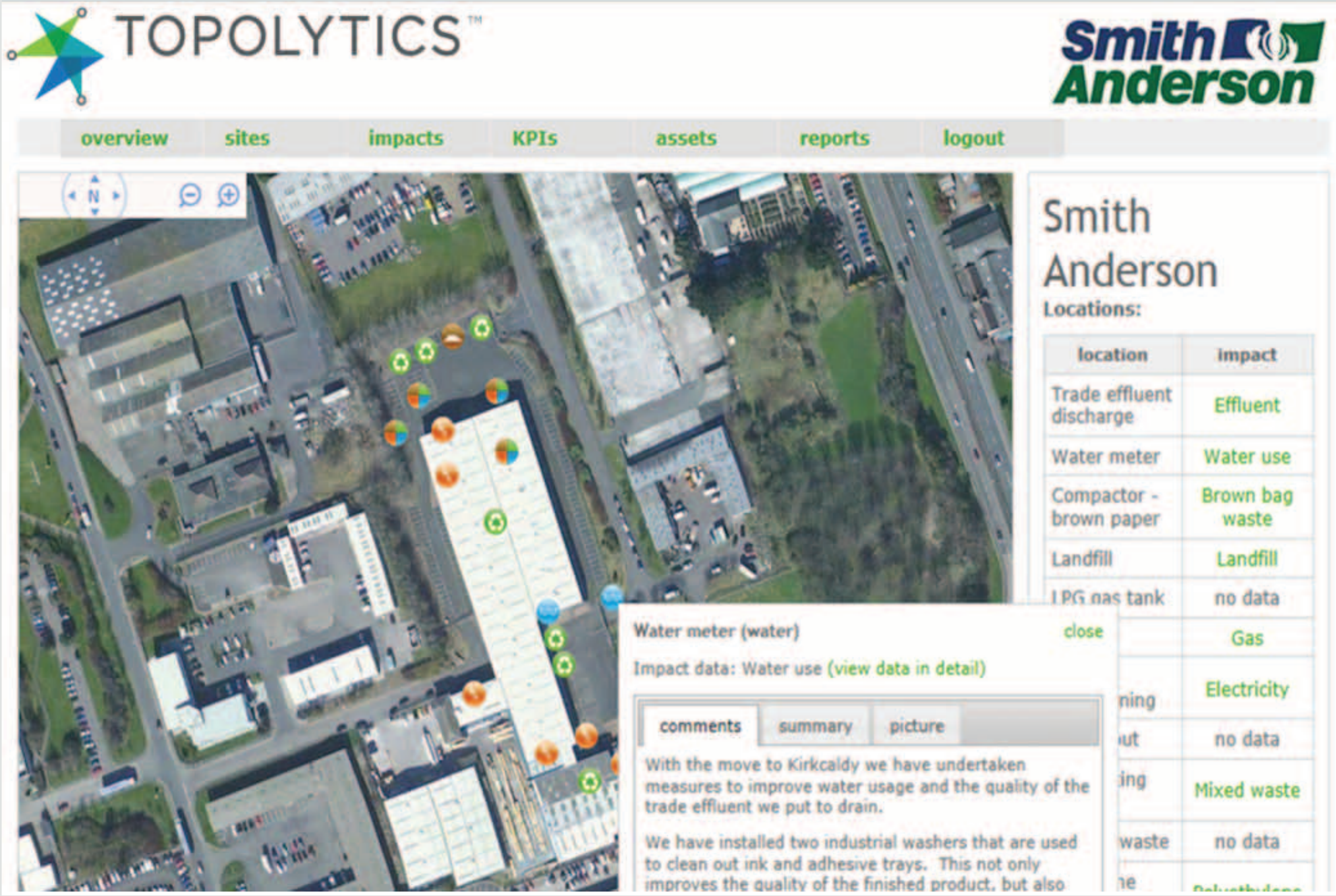
At the same time, the technological advancements seen within the smart cities arena are changing the ways in which companies measure, analyse and disclose information on emissions, waste and resource efficiency.

▲ **Figure 2. There has been a recent expansion of smart grid and demand management software, in line with the deployment of smart meters. (© Dpullman | Dreamstime)**

This is exemplified by the growth in the adoption of cloud computing, software as a service (SAAS) and access to big data generated by ground and airborne sensors (the industrial internet of things; IIoT). This in turn is challenging the nature of expectations around what a company measures, how it measures and what it discloses to different stakeholders. For example, the *Digital Present* report produced by the Financial Reporting Council concluded that investors prefer a timely and clear PDF version of an annual report[3].

Likewise, customers, employees, communities want to know about environmental and sustainability risk on a rolling basis – when contracts are up for renewal, when seeking new suppliers or during recruitment. In parallel, environmental compliance is shifting from a monolithic test-and-approve approach to one that is more nuanced and based on risk profiling[4].

While legal and customer compliance remain primary drivers for environmental measurement and management, they have been joined by the real cost pressures attached to raw materials conversion, energy and waste management. Taken together, there is real commercial pressure on companies to take a more sophisticated approach to environmental risk management. While the key technological tool deployed to achieve this goal remains the spreadsheet, there is an opportunity to turn the pain of environmental compliance into an opportunity to improve governance, enhance value and reduce costs.



▲ **Figure 3. Screenshot from the Topolytics software platform, showing environmental management in Smith Anderson (see Box 1). (© Topolytics)**

HARNESSING THE CLEANWEB

Discourse on environmental and clean technologies tends to default to hardware solutions such as wind and tidal turbines, energy from waste and water treatment. Within the energy sector, there has been a flowering of smart grid and demand-management software, in line with the deployment of smart meters (see **Figure 2**). Developments in software-based data processing and analytics stem from this and is starting to change the nature of the energy supply chain.

Software-based cleanweb approaches to industrial environmental management have been increasingly adopted by large enterprises. The latter deploy sophisticated sustainability, environmental health and safety and carbon management software from global IT vendors or niche suppliers.

Monitoring of environmental quality on a macro scale has also been undertaken using remote-sensing technologies and geographic information systems (GIS), from satellite monitoring of forest cover to assessments of water pollution from aerial scanners. Here, there has been a focus on multinational, national and local government applications. However, this is changing with the rapid development and adoption of open-source mapping and geographic information (GI) software, not to mention the revolution in data collection from new satellite platforms and unmanned aerial vehicles (UAVs). Fundamentally though, not all actionable insights can be gleaned from air- and space-borne

“with the growing adoption and democratisation of cloud computing, data analytics, sensors and geo-spatial technologies, companies can turn the environment from compliance pain to competitive advantage.”

“Our core assumption is that the measurement and visualisation of environmental management is best achieved through the lens of geography.”

sources, so there will always be the need for data from other terrestrial sources – so-called ‘ground truth’.

Back on the ground, across great swathes of business, in particular the industrials, manual processes and the spreadsheet still hold sway. These may be sizeable companies and may have environmental managers in place, or they may be medium-sized with no formal environmental management expertise in house. What they all face are the need to control costs and satisfy the varied environmental disclosure demands of their stakeholders – regulators, customers, employees, communities, investors or lenders.

BOX 1: ENVIRONMENTAL MANAGEMENT IN THE BAG

Smith Anderson is the UK’s largest integrated paper bag manufacturer and supplies 50 million paper bags throughout Europe every week. Its customers include leading quick-service restaurants, bakery chains, pharmacy groups and national wholesalers.

The company operates a certified ISO14001 environmental management system, which covers areas such as solid waste production, water use and effluent, materials storage and energy, and recycling (the company is a long-standing user of high-quality recycled paper). Its processes are subject to regulatory oversight, on effluent discharges and solid waste, for example. The company is also subject to scrutiny from key customers, who in turn are managing environmental risk within their supply chain.

Using the Topolytics platform, the company has been able to integrate data from a variety of sources, identify and visualise environmental processes and append contextual information such as narrative and documents (see **Figure 3**). This provides a ‘balance sheet’ view of performance and one that is constantly updated and readily accessible to customers and other stakeholders.

We believe that with the growing adoption and democratisation of cloud computing, data analytics, sensors and geo-spatial technologies, companies can turn the environment from compliance pain to competitive advantage.

IT’S ALL ABOUT THE DATA ... ISN’T IT?

There is significant growth in commercial activity around big data and the internet of things (IoT). While consumer applications receive media attention, use of new analytical and data-collection systems is proceeding quietly across industry. Within this broader spectrum of industrial analytics and sensing, Topolytics has chosen to focus on measuring environmental risk and performance, adding context and sharing the resulting insights internally and externally.

Our core assumption is that the measurement and visualisation of environmental management is best achieved through the lens of geography. The range of data associated with environmental metrics varies widely – from manual billing through to novel sensors. However, they all operate in time and space and the latter in particular is, we believe, the glue that binds of these processes and associated data together.

Topolytics therefore takes discipline and techniques from the world of remote sensing, GIS and big-data analytics to apply them to measuring and reporting on industrial environmental risk. This allows us to work with a range of data sources, including satellite and aerial imagery, fixed and mobile sensors, automated meters, spreadsheets and manual input (see **Figure 1**).

Our platform is designed to allow non-expert users to incorporate a variety of data sources and add context such as narrative, documents and images in order to generate a real- or semi-real-time view of risk and performance. The data can also be exported into standard reporting formats if stakeholders require them. The business can update the system or work with their chosen advisors to maintain the data and content.

Applying geographical discipline to waste, emissions and resources can provide actionable insights and enhance transparency. Data is generated from dispersed sources in different formats, therefore the 'geography of things' will be a key component of the wider industrial internet of things as applied to environmental management.

FROM CLEANTECH TO CLEANWEB

Companies that operate industrial processes in or on the fringes of cities have to manage environmental risk. At the same time they can benefit from municipal adoption of smart city technologies, such as improved transport systems. Fundamentally though, these companies face the same risks of climate change as their host cities, with the added pressure to be transparent on sustainability. The rate and extent to which business adopts technology varies across the full spectrum of processes. Specifically on environmental management, the cleantech push seen over the last 10 years, exemplified by hardware solutions to energy generation, is now evolving into the cleanweb era of data, analytics and sensor-based risk management and insight. ES

Michael Groves is a geographer with a PhD in aerial photographic interpretation. He has a 20-year career spanning environmental management, forest certification and sustainability and is the co-founder and CEO of Topolytics, a software platform for measuring, visualising and analysing environmental risk. (www.topolytics.com)

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New members and re-grades

Member is for those individuals who have substantial academic and work experience within environmental science.

Paul Adams - Senior Environmental Consultant
Kate Baker - Associate Director
Darren Banks - Senior Geo-Environmental Consultant
Sarah Bradford - Environment Manager
Anton Bradley - Environmental Consultant
Jonathan Buick - Climate Change Project Officer
Eleanor Burke - Principal Environmental Consultant
Simon Clennell-Jones - Unit Director
Andrew Collins - Air Quality Specialist
Carol-Mari Conaghan - Agricultural Consultant
Peter Crow - Landscape/Environmental Scientist
Grieg Davies - Environmental Scientist
Matthew Dilling - Principal Environmental Consultant
Elizabeth Diplock - Environmetnal Advisor
Adam Donnan - CEO
John Douglass - Evidence Specialist
Oliver Dube - Lecturer (Environmental Science)
Oritsejolomi Etuwewe-Mordi - Environmental/Instrument Analyst
Richard Furniss - Senior Consultant
James Gaffey - Researcher and Intellectual Property Manager
Matthew Gale - Environmental Officer
Christina Geraghty - Associate Director
Edvard Glucksman - Senior Environmental & Social Specialist
Emma Goosey - Knowledge Transfer Associate
Agnieszka Griffin - Senior Policy & Programme Officer
Gareth Griffiths - Process Scientist
Lucie Hankinson - Senior Contaminated Land Officer
Richard Hayes - Senior Environmental Consultant
Melanie Hobson - Director & Principal Consultant
Thomas Hogarth - HE Lecturer/Course Leader
Celia Jonquet-Burns - Senior Environment Scienctist
Rachel Kershaw - Contaminated Land Inspector
Christopher Kirley - Environmental Scientist
Christopher Lewis - Environmental Management Advisor
Keri Lewis - Senior Technical Officer
Iain McLellan - Lecturer (Environmental Chemistry)
Glenn Mulleady - Forest Keeper
James Nairn - Principal Geoenvironmental Engineer
George Owens - Director
Brian Payne - Nucelar New Build Deputy Programme Manager
Agnieszka Piatek-Bednarek - Environmental Sustainability Coordinator
Melanie Roxburgh - Senior Environmentalist
Lyndon Sackey - Assistant Operations Manager
Catherine Scheib - Senior Licensing Officer
Stephen Simmons - Managing Director
David Styles - Director
Rhodri Thomas - Knowledge Training and Training Manger
Daniel Walker - Scientific Officer
Lois Warnock - Senior Environmentalist
Emily Whan - Principal Consultant
Katherine Williams - Principal Environmental Consultant
Thomas Wright - Air Quality Consultant

Fellow is for esteemed individuals in environmental science and sustainability who are held in high regard by their peers

James Massey - Associate, Marine Sciences

Associate is for individuals beginning their environmental career or those working on the periphery of environmental science.

Pietro Bertagnolio - Experimental Atmospheric Physicist
Lewis Bird - Trainee Asbestos Surveyor/Contaminated Land Consultant
Katrina-Marie Blair - Graduate Environmental Engineer
Ian Brooks - Business & Operations Manager, Environment iNet
Patrick Clarke - Retired
Richard Claxton - Environmental Consultant
Amy Collier - NUS Students' Green Fund Project Assistant
Alexander Crayton - Assistant Air Quality Consultant
David Davies - Technologist
Emma Dunabin - Assistant Consultant
Bernard Erley - Graduate
Jose Estrada - Graduate Air Quality Consultant
Alexander Finney - Geo-Environmental Scientist
Simon Grubb - Environmental Consultant
Nicholas Hampson - Engineer
Tiffany Hepher - Graduate Technical Assistant
Monika Jankowska - Transport Planning
Paul Jones - Graduate
Jonathan King Yeun Lee - Business Development Manager
Yuen Ching Lo - Project Environmental Engineer
Ashley Lydiate - Graduate
Julian Mann - Graduate Air Quality Scientist
Munashe Musarurwa - Project Consultant
Bethan Pagett - Research Assistant
Rodney Painell
Kate Paxton - Environmental Specialist
Jonathan Randles - UK Quality& Environment Manager
Thomas Reade - Air Quality Consultant
Manuel Sanabria Soto - GIS Environmental Technician
Wai Chung So - Environmental Officer
Helen Travers - Graduate Environmental Planning Advisor

Affiliate is for individuals with an interest in environmental issues but don't work in the field, or for students on non-accredited programs.

James Wilson - Graduate
Andrew Bird - Student
Zoe Fleming - Atmospheric Chemist
Callum Harvey - Student
Isla Hoffmann Heap - Ecologist
Adam Newbery - Music Teacher
Edward Rees Williams - A Level Student
Amy Van De Sande -Student

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Reviving the flora of Cape Town

Nadine Coetzee describes a proposal to start the regeneration of the Cape Floristic Region in South Africa.

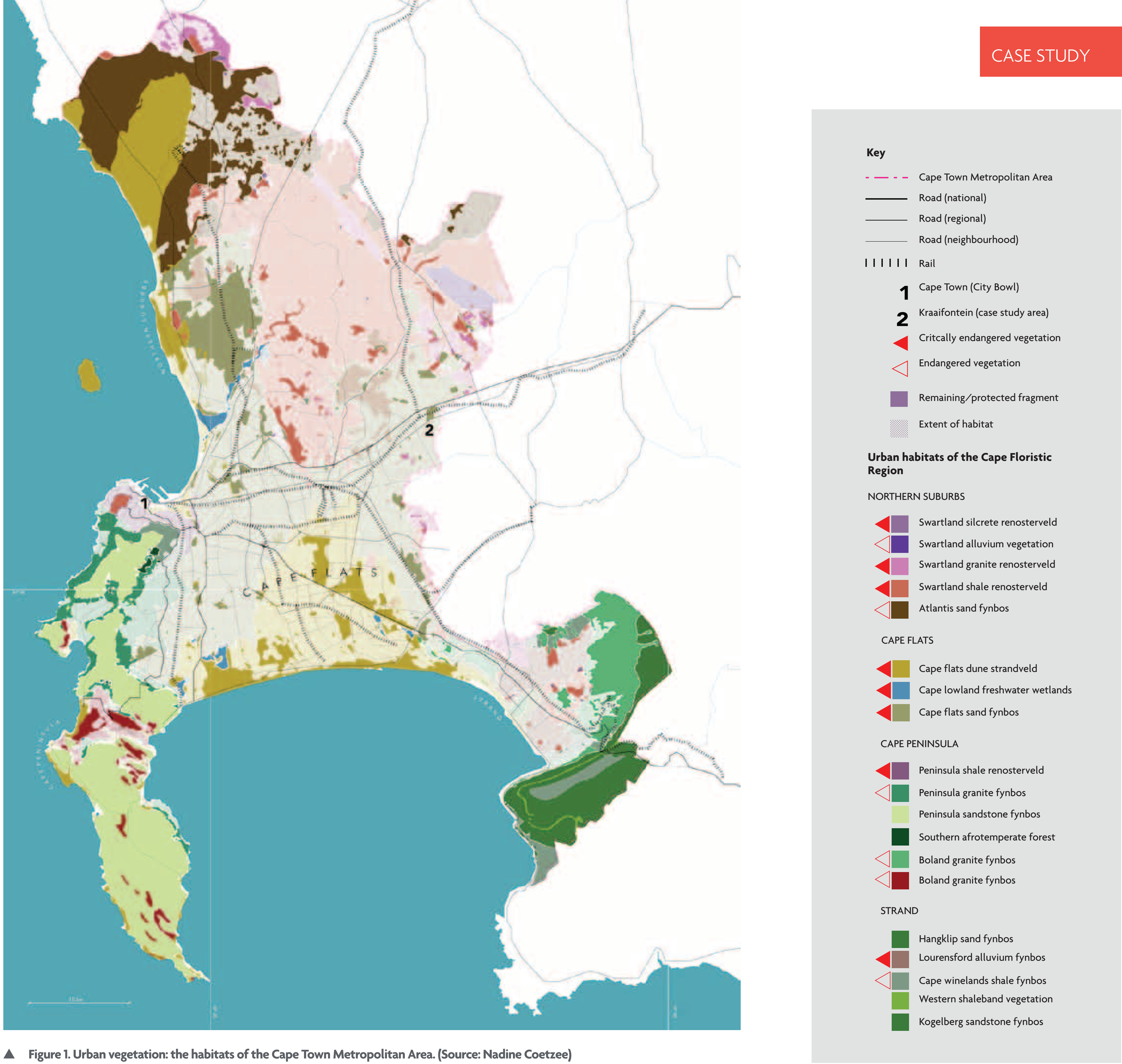
The city of Cape Town in South Africa is a unique entanglement of raw social history, rapid urban expansion, and extreme poverty. It is also the space with the highest concentration of plant species threatened with extinction in Africa[1]. Cape Town is therefore a space where the competition between social and natural priorities is extreme.

What makes the situation in this city so acute is that much of what grows here exists nowhere else. The climate and geology has given rise to an endemic vegetation that depends on fire for germination, requires little nutrition from the sands and explodes in a haze of colour with the first rains in a short-lived but vibrant competition for the relatively few pollinators. This is the Cape Floristic Region, the smallest of the world's six floristic regions. A significant part of it overlaps with the Cape Town metropolitan area (see **Figure 1**), and for this reason the flora is fast becoming an almost entirely urban vegetation as the city strives to meet the demand for housing.

THE CAPE FLATS

In winter, the low-lying Cape Flats, sandy lowlands behind Table Mountain, form the sponge for the runoff from the mountains that enclose them and they become a mosaic of shallow wetlands. The dry summer brings strong southeasterly winds and harsh sun that desiccate the landscape and leave a terrain of windswept sands. Fire spreads quickly across this highly flammable and tightly packed urban fabric, assisted by the strong winds.

Storm water runoff is currently redirected into retention ponds and drains that leave the dry sands barren and mobile. This has disrupted the stability the landscape of the Cape Flats naturally offers to the city. As heavy rainfall



▲ **Figure 1. Urban vegetation: the habitats of the Cape Town Metropolitan Area. (Source: Nadine Coetzee)**

is an increasingly frequent occurrence, these systems are stretched to bursting point. The spring display of colour is suppressed, thus threatening the endemic flora that makes this space internationally unique.

Internationally the best preserved natural landscapes of the world's cities are tied to the wealthiest neighbourhoods and the poorest are tied to the most unstable landscapes such as marshlands and dunes, making vegetation highly political. The apartheid regime violently expelled all non-whites from the city centre and deposited them on the Cape Flats (see **Figure 3**). The area remains largely unserviced and is simply a network of tarmac roads, shared toilets and a built fabric of nailed-together timber sections and corrugated metal

▲ **Figure 4. A public park in Kraaifontein East, mid-July 2014. (© Michelle Le Roux.)**

sheets perched on the sands.
Recently, the fast expansion of the city's periphery has seen the development of townships that are ill equipped to deal with the climate and a landscape damaged by those trying to survive on it. However, an adjustment of approaches to urban design and civic infrastructure could be used to bring the unique qualities of the Cape Flats to the fore.

KRAAIFONTEIN EAST CASE STUDY

Kraaifontein East (see **Figure 4**) is a place defined by its position on the edge of three zones: the sandy Cape Flats, the Cape Town metropolitan area and the habitat of the Cape Flats sand fynbos. Water forms the backbone of how this landscape functions, both in lack and abundance.

The piece of land in Figure 4 shows the situation in Kraaifontein East – it floods in winter and is thus a dumping ground for household waste, clearly distinguishing it as wasteland. Yet in the surrounding area this is the only stable patch of vegetation (now

◀ **Figure 3. A house on the Cape Flats. (© David Chancellor.)**

▲ **Figure 5. Kraaifontein stormwater retention pond, mid-summer 2015. (© Nadine Coetzee.)**

"it recognises the power of leading by example in neighbourhoods where simple changes multiply across a community as soon as their value is recognised"

largely dominated by alien grasses and the indigenous arum lily). This space exposes community attitudes, the lack of civic structures such as waste collection and the effects of water in an otherwise barren context. This is largely how the approach to water plays out in this area – both at the local and the strategic levels the presence of water on a site is perceived to render it useless.

The storm water retention pond in Kraaifontein East (see **Figure 5**) holds around 27 million litres in the peak rainfall season (June and July). The water is redirected to the pond in large concrete pipes that run from the slopes of the Jonkershoek and Helderberg Mountains, the Cape's wettest areas. Whereas previously the sandy ground of Kraaifontein East would have slowly soaked up this runoff and given rise to a colourful display of flowering bulbs in the usually grey *veld* (shrubland), now a large stagnant lake has become a permanent fixture, except for a few weeks in the dry summer. The resulting landscape is mostly of dry sandy expanses punctuated by a few pockets of dense alien species (acacia and kikuyu grass).

▲ **Figure 7. The land before: a working model shows a public park in Kraaifontein East in summer. Only small patches of alien grass persist. (© Nadine Coetzee)**

▲ **Figure 8. The land after: a working model shows the effects of the reintroduction of water to this public park. A system of rainwater collection and a stormwater outlet enable an endemic landscape to emerge. (© Nadine Coetzee)**

CASE STUDY

IMPROVING WATER MANAGEMENT

The proposal outlined here is for an alternative storm-water management system that would modify the existing system. The runoff from the surrounding mountains would be intercepted, stored and released into a number of existing open spaces across the township of Kraaifontein East. This could offer both a regular water supply for maintained planting and an overflow strategy that emulates the conditions that give rise to the explosion of colour in this bulb-rich vegetation. The principal change would be the interruption of the central storm water pipe at the highest point of the settlement, allowing for the redirection of water across the site (see **Figure 6**). The new water storage tank would be sited at the highest point in the township, in the corner of the local cemetery. From here a number of channels would carry water to a series of parks after irrigating the vegetation in the cemetery.

The proposal is intended to sit between civic implementation and *ad-hoc* adjustment. It is envisaged that the initial changes (interruption of the storm water pipe, storage and channels) would require state intervention and the use of public land. However it recognises the power of leading by example in neighbourhoods where simple changes multiply across a community as soon as their value is recognised. The effects of the reintroduction of water to this landscape and the anticipated floral display could establish and support a secondary system of backyard water use – contraptions for rainwater collection and storage as well as lean-to structures for cultivation. This would multiply the effect of the intervention on this endangered landscape and the overall appearance of the settlement.

A good example of one change leading to others is the work of an organisation called Ikhayalami in Cape Town where, through a strategy called 'blocking out', they have reorganised blocks of housing to create fire breaks, and allow more ventilation and light into houses. Ikhayalami themselves have organised a series of events where an area is deconstructed, reconfigured and reconstructed all in one day. As this is all carried out by the residents and costs little to no money. The strategy has been transferred through living example to neighbouring blocks. The result is a healthier and more fire-resistant built fabric.

With that example in mind, this proposal aims to enable two types of vegetation: maintained and seasonal. Trees are an alien feature in this landscape and thus need maintenance, but because of the shelter they offer and what they mean to the local populations, they have become significant. In Kraaifontein East, trees have been colonised by a number of churches that have adorned them with white painted patterns and rings of stones. These cultural practices are important as they are part of a relationship with and understanding of what this landscape could mean to residents.

▲ **Figure 9. A child plays in a municipal sink, Kraaifontein East, January 2015. A rare moment of moisture in an otherwise dry landscape. (© Nadine Coetzee)**

The core of this proposal is to expose how precious this unique landscape is, so as to tie the cultural identity of the inhabitants of the Cape Flats to their environment. If the presence of water was celebrated in the area shown in **Figure 4** and associated with an institution or public structure, this site could be transformed from a supressed wetland into an ecologically and socially valuable urban greenspace. The linking of the urban and ecological systems in the Cape Flats could form the basis of a strategy for its stabilisation and growth into a space of both natural and cultural value. A series of overlooked sites across the township of Kraaifontein East could be allowed to flourish simply by reimagining urban wasted space as a resource (see **Figures 7 and 8**).

SITE SPECIFICITY

The creation of systems that take their precedent from the landscape they serve are essential – they enable the creation of the best possible urban environments. The systems borrowed from more standard urban layouts would be destructive and inappropriate both in terms of the development of the Cape Flats from township to reasonable town and the celebration of this unique habitat.

The homes of the most vulnerable in urban areas often coincide with the least stable landscapes and thus the world's most endangered flora and fauna. Not only is it important to develop strategies for the conservation of these landscapes but it is also vital to develop ways and means of living comfortably in them. The marvel of Cape Town's internationally unique flora and fauna should be reflected in its environmental strategy. This does not require invention or great expense but a simple adjustment of existing systems to support an internationally important environment and thus expose its value. ES

Nadine Coetzee studied architecture at the University of Cambridge before working in Cape Town, Zurich and London. Having grown up in Cape Town, she has a particular interest in the city and its unique flora. Nadine recently gained her RIBA Part 2 from London Metropolitan University where she combined her interests in her final design proposal (partly described here). She currently works for an architectural firm in London and will return to Kraaifontein East within the next year.

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Smart or happy? Designing cities for people

Robert Ashcroft talks to **Riccardo Marini** about people focused approaches to urban design, and building happier cities.

OPINION

Riccardo Marini is Director of Gehl Architects, based in Copenhagen, and a graduate of the Mackintosh School of Architecture. Riccardo was born in the Tuscan city of Pistoia, and he is very aware that the place and its culture shaped a lot of who he is. He believes that people have to be central to the process of creating our future settlements and rethinking our existing ones.

"the biggest challenge is how we can create environments that are suited to *Homo sapiens*"

As an architect who would define himself as a modernist, he is acutely aware of the potentially destructive nature of architecture that does not know where it belongs and who it is there to serve. Over the years he has frequently observed the inability of professionals to actually listen to people and learn from past mistakes, and this drives him to ensure that there is meaningful engagement and that people come first.

Riccardo loves design and designing but is fascinated by what makes places work. The fact that places are a reflection of the culture of the people who created them is at the core of his passion for 'place making'. He has for many years endeavoured to show that the real value of place is far more profound than monetary value alone, and that the economic indicators that drive a lot of the current decision-making can only be achieved and sustained if you create the genuine article: a place that makes people happy.

We asked Riccardo to talk to us about his perspective on the future of our cities, and what lessons environmental scientists may be able to learn from this about how we consider and approach urban places and challenges.

As an architect who is interested in networks and the interaction of people, what do you think is the biggest challenge we face in the future of our cities?

As Jan Gehl says we know more about the habitat for a mountain gorilla than we do about habitats that are suited to *Homo Sapiens!* We are a gregarious species on the whole, we created cities and they are our best habitats. Since the late 20s or early 30s, we've changed the way we create cities. The advent of 'Taylorism' drastically changed the drivers that controlled city growth. The cities we developed or created stopped being our ideal habitats. People became secondary concerns in city development; what mattered was economic growth and efficiency. I ask a simple question to try and show this shift; what kind of place do you choose to go to on holiday? Yes, you might want to go to the seaside or a mountain top, but after those two different experiences you want to go somewhere to have something to eat, a glass of wine, a coffee and critically you want to share the experience with your fellow humans.

Whether it's a new town in China or a sprawl in a Latin American town that's growing really fast, they're not that kind of place. You're going to want to go somewhere that's more akin to a city created before the 1920s. There is an issue I think in terms of how cities are growing and why they're growing – there's a difference between the natural organic growth that controlled cities' evolution and the kind of expansion that's pumped full of steroids, which is what we do to our cities today.

So, the biggest challenge is how we can create environments that are suited to *Homo sapiens*. And by suited to, I mean that make us happy; that make us comfortable; that make us healthy. I think that's the most important thing. Being economically sound, being efficient, intelligent, smart, call it what you want, is a really good thing, but unless places are happy I won't want to be there and I don't think anyone else should be forced to live in those environments.

Given that most cities have evolved rather than been purposely designed, what small-scale interventions can we make to move towards happier cities?

A place is a reflection of the culture of the people who created it.

Recently I was in San Francisco, visiting our office there. I was staying in a nice hotel in an interesting part of town. I've been to America a few times and always enjoyed it, but on this trip found the place quite depressing. In San Francisco you can see what happens to people when they drop through the net and how the American dream is one which is all about the survival of the fittest, or the most ruthless - compassion does not seem to figure. There are structural issues here relating to societal issues and city governance, and it made me think: we're working on 'parklets', but that is actually wrong on one level.

▲ **Figure 1. Piccadilly Circus in London, where adjustments to traffic management have made the street better suited to pedestrians. (© Thomas Redfern | Dreamstime)**

▲ **Figure 2. Times Square, New York, before and after interventions to make this space better suited to pedestrians (© Department of Transportation - New York City)**

A parklet is a small extension to the pavement with facilities such as seating and plants for pedestrians using the street – they act as gathering places and look pleasant. To focus on making the place feel and look better is actually masking a deeper issue. Now, architects can only do so much, but it does not stop us thinking about what makes a healthy place, or a healthy city. Whether you look at cities growing very fast in China, or expansion in Africa or South America, you see that the nature of this expansion is largely driven by the search for efficiency: how can the place function better for the economic wellbeing of the city? I don't think this delivers the kind of places we really want.

We did a lot of work in New York under the Bloomberg administration to look at turning Broadway (which is a very interesting street within the urban matrix) into a more people-friendly place (see **Figure 2**). I think this was an intervention that was successful, everybody seems to really like it. What we did there was rebalance the amount of space that was given to people as opposed to vehicles and it worked. It was a great place anyway, but it has become obviously more suited to pedestrians and to people, which then makes it better.

However, look at other cities, as an extreme example Dubai. On the surface Dubai and New York may seem similar, with towering skyscrapers and so on. But Dubai was generated post-1925 and it was designed for the efficient movement of vehicles. It's not designed for people to walk around. Apart from not being particularly sustainable, that isn't a nice environment.

So, the question is what can you do? There are lots of things you can do, but sometimes it means quite drastic change to the way a city has developed in terms of why it was designed in a particular way. We need to put people back at the centre of the reasons we do things. The human scale is critical and interventions, however small, need to be more than beautification, they need to challenge where we have taken our cities and reclaim them for *Homo sapiens!*

So, improving the experience of pedestrians is key?

There are real challenges in terms of the geometry we use to allow for efficient traffic movement. For example, at Piccadilly in London some changes have been made which illustrate the difficulties. Here traffic has been slowed down by changing from a one way to a two way system, making it easier to walk across. But in the middle of the road you have a 'refuge' strip for pedestrians. The fact that this is required shows you that, although the new system is an improvement, the language you are using still favours velocity and cars. So even within the historic urban fabric of London the geometry can be altered in ways that make it quite uncomfortable for pedestrians. Cities need to bite the bullet and understand that the biggest asset they have is 'human capital' and if they are not attractive to humans they are on a road to failure.

But what is it really about opening the city up to pedestrians that makes it a happier place?

In our work we try to involve communities in thinking about where they live, and the future of those places. Architects tend to think, 'We know everything. We have all the answers', but this is totally wrong. Following the thinking of Jan Gehl, we as an organisation try to stop being the arrogant architect and realise that you are there to facilitate and to create places for humans. It's not just about making fantastic design statements – these things have to work and make people feel good. So, what we do is what we call co-creation: we involve people in developing an approach that basically gives us the programme or brief.

> **"green can be good and green can be bad – it's about the cocktail! "**

Now, I'm quite comfortable that I live in a liberal democracy (others may argue, but comparatively, we do), but it does seem that the democratic machine we have created to look after us can bring with it an inability to listen to the wishes and desires of the individual person in terms of their everyday needs. A lot of the processes that we get involved in relate to the creation of public space. I think this is an enhancement of democracy in cities because public space is one of those incredible equalisers: it doesn't matter who you are, how wealthy or clever you are, you legitimately can be in it. That's a process that I see being eroded in a lot of different places – the privatisation of public space. Whether that's making it a place you can only be in after buying an expensive coffee, or other forms of limiting access to public space. If you want to test this privatisation just take your camera out while walking along the Euston Road and walk into some of the well-manicured spaces in front of the gleaming new offices and see how long it takes for a security guard to come out and try to stop you.

When I think back to a small square in the town where I was born in Italy – everyone could be there at any time of day, it belonged to everybody. It facilitated and still facilitates communication and positive human exchange. That is a real, healthy thing for us as a species. One of the things that makes us feel good is positive human experiences, which can happen in a park or a square, or on a pavement, as long as it's not too noisy for a conversation or too cramped to push a buggy.

Do you see the benefits to adopting a systems approach to urban planning and design?

Thinking holistically is a welcome approach. It doesn't surprise me anymore, but so often I see lots of effort going in to resolve one issue, and the resolution of that one issue (in terms of meeting the targets that have been set) creates a multitude of other problems down the line. That's such a waste of time and money, and isn't efficient! If a systems approach means really understanding what you are there to do and it involves all concerned in the co-creation of the solutions then yes I can see the benefits.

Do smart cities offer better solutions?

I find it worrying when efficiency and economic output become the dominant drivers for urban change. When I was talking about the transition in the 20s and 30s, that is the change, and it is exemplified by a quote from Taylor (talking about the theory of management later named Taylorism) which I often use: "In the past man has been first, in the future the system must be first…"[1]. At this time the human focus was lost in favour of the economic. That's one of the reasons I'm very wary of the notion of smart cities. Smart developments are not always about making it better for the average person on the street, which I think a smart city should be all about. I talk about making cities happier not smarter. Because if the city's really smart it will make all of its inhabitants happy and make them want to stay there and produce more.

So then, what question should I be asking you? And what should environmental scientists be asking?

What is the right environment for Homo sapiens? We may understand what we need medically, or psychologically, but do we have the holistic picture?

Every now and then research comes out that says 'green is good'. Well, green can be good and green can be bad – it's about the cocktail! What are all the different ingredients that make those very special places that you remember, the places where you can meet and fall in love with someone?

I'm very proud to be an architect. We as a profession have created some fantastic things, but some awful things as well. What Jan Gehl started was a process of looking at the life that sits within these spaces, and making that central to measuring what makes a good place. I'm bound to say that I think he developed some good insight and understanding, but the story is not finished. In particular, I think that one of the things we should now be researching is why the financial models that deliver modern developments aren't delivering the places we want and need. ES

Robert Ashcroft is the Publications and Policy Officer at the Institution of Environmental Sciences and editor of environmental SCIENTIST. He holds a BA in Geography from Cambridge University and an MSc in Biodiversity, Conservation and Management from Oxford University. Before joining the IES team Robert worked as a researcher focusing on biodiversity and nature conservation at the Institute for European Environmental Policy.

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