

foresight

Cities Alive

Rethinking green infrastructure

ARUP

This report is a product of collaboration between the Landscape Architecture and Foresight + Research + Innovation teams at Arup and has involved a wide range of specialists within the firm.

Arup's Foresight + Research + Innovation team identifies and monitors the trends and issues likely to have a significant impact upon the built environment and society at large, researching and raising awareness about the major challenges affecting the built environment and their implications. We help clients think more creatively about the long-term future and manage risk and uncertainty more effectively.

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Foreword

“What should our designs try to achieve?
We must take a critical look at the brief, make it more comprehensive. We must look beyond the narrow object and ask ourselves: What will be the ecological consequences?”

—SIR OVE ARUP, FROM “OVE ARUP: THE PHILOSOPHY OF DESIGN”

As president of the Landscape Institute, I have rarely spoken directly about landscape architecture. Rather, I have discussed the problems facing us as a consequence of population growth and climate change, and how we need to rethink our world on a day-to-day basis if we are to deliver the towns and cities that will provide not only for our needs, but for our pleasure and delight — liveable places to live, work and play, where people can lead happy and healthy lives, despite the increased demands we will place upon them.

And in that future, the professions must fundamentally rethink “green”, not as an optional add-on, a desirable enhancement or a dutiful nod towards biodiversity, but as a fundamental part of the solution. We look to technology to solve our problems, but now we must equally understand the power that nature can contribute to urban technology and science.

The report explores that future, from those things we already take for granted to those more seemingly futuristic but which in reality are happening now. The Arup team has clearly articulated the problems and indicated the solutions; the challenge is for us all to deliver.

—Sue Illman, PLI HonFSE
President of the Landscape Institute

(Left) Crown Fountain, Millennium Park, Chicago

Executive Summary

“The role of green infrastructure in addressing the challenges of the 21st century cannot be underestimated. It is a natural, service-providing infrastructure that is often more cost effective, more resilient and more capable of meeting social, environmental and economic objectives than ‘grey’ infrastructure.”

— GREEN INFRASTRUCTURE: AN INTEGRATED APPROACH TO LAND USE, LANDSCAPE INSTITUTE POSITION STATEMENT (2013)

By working with the natural environment as a key driver *Cities Alive* presents an economic way of addressing the challenges of population growth and climate change in our cities to deliver significant social and environmental benefits.

Population growth, climate change, resource depletion, pollution and urbanisation are all major global challenges facing humankind and nowhere more than in our cities. The quality of our urban environments is particularly at risk and vulnerable. As we move towards a more sustainable future it is critical that cities adapt to and address these contemporary challenges.

Reflecting the scale of the challenges ahead, there is urgency to develop more sustainably and this has become pervasive at all levels of government. The 1987 Brundtland Commission looked to unite countries worldwide to pursue sustainable development, and in 2006 the Stern Review on the Economics of Climate Change discussed the effect of global warming on the world economy. The main conclusion of the Stern report was that the benefits of strong, early action on climate change far outweigh the costs of not acting.¹

Government policy on the natural environment

Emerging government policy in the UK such as the Natural Environment White Paper 2011 (NEWP)² and the National Planning Policy Framework 2012 (NPPF)³ recognise the essential contribution and services that by our natural environment can provide in the move towards more sustainable development. These policies also reflect the public’s interest in creating healthier, greener cities. Under the NPPF local plans are required to incorporate policies addressing strategic priorities, with specific reference to the landscape. It also requires public bodies to cooperate on these proprieties across administrative boundaries. The NPPF emphasises the importance of the multifunctional use of land, stipulating that planning should “promote mixed-use developments and encourage multiple benefits from the use of land in urban and rural areas, recognising that some open land can perform many functions such as for wildlife, recreation, flood risk mitigation, carbon storage or food production.”³

(Left) Wildfowl and Wetlands Trust London Wetlands Centre.



Triton Street biodiversity roof, London

The NEWP is a statement of adopted government policy that outlines the government's vision for the natural environment for the next 50 years, underlining its fundamental importance thus: "The natural environment underpins our economic prosperity, health and wellbeing. The aim of the White Paper is to 'set out a clear framework for protecting and enhancing the things that nature gives us for free, which are too often taken for granted.'¹²

The importance of ecosystem services

The NEWP lends support to the importance of "ecosystem services" and the promotion of multifunctional land use and connectivity. The ecosystem services concept promoted by the Millennium Ecosystem Assessment in the early 2000s⁴ looked to understand nature's value to society, as humankind depends in a multitude of ways upon the services provided by ecosystems and their components: water, soil, nutrients and organisms.

Collectively these benefits are known as ecosystem services and can be defined as the processes by which the environment produces resources utilised by humans such as clean air, water, productive soils, food and materials. To help inform decision-makers, many ecosystem services are now assigned economic values. In the UK the key messages of National Ecosystem

In many cases a substantial transformation of city environments will be required to create a better balance between green and grey.

"People want to be reconnected with nature and they want to transform underused land to produce clean air and clean water, good microclimates and good food. They recognise the urgent need to capture carbon and to create landscapes teeming with wildlife. At the same time, they want to be protected from flooding and want access to land for health and wellbeing. The landscape profession is best placed to deliver these aspirations — it is what the profession is qualified to do."

— MERRICK DENTON THOMPSON OBE, CMLI,
"GREEN INFRASTRUCTURE – AN INTEGRATED APPROACH TO LAND USE –
LANDSCAPE INSTITUTE" (2013)

Assessment⁵ are clear on the importance of nature: "The natural world, its biodiversity and its constituent ecosystems are critically important to our wellbeing and economic prosperity, but are consistently undervalued in conventional economic analyses and decision making."⁵ The importance of acting now is also spelt out: "Actions taken and decisions made now will have consequences far into the future for ecosystems, ecosystem services and human wellbeing."⁵ Included in this vision is explicit support for green infrastructure (GI). In an urban context the NEWP advocates that GI is "one of the most effective tools available to us in managing environmental risks such as flooding and heatwaves."²

A green-infrastructure-led design approach

In response *Cities Alive* proposes a design approach for urban environments that promotes nature as a key driver. This embraces the direction of national government policy described above that acknowledges the essential value of the natural environment and its role in underpinning our economic prosperity, health and wellbeing. The approach seeks to create healthier more socially cohesive and biodiverse urban environments and a connected city ecosystem for people and wildlife that also builds in

We need to consider design approaches that will work at a city scale...can we construct more courageous green-infrastructure-led design interventions?

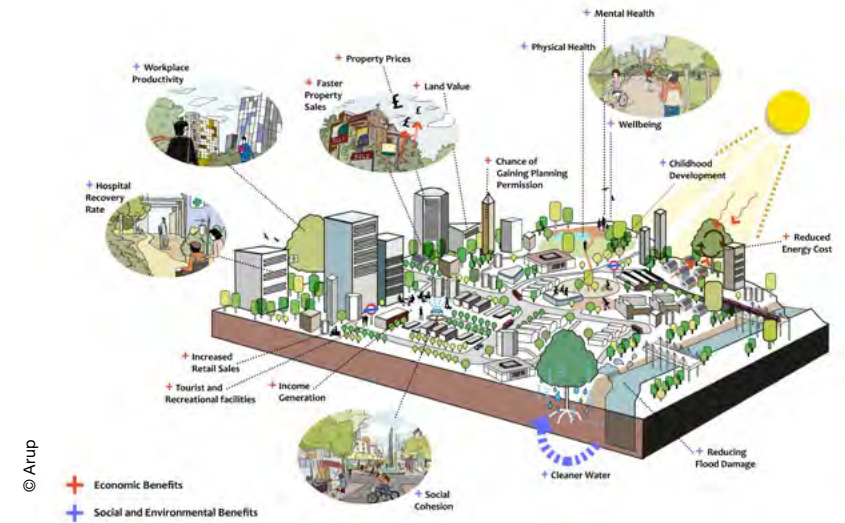


Berlin from the roof of the Reichstag

resilience measures against climate change in the form of storm, flood, heat, drought and pollution protection.

The *Cities Alive* approach seeks to positively utilise the key GI components that lie within our city environments and perform essential ecosystem services. These components may include open spaces, natural areas, urban woodland and parks; green streets, squares and public realm; sustainable drainage systems, rivers and waterways; cycleways and pedestrian routes; and smaller scale interventions such as green roofs, walls and facades.

A GI-led design approach aims to create a network of healthy and attractive new and upgraded city environments, sustainable routes and spaces. The approach would build on, strengthen and link existing GI components described above. Over time this resilient and networked “city ecosystem” will be capable of generating a substantial range of social, environmental and economic benefits for urban citizens, whilst also providing protection against the effects of climate change. A key component is also the promotion of multifunctional design (where a range of benefits are provided in one area through careful planning, integrated design and management) to deliver an array of substantial social, environmental and economic benefits.



A selection of ecosystem service benefits of urban green infrastructure

In a world where numbers matter *Cities Alive* uses global research to demonstrate these benefits. Using nature as a driver for the design of urban environments can deliver wide-ranging gains including greater social cohesion, improved mental and physical health (with resulting economic savings), and lower crime; economic vitality, inward investment and increased property prices; and better urban microclimates, reduced pollution, flood resistance, an increase in biodiversity and lower city carbon footprints.

Delivering green-infrastructure-led design

Delivering greener cities will require a wider understanding of the GI design approach and the associated benefits to bring it into a more influential position in the planning and design process. It also needs to be backed by stronger policy support, more collaboration, a willingness to invest, understanding and embracing new technologies, and a longer term view of the return in terms of benefits to society.

In many cases a substantial transformation of city environments will be required to create effective GI and achieve a better balance between green and grey. However by recognising nature as an opportunity for an effective



Madrid Río

solution and by realising that GI can be integrated and linked into existing and future built developments in an attractive way, the potential is there to create more liveable cities.

With the greener planning policies of recent years there has been a growing interest in more sustainable design in our urban environments. Green roofs, walls and façades are increasingly common as is water-sensitive urban design, an urban agricultural movement and low carbon development. These smaller scale GI interventions are vital and positively utilise pressurised urban space. However, because of the scale of the challenges ahead there is a need to also consider design approaches that will work at a city scale where real differences can be made. Can we construct more courageous environmental interventions — GI-led design that will permeate through cities to create more liveable urban environments?

Many landscape architects and designers of urban environments struggle to protect existing green space against development, or battle to get a successful balance of public realm or open space area within new development when the argument is purely about amenity or environmental benefits. Without new policy frameworks that will legally enforce greener practices, the route may be to demonstrate (using facts and numbers) the essential

“Our current mind-set is that economic success requires increasing consumption — instead we should be valuing processes that reduce consumption — instead of focusing on GDP growth, we should place more value on improving health, education and quality of life.”

— PETER HEAD, “A NEW APPROACH TO RESOURCES” (2013)

social and economic services that GI can provide in urban environments: a common ground for sharing; building community links; inward investment; a healthier population, reducing the economic burden on health services; reduced crime; flood storage, reducing pressure on city infrastructure; encouraging aspiration where there may be inequality.

It is also important to recognise that urban systems do not operate in isolation — they interact. This therefore suggests that for resilience to be effective, the parties involved in each urban system also need to interact and work together. A move towards more courageous environmental design will therefore require “joined-up” thinking; breaking away from silo cultures to encourage cross authority agreements. To realise coordinated resilience proposals in the future private and public sectors, government departments, companies and businesses will need to adopt a more collaborative approach with a view to longer term benefits. This approach can also involve looking at new funding models and engaging more user-driven design to encourage support from and acceptance by local communities. Opportunities for a bolder design approach are also offered by GI planning strategies, large scale infrastructure and regeneration projects



Eco-city by Arup

supported by established environmental policy — the challenge will be to push the GI design of these projects further into a more influential role to gain greater natural benefits and balance within cities.

A way forward

Cities Alive expounds the significant contribution that a GI-led design approach can make towards addressing social, environmental and economic issues in our urban environments, whilst also contributing to climate change resilience. To achieve these benefits it is critical that GI is given a more influential role in the integrated planning and design of our future cities.

(Right) Hyllie Plaza, Malmö, by Thorbjörn Andersson with Sweco Architects





© Ola Ericson (Image Bank Sweden)

Introduction

“Could an approach to planning and development that recognises the social, environmental and economic value of green infrastructure not only increase access to public green space, but help make urban areas more resilient to climate change?”

—TONY JUNIPER, “WHAT HAS NATURE EVER DONE FOR US?” (2013)

Cities need to be celebrated — through the centuries they have been vitally important in the development of mankind as centres of commerce, culture and learning. It is within the urban fabric where the greatest human advancements and changes in technology have occurred. It is vital that our cities continue to strive to be places of wonderment and centres of excellence against future challenges.

Only over the last 200 years has mass urbanisation really occurred, and as recently as 2007, for the first time in human history, the majority of people lived in towns and cities. With this continuing shift to urban living, cities are facing far greater social, economic and environmental pressures. From New York to Shanghai, our drastically different cities must all ultimately confront the same issues of climate change, scarcity of resources, environmental degradation, pollution and dangers to human health. A lack of response to these pressures, or business as usual, will have dire

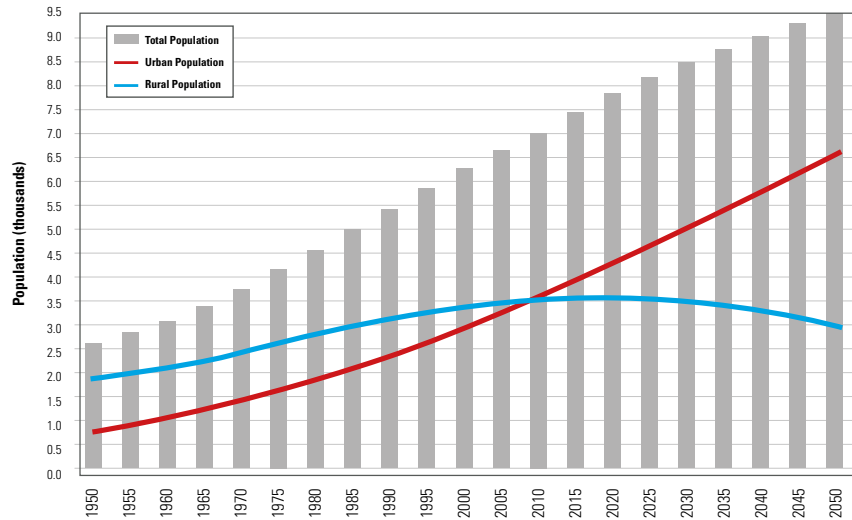
consequences. Can we rise to the challenge to make our cities life-enhancing communities of discovery, creativity and innovation that are safe and healthy for humans and ecology?

Urban spaces are inextricably linked to the environment of our planet and there is a compelling case for building new cities and retrofitting or expanding existing ones in ways that work in harmony with nature, by linking ecological and human systems. The city can become an ecosystem that embeds nature and people as equal partners to help rebalance growing urbanisation. The objective is to achieve a city that works in equilibrium and balance with nature, rather than against it, to address the current excesses of urban living. Ultimately cities must answer to the problems of keeping their citizens, happy, healthy and fulfilled in order to continue their important role in human development.

At present, most cities woefully fail to achieve any sort of balance between people and nature. As pressure has grown

Sustainable new build: Hammarby Sjöstad is Stockholm’s largest urban construction project. The “Hammarby model” has become a tool for environmentally friendly city development around the world. When completed in 2017, 26,000 people will be living here in 11,500 apartments. The district has been planned using an eco-cycle approach and is intended to showcase ecological and environmentally sensitive construction and living.

The urban and rural population of the world, 1950–2050



2009–2010 Revision of World Urbanization Prospects [from UN, Population Division of the Department of Economic and Social Affairs]

on expanding urban areas, urban green space has had to compete against high land prices and increasing densities of development and urban infrastructure, thus squeezing nature out of our cities. This has had a detrimental effect on urban environments with resulting social and health impacts.

There is a growing awareness amongst people and governments, backed up by global research, that increasingly recognises the social, environmental and economic benefits that nature can deliver in creating liveable cities. Governments are now recognising the value of the services provided by our ecosystems; European Union directives are imposing standards for air and water quality. This is reflected in a growing interest in and demand for more sustainable development in urban areas — for green infrastructure, open space and green roofs which are more commonplace and movements towards

For the first time in human history, half the world's population live in cities



Retrofitting the city with nature: The High Line New York: this project captured the public's imagination and helped redefine and globally influence what urban green space can be; it demonstrates how quality city space can positively utilise obsolete city infrastructure and also how a project of this scale can be successfully managed by the local community.

sustainable urban drainage systems, urban agriculture and low carbon residential developments. Whilst this recognition is growing, development can tend to be piecemeal or fall short of the ideal due to the complexities of planning systems and economic constraints. Some cities and places have been successful in understanding the challenges and are tackling them, but there is clearly no routine or consistent application of environmental policy. It is useful to understand why this is and investigate the lessons that can be taken from successful strategies and approaches.

Game-changing projects like the London Olympic Park (a component of a grand planning vision for the All London Green Grid), La Promenade Plantée in Paris and the High Line in New York have all spectacularly overcome the obstacles above. These ex-industrial spaces have been refurbished and by weaving nature



© Peter Neal

Maximising the opportunity of regeneration: the universally acclaimed Queen Elizabeth Olympic Park UK set new standards by weaving biodiversity and nature into the core of the project utilising a GI-led design approach.

into their fabric positively demonstrate what a GI-led design can achieve in the public's perception. They illustrate how obsolete areas of the city be successfully retrofitted for the future; these multifunctional spaces are both adaptable and sustainable, whilst also linking to a much wider network of natural ecosystems.

As we move to a highly urbanised future characterised by uncertainty and risk, there is a need to prepare cities to embrace new global drivers as well as offer potential solutions to the problems cities will face as a result. It is imperative that new urban development avoids the mistakes of the past by taking opportunities to create exciting and challenging architecture within resilient cities that will protect the most vulnerable against climate change and social inequalities.

“The urban landscape is essentially the overlay between a city’s natural systems – the water, trees, air quality, open space, and biodiversity – and its human systems – the sidewalks, bike lanes, fields, transit systems, infrastructure, etc. The two systems are intertwined to the point they are inseparable, and combine to make up what we commonly refer to as the public realm.”

— MARK HOUGH “URBANISM AND THE LANDSCAPE ARCHITECT” (2013)

Cities Alive is split into six main sections.

Following the Foreword, Executive Summary and Introduction, ‘Drivers of Change’ introduces the following main report sections 1-6.

Section 1 (tabbed in red) examines the potential social benefits of a nature-inclusive design approach. “Rethinking Urban Communities” considers how we can encourage investment in healthy and sustainable city lifestyles for social cohesion.

Section 2 (tabbed in green) considers the environmental benefits. “Smart and Resilient Environments” looks at the creation of resilient environments to combat the effects of climate change and the role of connected environments to foster urban biodiversity.

Section 3 (tabbed in blue) “Urban Resource Streams” considers the economic benefits in enabling energy and resource efficiency through effective and multifunctional use of urban space.

Section 4 (tabbed in light blue) features project examples that make a case for GI; good examples, facts and figures from cities around the world.

Section 5 (tabbed in grey) considers the delivery of *Cities Alive* and looks at options and approaches for the delivery of GI-led design.

Section 6 (tabbed in black) is the conclusion and proposes five main strategies for city designers — this way forward is also encapsulated graphically.



Designing the right balance: Hyllie Plaza, Malmö, by Thorbjörn Andersson with Sweco Architect — getting the right balance between hard and soft landscape is essential to build effective an green infrastructure that will create successful city places that will also combat climate change and future challenges to urban environments.



Maximising the opportunities of infrastructure: Madrid Río Project — The city of Madrid took a large-scale and bold approach to improving its city environment by digging 43 kilometres of tunnels into which the exit routes and a 6km section of the M-30 ring road motorway disappeared. West 8, working together with MRIO arquitectos, a joint venture of three Madrid based firms led by Ginés Garrido Colomero, designed the master plan for the reclaimed riverbanks and the new urban area. The **Salón de Pinos**, is a key area designed as a linear green space, which will link the existing and newly designed urban spaces with each other along the Manzanares River, located almost entirely on top of the motorway tunnel, with a “choreography” of 8,000 pine trees planted with a repertoire of cuts. This new green urban space 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.



© Oh-Barcelona (Flickr)

Drivers of Change

“Because of today’s speed of urban development and the almost total embeddedness of global processes in our everyday lives, designers of urbanism are better off keeping their eyes wider open than looking only on the site or even town they are about to work on.”

—FLORIAN LORENZ, “DESIGN ECOLOGIES TO FOSTER URBAN ADAPTIVE CAPACITY”, IFLA JOURNAL #2 (2013)

Most climatologists, social scientists and historians agree that human activity is currently the major force of change on planet Earth and that we will leave an ever-lasting geological record of these changes. By 2050, the human population will have reached 9 billion; of this, 75% are expected to be living in cities. Until then, climate change, resource scarcities, rising energy costs and a preoccupation with preventing and minimising the effects of the next natural or man-made disaster will undoubtedly shape our vision of the built environment. As major cities reach their boundary limits, extending transport networks and urban administrative sprawl will no longer provide an effective solution. Instead, demographic and lifestyle changes will serve as major catalysts in the shift toward increasing sustainability, resilience and adaptability in dense urban environments.

It is now generally recognised at all levels of government² that GI can provide a vital response to urban expansion. With urbanisation comes a host of different issues that can affect the quality of urban space: an ageing population in the developed world, flux in the growth and collapse of business, worsening urban microclimates, a decrease in biodiversity, fragmented or ring-fenced communities, increased risk and more expensive land. In the future, promoting and quantifying the environmental, social and economic benefits and role of a GI-led design approach as an integral part of the solution to urban environments in growing cities is likely to become ever more important.

La Rambla, Barcelona



© Jonathan Hinkle (Flickr)

Post Office Park Square, Boston (see 52)



© Paul Tran (DigitalStills.wordpress.com)

Millennium Park, Chicago



Figure 1: Drivers for Cities Alive This chart maps some of the specific drivers identified in this report over grouping of the key factors affecting and driving the future of the city. Some drivers cross multiple boundaries and some occur outside any of the key groupings. Some drivers also affect each other—where they overlap indicates these relationships. © Arup

1

Social Benefits: Rethinking Urban Communities



Queen Elizabeth Olympic Park, London: Large infrastructure projects bring opportunities for large-scale regeneration of city ecosystems. The bold decision to make the park, containing the major games venues, the centrepiece of a major regeneration project was rewarded with universal acclaim. The park now has the potential to make a dramatic impact on the economy, health and wellbeing of the population in the east of the city.

“Our job, as thinkers and practitioners, is to foster not only the adaptability of the space and of the services within the city, but also to stimulate transformation through flexibility that innovation and new opportunities need. This involves reconsidering the urban natural and built environment and also the attitude of managers and users.”

—MARTA OLAZABEL, “FOSTERING OPPORTUNITIES IN CITIES
IFLA JOURNAL #2” (2013)

The urban environment is changing. Driven by the need to create more sustainable development, urban planners and city councils are rethinking the very structure and function of their cities. At the heart of this movement is a focus on creating more sustainable urban communities and healthier places. A way forward is to rethink the design process and redefine the functions and vital role that urban greening can play in achieving this goal.

Since the creation of the first people’s park (Birkenhead Park, 1844, designed by Sir Joseph Paxton), urban planners have been aware that trees, planting and open space enhance the quality of life for town and city dwellers. Today these associations are becoming more explicit. An increasingly strong evidence base demonstrates the positive effects that access to good-quality landscape has on our health and wellbeing — and the negative effects of its absence. We also know that areas of social and economic deprivation, which are often linked with poorer health and reduced life expectancy, can also be associated with limited access to good-quality green space. All those concerned with creating healthy places — public health professionals, planners and landscape architects — need to recognise urban greening as an asset that has enormous potential to improve our health and wellbeing.⁶

“If you plan cities for cars and traffic, you get cars and traffic. If you plan for people and places, you get people and places.”

—ARUP, SLIMCITY
KNOWLEDGE CARDS (2011)



New Road Brighton by Landscape Projects and Gehl Architects

Urban green space provides vital places for recreation and physical exercise. These places are made for relaxation which acts to reduce stress and improve people’s physical and mental health.

People prefer living in the green neighbourhoods, and house prices in these areas are relatively higher. Research now tells us that contact with nature helps people recover faster from illness, reducing the cost of healthcare. The city is a place where the public realm, open space and parks provide vital places for social cohesion and community wellbeing.

People now migrate to urban areas for a whole host of reasons; for employment, but also for the vibrancy and culture of the city, experience and connection. With this comes the need for a new aesthetic function and identity in cities. In the future, the challenge for urban planning will not just be in squeezing the most out of the space, but in squeezing the most out of the experience of urban life.

In this regard, city designers must respond to this new criteria in their work. Community input is, and will continue to become more important in the planning process, and design needs to encourage healthy lifestyles, social interaction and new urban choices, whilst ensuring security.

“Healthy places make people feel comfortable and at ease, increasing social interaction and reducing anti-social behaviour, isolation and stress.”

—LANDSCAPE INSTITUTE, PUBLIC
HEALTH AND LANDSCAPE (2013)



The Green Link, Motherwell Scotland: A 7km cycleway is changing lives in Scotland's former capital of steel production. The benefits of increased exercise and a safer, greener community are delivering a social return of £7 for every £1 invested.⁶

1.1 Encouraging Healthy and Sustainable Lifestyles

As urban life continues to attract people with legitimate expectations for a high quality of life, cities will face increasing pressure to provide access to well-designed open space.”

—MARK HOUGH, “URBANISM AND THE LANDSCAPE ARCHITECT” (2013)

The economic transformation from the industrial revolution to the growth of the knowledge economy has fundamentally reshaped the way people live. Despite the prosperity and wealth many of these changes have brought, there has also been a range of negative impacts on people's health and on the environment.

Research suggests that by 2020 as many as two-thirds of the population in OECD nations may be obese but that this level will start to flatline as the new generation of conscious consumers begin to dominate demographics.⁷ Not only are this generation more conscious of the wider impact of their everyday routine and consumer habits, but there is now a focus on healthier, more sustainable and sociable lifestyles. This has led to the idea of the city

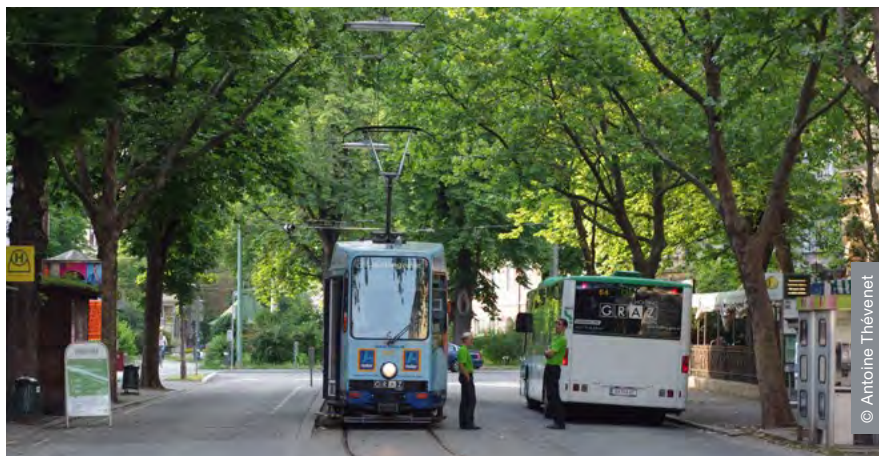


In Copenhagen measures were introduced to reduce traffic and make a city centre more for people. A six-fold increase in high-quality public spaces in the city led to a variety of social, environmental and economic benefits, including a 65% rise in bicycle use since 1970 via the city's cycle super highways. Use of public spaces generally has gone up as well, demonstrating that if a city is furnished with well-planned, well-managed open spaces, people will use them — even in a relatively cold climate like Copenhagen's.

as not just a machine for productivity but also a place for finding catharsis. People are also more globally attuned and environmentally conscious and therefore more likely to respond to better public transport infrastructure, convenient cycle routes and places for walking.

In European cities, cycle-hire schemes, hybrid buses working longer routes, congestion charging and the promotion of walking are all highly visible policy decisions that have begun to re-form the city and its public space.

Despite these schemes, the UK has the worst rate of child casualties from road accidents in Europe.⁸ Many urban planners bemoan the reluctance of governance and the public to engage more fully with public transport or cycling. In Copenhagen, increased investment in public space since the 1970s has been linked directly to a 65% rise in the number of cyclists and a significant drop in both the quantity and speed of automotive traffic.⁹ In London, the Exhibition Road development included a radical measure to remove street markings and signage. The aim was to ease the flow of traffic and pedestrians on the



Tree-lined street, Graz, Austria Tree-lined street, Graz, Austria

notoriously congested street as well as improve safety for a street used largely by tourists who may be unfamiliar with London traffic etiquette. The intuitive and adaptable space has already proven both popular and successful.

City trees can also enhance traffic calming measures. Tall trees give the perception of making a street feel narrower thus slowing drivers down. Closely spacing trees has a similar effect by creating the illusion of speed. Wide, treeless streets give the perception of being free of hazard and encourage faster and more dangerous driving. A study of Texan urban arterial and highway sites compared pre- and post-planting over 3-to 5-year time spans, and found a decrease in crash rates after landscape improvements were installed.¹⁰

In addition to discouraging or limiting vehicle traffic, some cities have begun implementing road reallocations or “road-diets”, where streets are redesigned to allocate more space for pedestrians, cyclists and vegetation. In cities like Chicago, passages and streets account for 25% of ground cover; closer to 40% when parking lots are included. It is increasingly recognised that transforming and reallocating some of this space can help improve the economic and social quality of neighbourhoods for example by increasing tree cover and green space. It will also encourage people

The UK Forestry Commission reports that a 1% reduction in the sedentary population of Britain is estimated to deliver a benefit of up to £1.44bn a year to the economy.



Exhibition Road Shared Surface

to seek alternate methods of transport and pursue healthier lifestyle choices.

Studies have shown that promoting healthier, more outdoor lifestyles can reduce deaths by 2-6 in 1,000 but encouraging healthy lifestyles also has a considerable economic benefit. A UK Forestry Commission report states that motivating even a permanent 1% reduction in the sedentary population of the UK is estimated to deliver a benefit of up to £1.44bn a year in economic benefits to the economy, equivalent to £800 per person. This is accounted for in social benefits and reduced health risks¹¹.

Evidence from Japan emphasises the vital role that tree-lined streets, parks and other green spaces play in our lives. Not only do they enhance our sense of community and our attachment to a particular neighbourhood - they can even help us live longer. Of more than 3,100 people, born between 1903-1918 in Tokyo, 2211 were still alive by 1992; the probability of their living for a further five years was linked through research to their ability to take a stroll in local parks and tree-lined streets. Research also shows that people will make more walking trips to task destinations (such as stores or coffee shops) when they perceive that there are many natural features in their neighbourhood. In less green neighbourhoods, people

← Leicester Square



Park in Amsterdam

“Researchers from the University of Exeter, using data from 5,000 households over 17 years, found that people reported lower levels of mental distress and higher degrees of life satisfaction when they were living in greener areas. Researchers agree that the body of evidence is sufficient for urban planners to factor in the benefits derived from green spaces when designing new developments.”

—MARK KINVER, BBC NEWS, GREEN SPACES “CAN SAVE NHS BILLIONS”

judge distances to be greater than they actually are, perhaps leading to decisions not to walk.¹²

Increasing green space is becoming an important core component of most urban environment policies. This research has shown that living in or near green space has a significant benefit for not only the physical but also the psychological wellbeing of city-dwellers.¹³ Even passive interaction with nature — simply being able to see a tree through a window — is enough to lower stress and blood pressure.¹⁴

Even passive interaction with nature is enough to lower stress and blood pressure.¹⁴

“Legible London is a pedestrian wayfinding system that’s helping people walk around the Capital. Based on extensive research, the easy-to-use system presents information in a range of ways, including maps and signs.”

—Legible London, Transport for London, 2012



© Katorisi (Wikimedia Commons)

Garden Playground Katori-City, Japan

“Increasing urbanisation has left our children with far fewer opportunities than previous generations to play freely outdoors and experience the natural environment. Good-quality public spaces — including well-designed school grounds — can help to fill this gap, providing children with opportunities for fun, exercise and learning.”

—HELEN WOOLLEY AND SIAN ROSE, “THE VALUE OF PUBLIC SPACE, CABE” (2004)

For children, interaction with and within green spaces is all the more important. A movement called No Child Left Inside founded in the United States around 2005 seeks to educate and expose children to nature in a bid to increase literacy on climate change and health while giving them exercise and strengthening their immune system.¹⁵

More directly related to health, the Lea Valley redevelopment that encompassed the Olympic Park for London 2021 is planned to continue operation as public sports and leisure facilities. As part of the Olympic Legacy, most of the facilities used for the Olympics will continue to be used by local teams and organisations to promote sport and healthy lifestyles. Bearing these kind of legacies in mind and considering alternate uses for open and public spaces that are adaptable to changing lifestyles is an important thinking point for a Cities Alive initiative.

Queen Elizabeth Olympic Park: The venues used for the London 2012 Olympic and Paralympic Games are intended to deliver an important legacy by providing future training facilities, promoting healthy living in the local community and acting as a magnet for major sporting events, visitors, sports clubs and business. Seven of the eight permanent Olympic venues' futures have been secured with appointed operators; London is on course to secure the future use of every permanent venue — a first for any Olympic City.



© Arup / LDCC



Centre Pompidou, Paris

1.2 Supporting Urban Communities

“As urban life continues to attract people with legitimate expectations for a high quality of life, cities will face increasing pressure to provide access to well-designed open space.”

—FLORIAN LORENZ, “DESIGN ECOLOGIES TO FOSTER URBAN ADAPTIVE CAPACITY”, IFLA JOURNAL #2 (2012)

City planners and politicians recognise the value of communities for social cohesion, the health of a city and the wellbeing of its citizens. They also know that well-designed communities and local neighbourhoods can play a crucial role in enabling healthy and sustainable lifestyles. The goal is to create and foster local communities that limit the need for car-based travel, while maximising the potential for walking, cycling and public transport. To achieve this, people must be given access to local services, have good public transport connections to other parts of the city and be given opportunities to work and play closer to home.

From producing fresh food to strengthening neighbourhood bonds, community gardens can have a huge impact on the quality of city life. Through its

“When I said in my inaugural address that Philadelphia will be the number one green city in America, I’m sure many felt the goal was too bold, too ambitious, perhaps unachievable. Now, looking back on the first year of Greenworks, I am more confident than ever that we will be successful... It puts people to work, and we’ve seen it all throughout the city and our job-training programs creating green jobs, strengthening our neighborhoods.”

—MAYOR MICHAEL NUTTER, CITY OF PHILADELPHIA (2013)

Philadelphia Green program the Pennsylvania Horticultural Society has helped thousands of Philadelphia residents turn neglected vacant lots into thriving community gardens in every corner of the city. Pennsylvania Horticultural Society supports these gardens with technical assistance, training, and networking.¹⁶

A research team has found that distressed neighborhoods where vacant lots have been converted into small parks and community green spaces are associated with reduced crime when compared to neighbourhoods with unimproved vacant lots. The study was conducted by a group from the University of Pennsylvania’s Perelman School of Medicine, using Philadelphia data compiled over the last decade. In some sections of the city, residents of neighbourhoods with improved vacant lots also reported “significantly less stress and more exercise,” suggesting that the improvements had an effect on residents’ perceptions of safety outdoors.¹⁷

A clear goal of Mayor Michael Nutter’s sustainability plan Greenworks Philadelphia is to add 500 acres of new publicly accessible green space to the city by 2015.¹⁸ The Green2015 initiative of Philadelphia Parks and Recreation and PennPraxis outlines the strategy for how to meet this 500-acre goal for Philadelphia. The goal of Green2015 is to unite city government and neighbourhood residents to transform empty or underused land into parks for neighbours to enjoy. Most of the land that can be greened is already publicly owned and therefore requires no money



© Sarah Blee, J&L Gibbons

Dalston Eastern Curve Gardens, London

to acquire. The planning, implementation and maintenance of these parks will be a collaborative effort among many partners, including neighbours, businesses, nonprofits, developers and the city.

The Mayor's Office in London is now committed to building 100 new pocket parks of 0.4ha or less by 2015 in reflection of the importance of green space to foster better local communities, new business and wellbeing for people in cities.

These policy decisions are leading to a new trend in localism. In various cities, subsidies are provided for local businesses that use locally sourced produce, often grown in urban green spaces. In Brixton, south London, the introduction of the Brixton Pound was an initiative to encourage local residents to shop locally, enhancing the local economy and community identity. With this increase in localism comes a need for new urban spaces and identities that can support interactions and activities to further strengthen burgeoning neighbourhoods and even whole cities.¹⁹

A well-designed urban environment is likely to have positive effects on the creation and growth of communities as they have the opportunity to build an identity for social interaction around these spaces. Green spaces, in whatever form, represent the greatest investment for the



© Infrogmation of New Orleans (Flickr)

Esplanade Ridge Pocket Park, New Orleans

"It is landscape professionals working in urban contexts which are confronted with both social and ecological aspects in their work and who are therefore able to build urban adaptive capacity in a social as well as ecological sense."

—FLORIAN LORENZ, "DESIGN ECOLOGIES TO FOSTER URBAN ADAPTIVE CAPACITY", IFLA JOURNAL #2 (2012)

increase of social capital. New York's High Line is a great example of a community-led regenerative project that has strengthened the identity of the area.²⁰ Every stage of the project was led by the Friends of the High Line with regular consultations with residents and business owners. Following the opening of the first phase in 2009, over 30 more community projects were under way in the neighbourhood.²¹ However, some also comment that the High Line and similar projects of regeneration can have a negative effect of touristy, overpriced and shiny gentrification.²² Directly inspired by the High Line, the High Line for London competition and New London Landscape project are catalysts for new types of GI that were voted on by the public. An open, competition-driven, democratic decision-making process may become more common for future public works.



Unrest at Gezi Park, Istanbul

Conversely, the architecture need not be expressly “green” in the traditional sense for communities to thrive around it. Torre David in Caracas is a startling example of what happens when a community seizes the initiative of self-government and community resilience in the face of poverty and homelessness. The residents, who are all squatters, have turned an uncompleted banking skyscraper into a small village with 700 families, water, electricity, health services and plans for wind turbines and urban farming.²³ Here the architecture has become the very fabric of the new community built around it instead of an “untouchable” monument.

In another even stronger example, the wave of unrest that gripped Turkey in early 2013 began as a result of government policy decisions to remove and develop on top of public parks, particularly centred on Gezi Park in Istanbul. Here the green space became a place for a unique and empowered community to evolve and a place for them to call their own, much like the parallel Tahrir Square in Egypt or Zucotti Park in New York acting as the centre of the global Occupy movement.

Commissioned by the Architecture Foundation in collaboration with Team London Bridge and Southwark Council, the Gibbon’s Rent project is transforming the public realm of a long-forgotten cut through into a

The green space became a place for a unique and empowered community to evolve

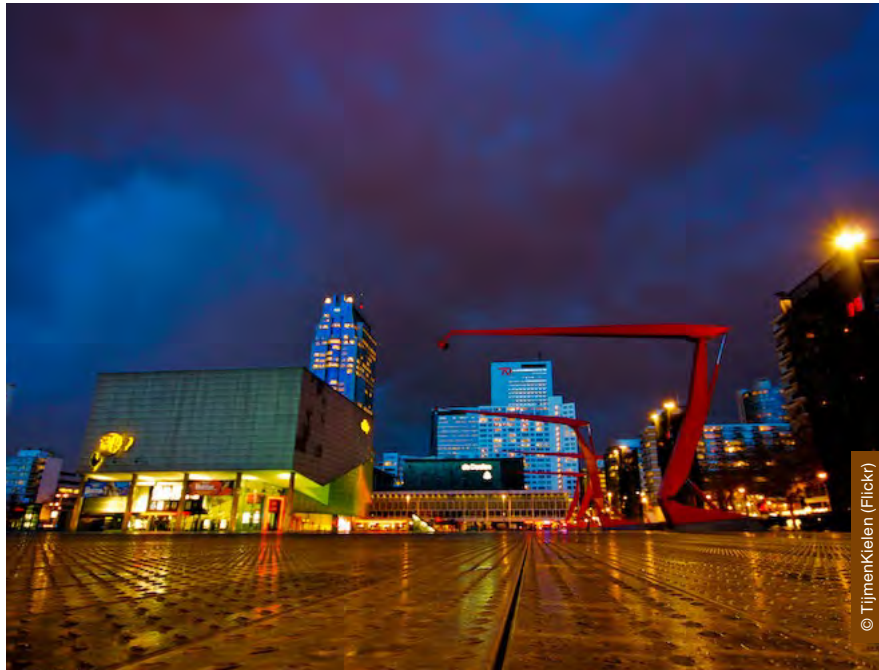


Park(ing) Day

permanent green space. The project, run by Superuse Studios, employs resource-based design — “superusing available flows and resources and connecting them into urban ecosystems.” The project also features public event programmes to inform and encourage community participation.

There are also several consistent part-activism movements working their own quieter interventions into the city. Guerrilla Gardeners stalk the city at night, planting flower beds and performing small-scale landscaping on neglected public spaces. Park(ing) Day is a one-day event that originated in San Francisco and has been running since 2005. Street parking spaces are greened with turf, garden ornaments and furniture to highlight issues around urban green space, particularly the prevalence of a car-dominant environment in our cities. These kind of humorous, tongue-in-cheek interventions are becoming more popular and the movement has spread to many cities in the west (in 2011 there were reported to be 975 “parks” in 162 cities). It may well be that planners and city officials can strive to develop ways to respond to these interventions and look to better plan urban environments for people rather than cars.

There are also several consistent part-activism movements working their own quieter interventions into the city.



Schouwburgplein in Rotterdam is a great example of an open environment directly responsive to the intervention of the public where visitors have almost total control of the strange, abstract sculptures that provide lighting.

In Toronto there is a strong sense of greening urban spaces, where environmentally friendly development policy is leading the charge on the city's recent population explosion. However, some parks and spaces remain neglected as government support fails to keep up with the spread of the built environment. In the future, more community-driven initiatives like those described on the next page may lead to landscapes maintained and supported by a willing and educated public.

Pocket Park Philadelphia — part of Greenworks Philadelphia, an initiative to add 500 acres of new publically accessible green space to the city by 2015



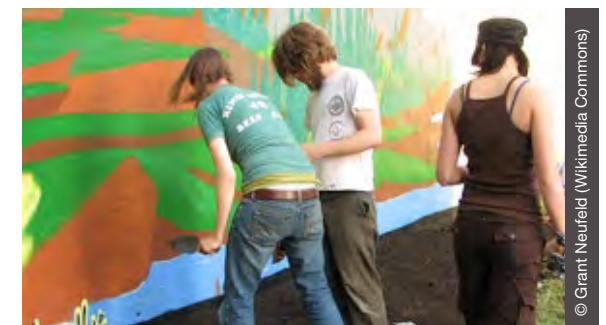
Park(ing) Day



Occupy Zucotti Park



Guerrilla gardeners planting vegetables in Calgary





© Landscape Projects / Gehl Architects / Shaw and Shaw

New Road Brighton: Making an investment in the high street through high-quality public realm design can contribute to a popular and different offer to out-of-town shopping.

1.3 Investing in Liveable Spaces

“Urban regeneration programmes in the UK over the past 20 years have increasingly focused on attracting investors, middle-class shoppers and visitors by transforming places and creating new consumption spaces.”

—MIKE RACO, “REMAKING PLACE AND SECURITISING SPACE” (2003)

In an age of growing uncertainty security can become a paramount concern for urban communities. Reinforcing the identities of local communities can offer a more efficient way of driving bottom-up actions to secure and improve lifestyles. High-quality urban spaces can provide a boost to local economies by giving a place for people to meet and socialise, using entertainment services in the local area instead of travelling out of town. This encourages local enterprise and in turn bolsters the financial security of the local area. While the trend towards private and semi-private urban realm within large development projects can be seen positively in terms of investment, it can also be viewed negatively as a move towards a surveillance culture and exclusion of public realm for all.

The high street has economically suffered in recent times. The growth of massive out-of-town shopping



© Arup

Fitzroy Square, London: Green space provides a haven for social interaction on a summer's day.

centres has drawn trade away from traditional central commercial hotspots. However, some of the cities suffering from these exoduses have also seen a rise in small, independent, boutique shops and the trend toward “pop-up” short-term commercial enterprise.¹⁴ Thoughtful planning can play a key role in sustaining the commercial lifeblood of the urban environment. The New Road project in Brighton was a former run-down high street dominated by vehicles. A high-quality public realm scheme by Gehl Architects introduced shared surface, which has had a dramatic effect on boosting the local economy. Since its opening, traffic levels in the street have dropped by 93%, whilst cycling and pedestrian numbers have risen by 22% and 162% respectively. Now one of the most visited streets in Brighton this is an example of how investment in liveable urban space can reap dramatic benefits for the urban population.²⁴

A distinguishing element of the High Line project in New York is the extraordinarily and unexpectedly low crime rate, with no reports of any serious crime in its history and only two complaints — one for minor graffiti and another for a lost wallet. Commentators put this down to the effect of a large community around the park and the informal protection that comes of such a tightly knit community with a shared space to protect. A study of 98 vegetated

A distinguishing element of the High Line project in New York is the extraordinarily and unexpectedly low crime rate.

“First, [green space] helps people to relax and renew, reducing aggression. Second, green spaces bring people together outdoor, increasing surveillance and discouraging criminals. Relatedly, the green and groomed appearance of an apartment building is a cue to criminals that owners and residents care about a property and watch over it and each other.”

—FE KUO AND WC SULLIVAN, “ENVIRONMENT AND CRIME IN THE INNER CITY: DOES VEGETATION REDUCE CRIME? – ENVIRONMENT AND BEHAVIOUR” (2001)

spaces in Chicago showed that they cut crime rates in half by inspiring pride for the area and mitigating psychological precursors like stress and anxiety.²⁵ New urban spaces are more often taking into account CPTED (Crime Prevention Through Environmental Design) principles in order to build secure and resilient communities. In Birmingham, UK, the use of brighter street lights and the widening of footpaths achieved a 70% drop in petty crime, while in London, various neighbourhoods applying these techniques have experienced not only a drop in crime but also a considerable drop in the fear of crime — in some cases up to 83%.²⁶

In 2001, researchers at the University of Illinois studied how well residents of the Chicago Robert Taylor Housing Project (the largest public housing development in the world, comprising 28 tower blocks) were doing in their daily lives based upon the amount of contact they had with nature. The case study investigated whether shared green spaces, particularly those with trees, helped to strengthen social ties among neighbours.²⁷

The research found that residents who had contact with nature had significantly better relations with and stronger ties to their neighbours — meaning that those residents who lived with trees nearby socialised with their neighbours more, felt safer and suffered 52% fewer

Residents who lived with trees nearby socialised with their neighbours more, felt safer and suffered 52% fewer crimes.



Købmagergade, Copenhagen: shopping street

crimes. They also felt emotionally and physically healthier than those in treeless blocks.

The study concluded that “far too many poor, inner-city neighbourhoods remain urban deserts.” Planting more trees in these areas would “help improve residents’ social support thereby potentially reducing the burden on public social service agencies.”²⁷

In a security-conscious world it appears that gated communities are on the rise. In an extreme version of such security-driven design, the architecture of Israeli settlements is designed to be easily defensible, often based on medieval European fortifications. This is a recent example of the worrying and growing trend of “weaponised architecture”²⁸ and highlights how resource and land scarcity and global conflict are forcing unique criteria in landscape planning to the surface.

Thoughtful planning has the potential to facilitate highly local, independent retail spaces that could revitalise communities or introduce new types of consumer behaviour. In a future of further financial uncertainty, this kind of adaptability will be ever more important as urban planning provides a backdrop for the changing desires and habits of consumers. Studies have shown that well planned rebranding of urban shopping spaces can increase commercial trading by up to 40%.²⁹

Thoughtful planning has the potential to facilitate highly local, independent retail spaces that could revitalise communities or introduce new types of consumer behaviour.

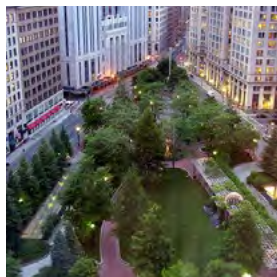
“As towns increasingly compete with one another to attract investment, the presence of good parks, squares, gardens and other public spaces becomes a vital business and marketing tool: companies are attracted to locations that offer well-designed, well-managed public places and these in turn attract customers, employees and services. In town centres, a pleasant and well-maintained environment increases the number of people visiting retail areas, otherwise known as ‘footfall.’”

—HELEN WOOLLEY AND SIAN ROSE, “THE VALUE OF PUBLIC SPACE, CABE” (2004)

Further to this, research has shown that people who work in buildings who can see green space take almost a quarter less time off work than those who cannot.³⁰ Green space has also been shown to increase land value by 22%.³¹ In 1992, a 500,000 square foot parking garage in the centre of Boston’s financial district was demolished in a joint public-private venture to be replaced by a park and underground car park. As of 2009, revenue from the car park funds the park maintenance and an excess of around \$2m for public spending. In addition, property prices in the area have risen around 10%, attracting wealthier businesses.³² This is a fantastic example of the potential of investing in GI where the multipurpose use of space can make both attractive and useful space profitable.



Post Office Park Boston: Before
© landscapenotes.com



Post Office Park Boston: After
© landscapenotes.com



Chattanooga, Tennessee

Between 1988 and 1996, the city of Chattanooga, Tennessee, managed to increase property value by 127.5% and tax revenue by 99% following a determined program of urban rebranding in the form of \$500m in greenways and tree planting.³³ The idea of planting trees in Chattanooga has been around for a long time. The remnants of a turn-of-the-century effort evident in the older sections of the town where large and stately willow oaks can still be seen. This tradition continued in the 1960s when the Scenic City Beautiful Commission spearheaded the planting of several hundred trees in the downtown area. The City of Chattanooga initiated a new Urban Forestry program in 1989 to manage its natural environment resource. Considering that publicly managed trees in Chattanooga occur on almost 1200 miles of streets, 100 miles of alleys, over 35 parks, two public golf courses, a cemetery, and an extensive greenway system, the program is charged with managing a very large resource base. The environmental, aesthetic and economic value and impact of this program to the citizens of Chattanooga and its guests is potentially very great. Therefore, Chattanooga has recognised the importance of its natural environment resource and has taken important steps to provide professional management to sustain and enhance it.

Green space has been conclusively and repeatedly proven to have huge economic benefits.



A pocket park in Barcelos, Portugal: green space is valuable at all scales in the urban environment.

A problem often encountered in urban planning is a lack of funding for landscape or GI. Although green urban space has been conclusively and repeatedly proven to deliver huge social, environmental and economic benefits, it is given a low priority by investors who want to maximise development space. One way forward to create a better “grey-green” balance for the benefit of urban citizens could be to consider alternative models of funding such as crowd funding, working on public-private partnerships or even a combination of sources, so that the interests of business and the city environment can both be met. The Bankside Urban Forest in London is a great example of where multiple private and public bodies and institutions have worked together to increase tree coverage in line with London’s overall vision for greater tree cover in the city.³⁴ The US, Germany and, increasingly, China already have a well-established culture of setting aside finance from project budgets for green space. Future developers will have to work to bring the benefits of good green space planning to investors in order to duplicate that culture elsewhere.



Bankside Urban Forest: Multiple private and public bodies and institutions are working together to create a network of green connections. It is a good example of a series of individual small projects having a large-scale impact when woven together to form a new landscape across an urban area.

Launched in 2007, Bankside Urban Forest is a long-term partnership project that is looking to improve the network of streets and public spaces between the riverside and Elephant and Castle, spreading the benefits of regeneration deeper into the Borough, making Bankside a better place to live, work and visit. By working with private and public partners, local residents, businesses, developers and landowners, the project aims to implement green streets to encourage cycling and walking and lower traffic speeds.

By using the term “forest” the project hopes to inspire imagination. The strategy is not literally to turn the area into a forest, although it does create opportunities for GI, via the design of tree planting, planted walls and other means.

2

Environmental Benefits: Smart and Resilient Environments

Hammarby Sjöstad, Sweden: The Hammarby Model has become the approach for environmentally responsible and sustainable development across the world.

“In the last decades, the global effort has continued to address the ideal healthy green city. However, many meaningful ideas remain only on paper — so many words, so little action. It is time for the mise en scene of thought to involve all the players; designers, engineers, politicians and citizens.”

—MARTA POZO GIL, “WILD CITY”, ARCHITECTURAL DESIGN #223 (2013)

Climate change is one of the major drivers of change that can detrimentally affect the city. Sea levels and temperatures are already beginning to rise, and unadaptable or poorly designed urban environments will undoubtedly suffer the most from these changes. Considerate planning with multifunctional GI design can present opportunities for dramatically increasing resilience in urban environments. Better protection from climate change may also be supported through contributions from innovative technologies, long-sighted forward-planning strategies and considered preparation for future adaptability.

In addition to this, planners, developers and designers have to consider what role they have in fostering sustainable urban environments — whether to adapt and change to new conditions or to introduce smart, resistant factors into new designs in order that they can endure climate change.

Climate change is one of the major drivers that can affect the city.



Flooding in Florida

2.1 Enabling Long-Term Climate Resilience

“[Climate change] is the as yet imperfectly perceived geophysical and geopolitical base of 21st-century civilisation. The challenge is not to solve a problem, but to manage a panoply of risks at every level from that of the farm and city, up through the state and region to the globe itself.”

—MEGACHANGE: THE WORLD IN 2050, THE ECONOMIST (2012)

The effects of climate change are becoming more visible in the context of the urban environment. Some places face physical degradation as stone and brickwork crumbles under severe weather. Recent natural disasters around the world have highlighted the lack of preparedness of many urban environments in the face of climate change. In the future, a GI-led design approach can be employed to weave nature into the city to provide vital carbon sinks and effective mitigation against risks such as flooding, heatwaves and drought. An awareness too

Awareness of new technologies and techniques will also become important in the resilience of the city against climate change.



The Louisiana Speaks Regional Plan: New Orleans is moving to more natural solutions to climate change using a GI-led design response.

of new technologies and techniques will also become an important consideration in developing resilience in cities against climate change. Planners, developers and designers therefore have the opportunity to establish themselves at the forefront of climate change adaptation techniques.

Initiatives like the European Union GRaBS (Green and Blue Space) are beginning to establish frameworks for these kind of considerations, collaborations and changes to be made.

In England and Wales an estimated 2.7m properties are at risk of flooding⁵⁴. New urban planning models suggest that where appropriate, space should be allocated for water-sensitive urban design (WSUD) and features such as new water bodies, reed beds and areas of ground percolation can also be designed for buffering, water filtration and drainage. These types of integrated GI solutions can create attractive new natural features in the city environment whilst also offering climate change adaptation.

In England and Wales an estimated 2.7m properties are at risk of flooding.

“Unfortunately, it has taken a series of water-related disasters to make people see that status quo engineering standards — the pipes, walls and levees — may not be the only or best way for handling water, whether it be too much or too little. Hurricanes Katrina and Sandy, the floods in the Midwest and droughts across the southern half of the country have each shown the need for innovative ways to manage water. Cities are looking toward green infrastructure as a means to not only better deal with stormwater, but to also mitigate flooding, increase biological diversity, and provide cleaner water and air.”

— MARK HOUGH “URBANISM AND THE LANDSCAPE ARCHITECT” (2013)

After the failure of the structural flood defences in New Orleans after Hurricane Katrina in 2005, the state of Louisiana and city of New Orleans have taken steps to increase the resilience of the city to sea level rise, hurricanes and flooding. What is significant is there has been a clear shift from structural defences to more natural solutions utilising green and blue infrastructure inspired by the Dutch experiences.³⁵

In Northumberland, woodlands have been shown to provide £1,200 per hectare in flood alleviation savings versus the cost of engineering a solution.³⁶ The Mt. Tabor sustainable drainage system installed in Portland, Oregon is another example of climate-change-resistant measures in action. This system uses the terraces of the mountain for stormwater processing with the lower areas processing the water for human consumption while the whole area is surrounded with walkways and promenades. The system effectively copes with storm events whilst using nature to clean road run-off. As a result overflows into local rivers have been cut by 35%.³⁷ The sustainable drainage system installed in Portland Oregon led the way in demonstrating how natural drainage can be attractively integrated into the urban landscape.



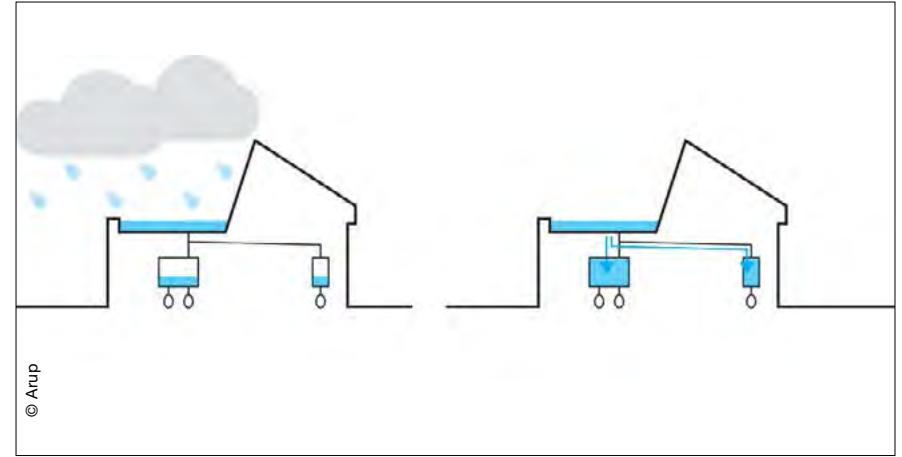
Road run off entering this sustainable drainage system in Seattle is cleaned by nature

Urban areas will have to cope with increased rainfall events that will occur due to climate change. Directing more rain into surface water drainage systems will often overload them, causing floods. The sustainable solution is to use natural systems to slow down, hold and buffer storm- and rainwater and allow it to infiltrate naturally back into water courses. This means a better balance of areas of floodable vegetation and more permeable surfaces is required in urban areas to replace impermeable concrete, tarmac or roofed areas.

Like the system in Portland, sustainable urban drainage can be designed to be easy to manage, requiring little or no energy input, and environmentally and aesthetically attractive. These systems may include reed beds and other wetland habitat that can collect, store, and filter polluted water whilst also providing wildlife habitat.

In Rotterdam the Spangen district has almost no open water and a high proportion of paved surfaces within a dense urban environment. In order to build resilience to climate change a series of attractive, well-vegetated water squares have been proposed in the district. The design of the central area of each square has been lowered and paved to act as a buffer for rainwater. Paved surfaces around connect to the central area which will occasionally fill to reduce the impact of rainfall and storm events on the

Urban areas will have to cope with increased rainfall events that will occur due to climate change.



Water roofs offers a simple and cheap way to attenuate stormwater flows — by storing water temporarily on a flat roof.

city infrastructure. This is a creative and realistic solution to deal with climate change in an effective way that can be adapted to virtually any urban situation.³⁸

A critical objective for the Rotterdam authorities was the need to create substantial additional water storage capacity within the city. One option that was realised was to incorporate 10,000m³ of underground storage within the design of a parking garage beneath Museumplein square. Water is stored in a separate reservoir which utilises the residual space beneath the parking garage's entrances and exits. This proposal alone provided 12% of the water storage capacity required for the city centre.³⁸

This example, which uses city space in a highly effective way, requires thinking and cross-collaborative authority agreements. Therefore, the realisation of coordinated resilience proposals for the future will require utility companies, businesses private and public sectors to adopt a more collaborative approach with a view to longer term benefits of current actions and proposals.

Arup has been working with Sheffield City Council UK on a pilot study to assess the city's resilience to the effects of climate change.³⁹ The study looked at how climate change may impact urban systems such as transport, waste management and food supply,



© Sookie (Flickr)

Toronto, Canada: Green roofs attenuate run-off offering mitigation to existing city drainage systems.

questioning whether they are able to meet the pressures that climate change will place upon them. The important realisation from this study was the recognition that urban systems do not operate in isolation — they interact. This therefore suggests that for resilience to be effective the parties involved in each urban system also need to interact and work together.

In Chicago, urban planners are building in climate change resilience now. The city has more than 13,000 alleys that total more than 1,900 miles of area. Those 3,500 acres of alleys consist of enough impermeable surfaces to equal the paved area at about five mid-sized airports. Rainwater can no longer soak into the ground, so the city is more prone to flooding. Because the cost of retrofitting conventional storm drainage systems is prohibitive, the City has started a programme of building permeable pavements that allow stormwater to filter through, “catch basins” to capture water and funnel it into the ground, and high-albedo pavement to reflect sunlight to reduce the heat island effect. These measures will not only help guarantee longevity for Chicago’s environment but will save the city money in the longer term.

The Green Alley scheme involves the redesign of streets for heat expansion and water permeability in expectation of increased rainfall.



© Dollia Sheombar (Getty Images)

Rotterdam: the floating pavilion by Deltasync and Public Domain Architects

In an even more extreme case, Rotterdam is already prototyping and testing new climate-change-ready and carbon-neutral floating constructions.⁴⁰ These floating half-domes aim to pilot future construction options for the sea-level rises expected to affect Rotterdam in the next few decades. The structures are solar-powered and carbon neutral. Rotterdam aims to be fully climate-proof by 2025.⁴¹

This kind of approach to adaptability has to be taken into account if major infrastructure and development projects are to last in a world of climate change. The Thames Barrier in London was recently re-appraised to be suitable for flood protection until 2070 despite inevitable rises in sea level. This can be put down to worst-case foresight analysis in disaster protection. The same sort of foresight now needs to be applied to even seemingly minor and everyday urban space projects.

This kind of attitude of adaptability has to be taken into account if long term projects are to last in a world of climate change.



Augmented Reality

2.2 Creating Smart and Connected Landscapes

“Nowadays, a ‘smart city’ should be able to negotiate spaces, social networks and technology as smart infrastructure. It is evident that designers in urbanism will have to negotiate these diverging goals if urban areas shall be successfully managed and developed.”

—FLORIAN LORENZ “DESIGN ECOLOGIES TO FOSTER URBAN ADAPTIVE CAPACITY”, IFLA JOURNAL #2 (2013)

In the developed world, 2050 will mark the coming of age of a generation of digital adults who will have grown up engaging with smart devices and materials. They will have experienced technological breakthroughs that will redefine how human beings interact — not only with each other, but with their surrounding environment. We could be living in cities where everything can be manipulated in real-time and where all elements of the urban fabric are part of a single smart system of an “internet of things”. These expectations set the tone for an environment that invites



Miami Beach Soundscape

responsiveness and adaptation with ease — a place where hard infrastructure, communication and social systems are intertwined, with a conscious awareness of the need to integrate and engage in sustainable design practices.

The recent release of Google Glass heralds the beginning of an age of augmented reality. Citizens may no longer be solely engaging with either the physical landscape or the digital, but with both simultaneously. City designers and the digital environment need to be ready to respond to this. Maximising the opportunity for data sharing within public spaces may become a common consideration for urban planners. Data from citizens could be used to optimise the way the space is used, and data in the space could be used to add another layer of entertainment, business or services to it. People may go to one open space to play video games with each other in much the same way that Washington Square is used by chess players now, or another to see streamed concerts or sports events. The physical and digital might also merge in the form of virtual events digitally projected into certain public spaces where people might congregate to watch and interact together.

A precursor to this type of public space can be seen in the Miami Beach Soundscape. Here, high-tech speakers amplify the sounds of concerts held inside the adjacent

The recent release of Google Glass heralds the beginning of an age of augmented reality.



© HyunJune Yang / SADI

D'Nature modular digital greenspace

New World Symphony Center as visuals are projected onto a massive wall. This is a small, green reflective space that is fully integrated with advanced media features to bring the public into the digital sphere from outside the intended space. In the future, we may see these kind of experiences grow ever more augmented as multiple global locations are connected for a shared experience through digital means. The fledgling HELLO Europe! project is an exciting example of this kind of public, digital interventionism. Giant screens were erected in public places at street level around Europe and randomly connected to each other for a few minutes allowing people across Europe to interact with each other. Once these kind of ideas migrate into augmented reality and networking, public spaces will start to look very different through the eyes of devices. Despite being digital experiences, these projects will need to be based in comfortable and weatherproof spaces.

Even more extreme could be the consideration of virtual environments. Where space is at a premium, projects like Yanko Design's D'Nature modular digital greenspace could supplement existing real greenery to complete a more comprehensive environment.



© Fongemind ArchiMedia (Flickr)

Taichung Gateway Park Proposal, Taiwan

Smart landscapes would also enable more efficient use of resources. New technologies could enable lighting or heating that responds to people's presence instead of being always on as well as smart systems that protect the system from weather with ejecting shades, rain cover or heating pathways.

Schouwburgplein in Rotterdam (Page 48) is a great example of the beginnings of this kind of responsive, smart design. At a more personal level, Energy Forest in Pittsburgh uses clever technological devices and postmodern design principles using the natural resources of wind and water to create interactive light shows that respond to conditions in the slope-based park. Water passing down the hill over the LED-lit path causes them to light up while tall aluminium poles create a similar effect using the wind and vertical fans. Public spaces may also find themselves having to compete with the digital space for attention, and in this they will have to be particularly innovative and attractive to urban citizens.

Energy Forest in Pittsburgh uses clever technological devices and postmodern design principles using the natural resources of wind and water to create interactive light shows.



© Pro-Teq Surfacing

Pro-Teq Surfacing UK Ltd — Starpath

“Cities of the twenty-first century may well be designed around the mobile phone in the way that cities in the twentieth century were designed around the car.”

— BEN HAMMERSLEY, “64 THINGS YOU NEED TO KNOW NOW FOR THEN” (2012)

Pro-Teq Starpath is a sprayable coating of light absorbent particles that harvest ultraviolet rays from the sun during the day and then illuminate at night. Because it is in a spray form it can be applied to nearly any solid surface from timber to cement, after it is set, allowing easy application after a development is finished. Starpath has the potential to reduce the need for complex lighting installations in parks and alleyways while allowing for the introduction of lighting and the safety and security that brings. Another benefit is that since its nonreflective and relatively low intensity, it doesn't add to light pollution.

New York's Freshkills development is a massive parkland planned to be built on landfill, and therefore any construction of foundation-supported signage is prohibited. As a solution, New York's Parks and Recreation department commissioned an augmented reality app from media architects Med44⁴² that utilises a smartphone's in-built compass and GPS to show facilities, projects under



Smartphone augmented reality App

construction, wildlife sightings, links to articles, video and photos and a walking guide for park visitors — all of this without impeding on the natural environment.

This kind of approach significantly lowers the cost and complication of implementing signage in a large and complex development as well as providing a purer experience for visitors to the area.

New smart transport links will also require integration. Personal rapid transport may become more popular, in which case landscapes will have to make themselves ready for this level of automation. Before this, road safety remains a primary concern as experiments in shared space, where ground space is shared equally between pedestrians and other methods of transport, are proving remarkably successful as in London's new Exhibition Road regeneration. In dense urban areas, already experiencing a decline in private transport, shared spaces may become more common.

From a design perspective, advances in geographical information science (GIS) can also allow for smarter planning of urban landscapes. GIS uses overlays of different factors of a landscape to calculate optimised layouts for a variety of land uses, from agriculture to ecological potential, calculating best travel routes and the potential for alternative future applications for the space.

In dense urban areas, experiencing a decline in private transport, shared spaces will become more and more common.



GIS – Geographical Information Science – mapping

GIS can be a powerful tool in mapping people’s relationship with their environment and ensuring that they are used optimally and for the best outcome for everyone. New York City Parks Department uses another piece of software, iTree, to calculate the cost benefit of public amenities. It has discovered through this that trees provide for some of the best return on investment. New York City’s more than 600,000 trees provide an annual benefit of \$122m for the city and its businesses - more than five times the cost of planting and maintaining them.⁴³ More common and more rigorous applications of this kind of technology may lead to more future-proofed and efficient environments at a time where space is at a premium.

For a more general overview, programs and audits such as C40. The C40 Cities Climate Leadership Group is a network of the world’s megacities committed to addressing climate change can provide comparative data on the design and demographics of the city. These wide-ranging projects read into the wealth, health and environment of the city to extract vast amounts of comparative, qualitative data. By drawing information from a wide net of cities and comparing them across a wide range of variables planners can draw patterns and relationships as well as prove the worth of a GI-led design approach in tackling the problems facing particular cities.

These wide-ranging projects read into the wealth, health and environment of the city to extract vast amounts of comparative, qualitative data.



Vertical Ecosystem, Spain: In denser urban environments, creative design that effectively utilises city space can provide valuable linked habitats for wildlife.

2.3 Fostering Urban Biodiversity

“Thinking of the city as the habitat for all species, and not only people, can establish a more symbiotic relationship between buildings, land and nature, creating intriguing and exciting functions of landscape and building functions.”

—MARTA POZO GIL, MVRDV, AD (2012)

Biodiversity should always be a premium concern for the urban environment. Not only is the future of the planet threatened by the city that grows while taking from nature without giving anything back, but biodiversity is a great indicator of the ideology of a development. It can be a gateway to other green techniques and technologies that can help to sustain the urban ecosystem as a whole.

Biodiversity is vital to a healthy urban environment, and it can also provide a boon to the economics and resources of the city, providing tourist attractions or sources of revenue as well as making the environment of the city feel more alive and fulfilling for citizens.

A key objective of the development of the Olympic Park in London was to leave a valuable legacy of open space and biodiversity to act as a catalyst for the regeneration of this area.



Luminosity has a long history in biology with bioluminescence used as a core tool of molecular biology to allow scientists to understand the inner workings of the cell. The first bioluminescent plant was made in 1986. Long-term ambitions of this work include the development of glowing trees that can be used to replace street lights, saving CO₂ emissions.

“...Of the many issues affecting the world’s biodiversity today, habitat destruction is often cited as the main contributing factor. Cities and urban populations are expanding at a rapid rate, with ecologically sensitive areas increasingly at risk of becoming lost within their fabric and fragmented to a level where they cease to function.”

—AUSTIN BROWN AND DAVID LEWIS, ARUP (2013)

Urban green space provides natural habitats for many species. A key objective of the development of the Olympic Park in London was to leave a valuable legacy of open space and biodiversity to act as a catalyst for the regeneration of this area of East London. The hope is to encourage a return of historically native animal species, some of which are now fleetingly rare. This use of the urban environment as opportunity for animal repopulation and preservation will become a crucial part of future planning.

The UK Wildlife Trusts Living Landscapes Initiative is a landscape-scale conservation effort to target and halt the decline of wildlife and restore the natural environment. This work focuses on landscapes or large areas, rather than individual habitat patches employing a multidisciplinary approach (eg, habitat creation, restoration and provision of

The design must serve more than just an aesthetic need in order to support fledgling ecosystems.



Queen Elizabeth Olympic Park — ecological habitat

“One welcome success in incorporating green spaces into urban life was the 2012 Olympic Park in London...I visited a few months before the Games and wandered beside a recently established reed bed, where a small black, red and white bird flitted across a path. It was a stonechat, and the first of its kind recorded in that part of East London. Nearby, at the edge of a newly created pond was a grey wagtail. It seemed an incongruously graceful bird to be found on a building site. But these and other creatures were not there by accident. The creation of natural habitats for local wildlife was an integral part of the overall design of the Park with sustainable drainage incorporated with the creation of wetland. These features quickly attracted other birds, including little grebes and reed warblers, and as these areas mature other wildlife will join them.”

—TONY JUNIPER, “WHAT HAS NATURE EVER DONE FOR US?” (2013)



© Fons Heijnsbroek (Flickr)

Street Kattenburgergracht in Amsterdam: features large elm trees which bring many benefits to the street in terms of the play of light and shadow, seasonal change, shade and shelter and visual delight for residents and visitors.

landowner advice. Work is carried out in partnership with a range of organisations and local communities to deliver environmental and health benefits for people, skills training and green tourism, as well as improving conditions for wildlife

Importantly, this leads to the need to consider the kind of designs and habitats that will appeal to animals and plants, not just to humans. It also means that the design must serve more than just an aesthetic need in order to support fledgling ecosystems. Management must be flexible⁴⁴ and responsive to potential species that may choose to inhabit urban green spaces in order to nurture them. This will lead to greater ties between planners and ecologists working with biodiversity.³⁷

Much like with Chicago's plans to introduce flora from southern states to prepare the ecology for global warming, planners and developers will need to consider what new species might dominate a city of the future, not just the past. Thinking even further afield are ideas around what new species might be introduced through new technologies. Synthetic biologists are already working with ideas splicing bioluminescence into trees which would significantly lower the environmental impact of street lighting and provide a brand-new form of infrastructure.



© Bryce Edwards (Flickr)

Promenade Plantée, Paris — positively reuses obsolete city infrastructure

A lot of the projects to reintroduce natural filtration through wetlands like the Taichung Gateway in China will, through their very nature, reintroduce biodiversity as large tracts of land are turned over to natural processes. More established urban environments will struggle to reintroduce urban biodiversity where space is constrained — for these areas, methods can be developed that will allow integrated design for biodiversity. This may involve green roofs, walls and facades, reuse of old city infrastructure and even temporary occupation and beautification of neglected spaces.

In dense urban environments designers will need to be creative and plan GI using the multiple layers of the city. This will involve using city space more effectively by exploiting available space on roofs, balconies, walls and building elevations and by redefining new uses for obsolete grey city infrastructure. After the success of the Promenade Plantée in Paris and the High Line in New York City many cities are planning elevated or ground-level linear parks reusing urban infrastructure. This includes the Bloomingdale trail in Chicago, the Maidashi Ryokuchi in Fukuoka in Japan and the Reading Viaduct in Philadelphia.

In Los Angeles there are plans to reintroduce biodiversity through reflooding the concrete storm drains that cross the city over the path of the original river.

In Los Angeles there are plans to reintroduce diversity through reflooding the concrete storm drains that cross the city.



High-rise greening: The Bosco-verticale by Stefano Boeri, Milan. The concept is to reforest the inner cities with two high-rise apartment blocks covered with the maximum amount of vegetation.

These would be turned into open wetlands reintroducing native species to the area but also encouraging aesthetic diversity in the notoriously concrete Los Angeles landscape. Projects like this are a prime opportunity to introduce ideas of biodiversity into the very heart of the city.

In some cases planners are even looking underground. The plans for New York's LowLine would make it the world's first underground park using fibre optics to create remote skylights. If the plan works it may encourage other cities struggling to find space to think about new and alternative locations.

In the 1980s in Austin, Texas, Mexican free-tail bats started gathering each summer under the Congress Avenue Bridge. Initially a nuisance to local authorities and residents the colony, now some 1.5m strong; the largest urban bat colony in the world has become one of the city's largest tourist attractions.

Natural, wild grasslands and woodland, left to their own devices, are key places to encourage biodiversity in city environments.



LowLine, New York

The urban environment needs to be planned to enable preservation of valuable natural and seminatural areas that support habitats for wildlife. At the same time opportunities for creating new areas where nature can flourish unabated are required to bring balance and harmony into the city. Natural, wild grasslands and woodland, left to their own devices, are key places to encourage biodiversity in city environments.

The City of Basel in Switzerland has the highest area of green roofs per capita in the world. Initiatives aimed at increasing the provision of green roofs in Basel were initially driven by energy-saving programmes and subsequently by biodiversity conservation. Green roofs were funded by the city for a two-year period, and convincing evidence that green roofs can protect endangered invertebrate species has emerged. The green roof programme is now used as a form of ecological compensation where developments have led to the loss of habitat.³⁸

The green roof programme is now used as a form of ecological compensation where developments have led to the loss of habitat.

The world's largest urban bat colony, Austin, Texas



3

Economic Benefits: Urban Resource Streams

Landschaftspark, Duisburg Nord, Germany by Latz + Partner. The existing patterns and fragments formed by industrial use were taken, developed and reinterpreted by interlacing existing fragments into a new landscape.

“Most of the current world population live in mechanized and urban environment, but as a societal whole still continue (in a fashion) to forage for food, minerals, oil, gas, and other valuable resources all around the world using extensive industrialized methods of extraction. With a growing urban population and competition for resources it is becoming necessary to develop more efficient methods of foraging in all regards.”

—MARTA POZO GIL, “WILD CITY”, ARCHITECTURAL DESIGN #223 (2013)

Whether in regeneration or advanced planning building nature into the fabric of the cities can provide both aesthetic beauty whilst delivering real resources into urban environments. As space becomes a premium resource, the opportunity to maximise the productivity of multifunctional design and shared space is something that is likely to become more valuable in the future as the demand on resources and services increases.



Chicago urban farm

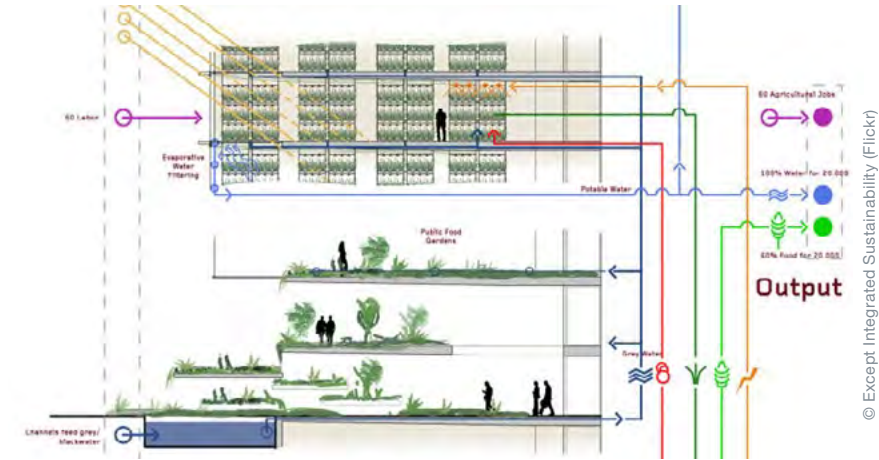
3.1 Integrating Urban Food

“Rooftop farms in some of the world’s most crowded cities, including Hong Kong, New York and Tokyo, are adding green to the gray. They are reconnecting city dwellers with nature, teaching consumers about homegrown food and offering a glimpse, perhaps, of a more secure and sustainable food supply.”

—MARY HUI, NEW YORK TIMES (2012)

Many commentators now predict that we will see peak food around the world in the next two decades— we will begin to consume more food than we can possibly produce. Following that, alternatives to the current model of mass agriculture will have to be found. A big potential for an alternative model lies within the idea of the natural city.

At present, making food that is nutritious, sustainable and abundant poses a significant challenge in itself. In the future, factors such as climate change, long transport distances, a reliance on petrochemical industry for fertilizers, volatile markets and inefficient safety standards could lead to an increasingly severe version of our current food crisis. Demographic and lifestyle changes will serve as major catalysts in the shift towards an increase in densely populated and utilised urban environments. Rising



Vertical farming can maximise available urban space – an extract from an operational and flow diagram

food prices, the growing population and environmental concerns are just a few issues that will affect how we feed ourselves in the future. In addition to improving physical, psychological and social health, green spaces allow for a more pragmatic health solution — urban agriculture.⁴⁶ By 2050, food security may be one of the most critical factors of global geopolitics, with its intimate ties to oil prices, transport networks, climate change and population growth.

Brought about by a concerns over rapidly depleting natural resources, global food trade, lack of physical space and climate change, food production systems, like green spaces, could become integral elements in urban environments. Vertical farming techniques and urban agricultural systems, such as hydroponics, can potentially be utilised to help address the impending crisis in world food production.

As a response, there has been a widespread emergence of movements such as guerilla gardening, co-operative urban farm schemes, vertical farming proposals, and aquaculture in urban settings. These primarily utilise the interstitial spaces within the city — rooftops, public parks, road edges and underused transportation infrastructure.

In addition to physical, psychological and social health, green spaces allow for a more pragmatic health solution— urban agriculture.



Aerial view of Lufa Farms, Montreal: the world's first commercial rooftop greenhouses that make effective use of urban space.

Vertical farming — with the use of integrated aquaculture systems — presents a potential solution to the critical issue of feeding a growing population within the context of the city. The concept is to contain, the production of food, harvesting of green energy, and a closed feed system in one building, with limited transportation and distribution requirements. A dense concentration of agricultural activity is contained within a minimal urban and carbon footprint, merging seamlessly with the existing urban structure.

Current experiments in urban farming include a 15,000-square foot rooftop in Brooklyn that produces 500 pounds of produce a day, Growing Home in Chicago with an incredible 13,000 pounds. VertiCrop proposes urban solutions producing 20 times the food mass of field farms with only 8% of the water. In Brooklyn, organic supermarket giant Whole Foods has teamed up with Gotham Greens to open a 20,000-square-foot greenhouse and growing space to supply its local stores. This will lower transportation costs and the carbon footprint.

A dense concentration of agricultural activity is contained within a minimal urban and carbon footprint.



Union Street Urban Orchard was a temporary installation for the London Festival of Architecture. It provided a positive initiative to reintroduce urban green infrastructure as a means of developing community spirit.



Eco-city, China by Arup

“The scale and type of urban foraging can be very diverse; ranging from harvesting edible and medicinal plants for private use, to community groups dealing with fruits collection and utilization at a city level.”

—VLADIMIRS GUCULAKS, IFLA JOURNAL 2 (2011)

More purpose-built vertical farms have long been on the planning agenda for many cities and the first commercial farm was recently opened in Singapore. Sky Green Farms consists of 120 9-meter aluminium towers able to produce half a tonne of vegetables per day. These will soon become a regular feature of urban construction, adorning the outside of tall buildings around the city. For now, the drive for locally sourced produce has started to bring agriculture into the city.

The Biophilia Hypothesis proposes a more rugged alternative to organised urban farming. It points out how urban wildlife has adapted to foraging in the urban environment and humans may soon too. Proponents of the Biophilic City maintain that better education about the possibilities of urban foraging and guidelines promoting wild vegetation for human wellbeing may lead to a revolution in the way people interact with the city, introducing a new, wild

urban consumer ecosystem into which urbanites are fully integrated.

Initiatives are already underway around the world to educate people on how our diets will have to adapt to climate change, and Biophilic foragers, eating weeds and vegetation in the wild urban environment, could form a part of this change.

Could further speculation about food demand could see huge swathes of parkland being turned into active farms? Coupled with climate change this could mean rice paddies in Parliament Square, as envisioned by the Postcards from The Future project.⁴⁷



© Carlos Felipe Pardo

Cheonggyecheon River Park Seoul: the sculptural remains of the former three lane highway stand as reminders of one of the most polluted areas of the city; now renewed into a healthy river park for urban dwellers and visitors. (See Page 119)



© M. Peinado (Flickr)

Madrid Río

3.2 Renewing Urban Spaces

“The ubiquity of the High Line as an urban design topic demonstrates the far-reaching impact it has already had. This idea of creating dynamic spaces out of abandoned industrial wastelands has captured the imagination of cities across the country, as is made evident by examples of reclaimed industrial piers, steel yards, rail yards and upcoming High Line wannabes in Chicago and Philadelphia.

—MARK HOUGH, “URBANISM AND THE LANDSCAPE ARCHITECT” (2013)

In many cases a substantial transformation of city environments will be required to create a better balance between green and grey. With urban space under development pressure, a multifunctional design approach, which is a key component of a GI, fits with the need to regenerate, rebrand or renew neglected or abandoned urban space to maximise the creation of new dynamic and flexible urban environments for people.

At the Mt Tabor regeneration site in Oregon, the same water system that filters the drained stormwater also provides the energy that fuels its own processing,

making this a model for future water processing plants. The new Taichung Gateway Park in Taiwan is another larger investment in water treatment with a large reedbed providing for more natural water processing against a historically high amount of pollutants. To the outside eye it appears to be an untamed meadow and marshland but water is carefully channeled for cleaning. This is a great example of how, when space is hard to come by, thoughtful planning and considerate use of space can enable pleasant multipurposing.

In an intrepid move to combat, noise and pollution and provide a healthier and enjoyable environment for its citizens and tourists, Madrid buried 43km of its M-30 ring road motorway. The Madrid Río project restored the Manzares River and formed accompanying areas of open parkland, gardens and promenades. The Madrid Río project ably demonstrates the value in a bold approach to reclaiming urban space from roads to fashion multifunctional urban environments for people that are healthier, quieter and beautiful and can also promote economic benefits via tourism. In Shanghai, there already talks of an underground grassed park as part of its 107m-square-foot underground developments.

The ongoing Freshkills development in New York is looking to reclaim one of the area’s largest landfills to create

The Madrid Río project ably demonstrates the value in a bold approach to reclaiming urban space from roads to fashion urban environments for people.

“All around the world, highways are being torn down and waterfronts reclaimed; decades of thinking about cars and cities reversed; new public spaces created.”

—MICHAEL KIMMELMAN, NEW YORK TIMES (2011)

a park 2.7 times the size of Central Park. Much like with Lee Valley there is large-scale planning to use much of the park for needed sports and recreation facilities. As time passes and levies on landfill become more severe, new applications for these former interstitial spaces are going to be more in demand and developers will be challenged to think of ever grander and more innovative visions for them.

In Europe, a growing concern to help reduce the carbon footprint of construction as well retain a more authentic feel has led to a growth in desire for locally sourced, traditional materials. The aim with recent developments in Upton, UK, was to create an urban extension that homaged the construction styles and techniques of the past while also setting new standards in green technology and construction methods, including the integration of photovoltaics, WSUDS and Micro-CHP (combined heat and power) energy management as opposed to boilers. The design went through extensive consultation with locals to help write up a construction code for the concepts and styles to define the new construction to include the use of only recycled, locally sourced materials. Similarly, Daybreak Community in Utah, USA, uses rocks removed from a local mining operation to construct the parkland of the settlement.

In the UK, partly inspired by the success of the High Line and from an idea by Joanna Lumley, Thomas



Garden Bridge, London

Heatherwick has proposed the Garden Bridge. This footbridge- being developed by Heatherwick Studio, Arup and Dan Pearson studio, will be replete with grasses, trees and plants, offering a new green space across the Thames in the very heart of London. The project is designed to encourage walking and engagement with the natural world in the heart of the city.

In Ghana, the new HOPE city tech hub is a \$10bn project aimed to increase tech investment in the area. Although aimed to house 25,000 and full of cutting edge environmental technology it is still based around the principles of community and resilience that dominate traditional Ghanan public space, with the buildings arranged in an open clear compound and a lot of visibility. The aim here is to provide the keystone for a new type of city for Africa. Here we might see a uniquely African brand of natural city evolving, in respect of culture and tradition in what will soon be the world's most rapidly urbanising continent.



Urban green in Bilbao, Spain



Green Wall, The Palace Hotel, London: Living walls can make a significant contribution to building cooling and insulation, thereby helping to lower energy consumption.

3.3 Enabling Energy and Resource Efficiency

“Cities already consume 60% of all drinking water worldwide, either directly or indirectly through irrigation for food crops. Moreover, although cities occupy only 1% of the Earth’s surface, they account for an estimated 75% of global energy consumption and 80% of greenhouse gas emissions generated by human activity.”

—ULRICH EBERL, “LIFE IN 2050” (2011)

Cities currently hold 60% of the world’s population but are responsible for 80% of emissions.⁴⁸ If the population of cities is to continue to grow there needs to be a drastic rethinking of how green solutions are implemented in the city. Environmentally aware planning has a key role in making our cities more efficient and getting us to consider new behaviours that will help to alleviate this footprint.

Studies have shown that the careful deployment of GI in the city can cut energy and resource costs drastically and act as carbon sinks to mitigate the risks of climate change. A living ecosystem that can be fully integrated within the city can make a city vastly more efficient and

improve the quality of life and the resource prosperity of residents.

Trees are well known to have massive benefits for the climate. Not only do they provide for absorption of carbon dioxide but they can also act as natural coolers and insulators. Even modest tree cover has the potential to drastically reduce the urban heat island effect of cities through evapotranspiration and shading. Placed directly in front of south-facing walls they can significantly cool a building and reduce the cost of air conditioning and cooling energy bills. In a similar way, installing green spaces on the roofs of buildings can better insulate them to reduce energy bills significantly.

The installation of a green wall at Edgware Road underground station in London has been shown to supply warming benefits to the building. The wall also acts as a physical filter for pollution when the fine particles (known as PM10s) are trapped on the surface of leaves. When carried into the lungs PM10s make chronic diseases such as asthma and bronchitis worse. Therefore interventions such as these are effective in creating healthier urban conditions. Green walls were show to reduce building temperature by 11 degrees and around 4 degrees in cities like London and Montreal. In Copenhagen as part of the city’s plan to be climate neutral by 2025, any roof with

Cities currently hold 60% of the world’s population but are responsible for 80% of emissions

“Firstly — as designers in urbanism — we can understand what we do as a guiding of urbanism; we are as much observers, mitigators, mediators and creators of what is happening in our cities.”

— FLORIAN LORENZ, “DESIGN ECOLOGIES TO FOSTER URBAN ADAPTIVE CAPACITY”, IFLA JOURNAL #2 (2013)

less than a 30 degree slope is required to have a green roof. These kind of policy approaches need to continue and become commonplace in the future, as governments fall into line with the demands of a new climate and urban planners are asked to respond.

GI can also be considered as a way to ease the aesthetic and environmental impact of the construction process. Several companies offer mobile green walls for use instead of garish and complex construction hoardings. Mobile green walls can offer opportunity in terms of the adaptability of a space too, allowing it to be moved and reshaped easily without impact on its carbon footprint. They can also be used in interior spaces, providing quick solutions to temperature control and reducing the demand on building infrastructure.

Additionally, for the construction stage, the local sourcing of materials and the streamlining of the construction process will set the stage for a green ideology throughout the project. Developers need to consider not only how the end product of their design can be as resource efficient as possible, but how the very planning and development can be.



Large species trees present an important opportunity for resource efficiency in urban environments by providing shade, shelter and protection from wind.

Large trees also present another important opportunity for resource efficiency in urban environments. Well-planned trees can provide shade in intense direct sunlight as well as provide windbreaks and shelter to protect public spaces from cold winter winds and reduce demand on air conditioning systems.⁴⁹

New materials such as ‘green concrete’ that absorb carbon from the atmosphere and can absorb and store thermal energy are also currently being researched. Since concrete will always compose a significant proportion of the city, enabling it as a source of resource efficiency will have significant impacts on the urban environment.⁴⁹

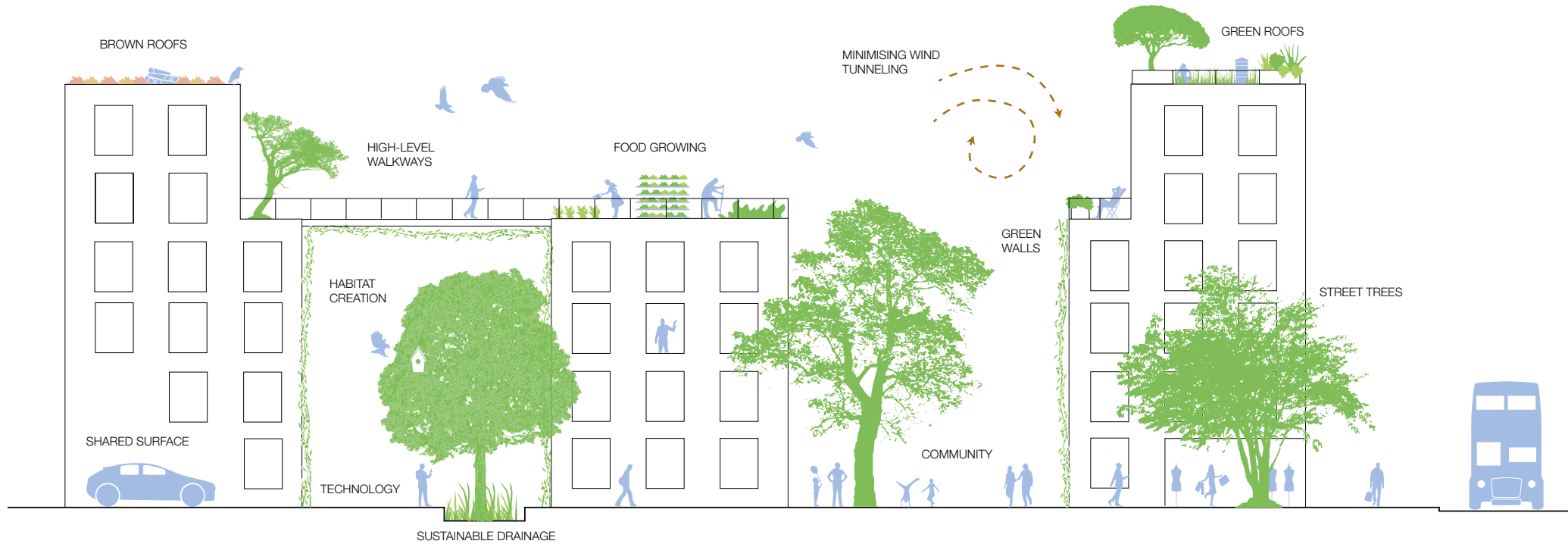
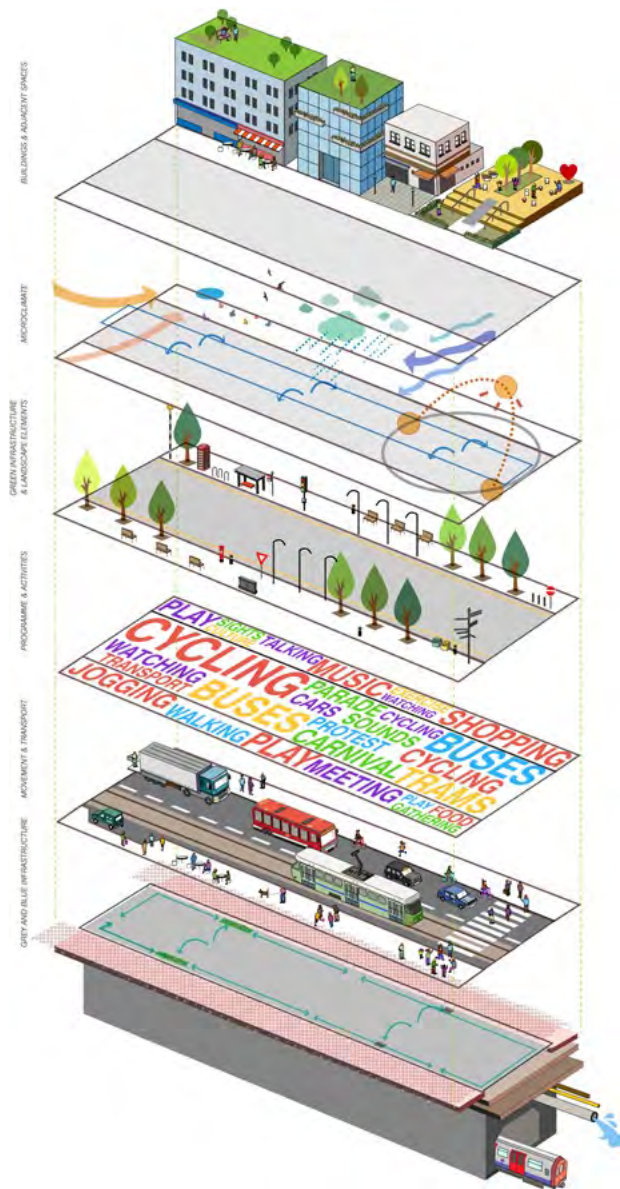


Figure 2: Multilayered and integrated green infrastructure

Urban planting offers significant opportunity for resource efficiency: providing shade to intense sunlight, reducing demand on air conditioning systems and providing windbreaks to prevent cooling. As space in urban environments becomes more precious, planning for GI needs to be considered using a multilayered approach to ensure effective urban greening. © Arup



Resilient streets: this drawing illustrates the GI-design requirements for a high-quality street environment that also builds in climate change resilience. © Arup



Southbank, London

Streets are the life blood of our towns and cities. They facilitate a huge variety of activities and functions which can constantly change and evolve, reflecting the local dynamics of place. Streets are part of our collective consciousness providing the backdrop for social interaction, culture, music, film, food, memories and identity. The quality of these important thoroughfares and spaces has a direct bearing on the economic, social and environmental success of the wider city and its inhabitants. Yet despite this significance, streets have been seriously neglected over the last few decades, and many have become cluttered, traffic dominated, polluted, poor quality environments. Although streets are used daily by everyone, they are often seen as a no-man's-land that no one wants to take ownership of, or pride in.

Moving to a greener, multiuse, multisurface, active street environment is often difficult for a number of reasons. In many areas traditional car-dominated design still dictates standards and design approaches. Disparate stakeholders with different impacts and requirements on the street environment and no overall coordination can make management fragmented. The true value of quality streets and public realm is often overlooked by local councillors and politicians due to other short-term political priorities, even though street space is cited in

“This research shows how good street design contributes both economic benefits and public value. It shows that investment in design quality brings quantifiable financial returns and that people value improvements to their streets. Simply improving street design can make a major difference to market values. For the first time we can see that the best streets really are paved with gold.”

—CABE, “PAVED WITH GOLD”, THE REAL VALUE OF STREET DESIGN (2007)

community surveys as being amongst the most important local services. Quality street and public realm design offers good value in terms of investment cost, but schemes often struggle to obtain adequate capital and importantly revenue funding. Confusing and often complex regulatory frameworks also make management and enforcement difficult with a frequent lack of available resources within local authorities.

However with global trends in urbanisation and sustainability, streets are increasingly being seen as key to enhancing quality of life, offering alternative forms of movement to the car and supporting street-based growth in local leisure, retail and commercial economies. They can also be vital in contributing to climate change resilience via microclimate amelioration, sustainable drainage and storm protection, urban pollution and biodiversity, with the quality of the street environment having a direct impact on the success of the local economy and the health and wellbeing of the local population.



San Francisco: Better Streets Initiative

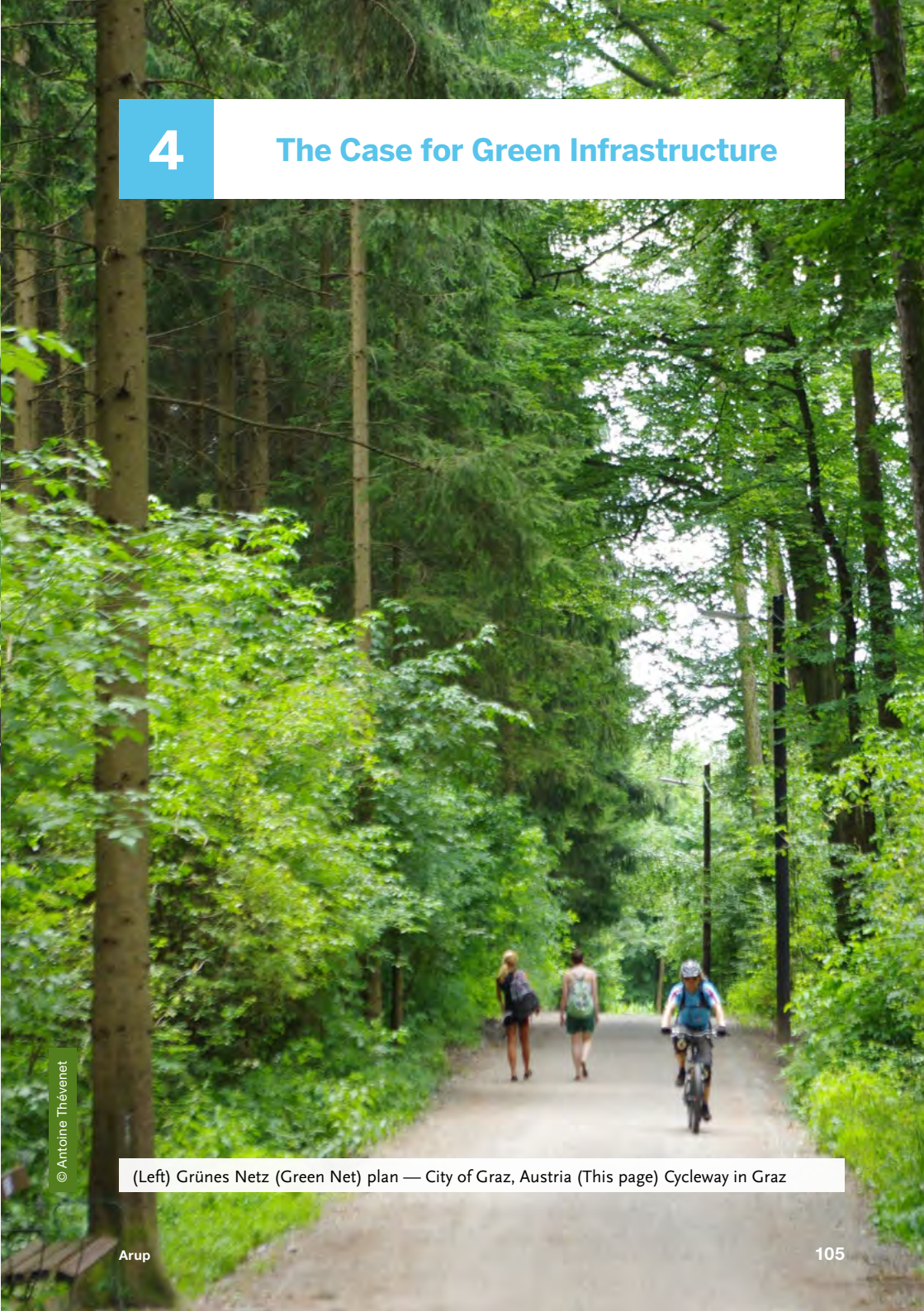
The role of “champions” or civic leaders are fundamental to raising the profile of streets. The importance of funding mechanisms and management and maintenance strategies must be acknowledged and in place from the outset. The rise of business improvement districts in the UK is a positive way for local businesses to act as a platform to take the lead in enhancing their local street and urban environments. This could be coupled with a more bottom-up approach where local communities are empowered to reclaim their streets, ensuring community ownership and therefore use and success. Small-scale local interventions can then provide catalysts for further investment. The San Francisco Better Streets Initiative is a good example that gives local residents and small businesses the opportunity to “green” their streets through a simplified application process and providing them with a toolkit to create new green spaces and interventions within their community. A holistic approach, working in collaboration with key stakeholders and community, is the key to unlocking the potential of streets and ensuring their durability and long-term success.

4

The Case for Green Infrastructure



© Stadt Graz, Stadtbaudirektion



© Antoine Thévenet

(Left) Grünes Netz (Green Net) plan — City of Graz, Austria (This page) Cycleway in Graz

Urban areas are usually warmer than their rural surroundings, a phenomenon known as the “urban heat island” effect. As cities develop, more vegetation is lost as more surfaces are paved or built on. This change in ground cover results in less shade and moisture to keep urban areas cool. The UHI can affect communities by increasing energy demand, air conditioning costs, air pollution, heat-related illness and mortality, and water quality. Increasing tree and vegetative cover (i.e. converting grey to green) as shown in this tram example in Strasbourg is an effective strategy to reduce the heat island effect.



© Compagnie des Transports Strasbourgeois

“The role of green infrastructure in addressing the challenges of the 21st Century cannot be underestimated. It is a natural, service-providing infrastructure that is often more cost-effective, more resilient and more capable of meeting social, environmental and economic objectives that ‘grey’ infrastructure. It has never been more necessary to invest in green infrastructure.”

— LANDSCAPE INSTITUTE POSITION PAPER: GREEN INFRASTRUCTURE, AN INTEGRATED APPROACH TO LAND USE (2013)

As described in the executive summary GI (in the context of this report) is defined as the system of open spaces, natural areas, urban woodland and parks; green streets, squares and public realm; rivers and waterways; and smaller scale interventions such as green roofs, walls and facades — all of which lie within the physical networks of cities themselves and their immediate hinterlands, and perform essential ecosystem services.

The importance of GI is supported by a growing body of research from around the world that is providing convincing proof of the widespread social, environmental and economic benefits it provides, along with the vital role as part of a multifunctional design approach in contributing to climate change resilience in our urban environments. Delivering the next generation of GI, however, requires a wider understanding of the GI approach and the significant benefits it can deliver, to bring it into a more influential position in the planning and design process. GI also needs to be backed by stronger policy support, more collaboration, a willingness to invest and a longer term view taken of the return in terms of benefits to society. Urban landscape

elements need also to be considered in the cost benefit analysis of development, given their longevity and design life compared to contemporary development. Many trees will outlive new development and their owners.

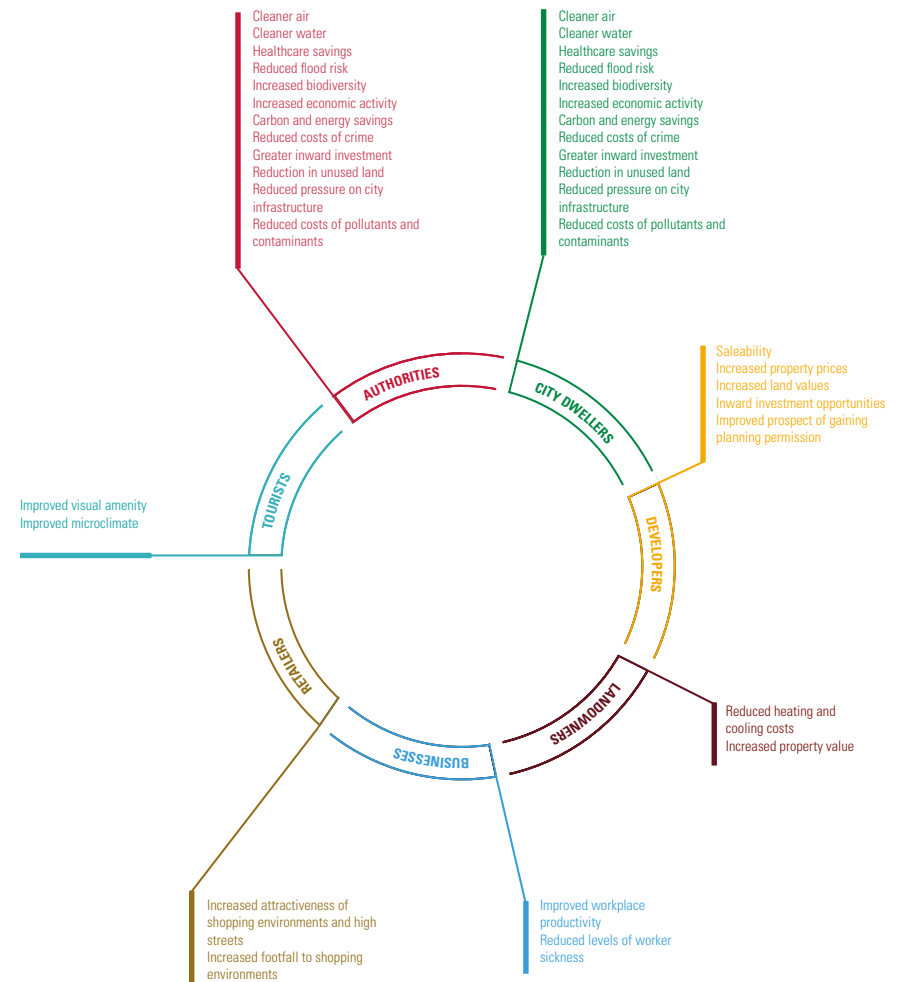
A GI-led design approach has the potential to unlock complex interactions between, say, development, housing, flood management, food production and biodiversity. By adopting a multifunctional design, approach more dynamic, integrated and forward-thinking solutions can be realised that can also generate multiple secondary benefits. This integrated approach can unlock the design potential of our urban environments and create significantly better streets, public realm and city open space for urban citizens. The landscape architectural profession with its proven track record of delivering GI at multiple scales, is ideally suited to lead this approach.

This section of the report sets out case studies and provides facts and figures that support the case for GI-led design in our urban environments.



© Arup

CASE STUDY: BENEFITS OF GREEN INFRASTRUCTURE



The Case for GI

Figure 3: Benefits of green infrastructure All city stakeholders benefit from green infrastructure. This chart shows some typical groups involved and the economic, social and environmental benefit to each. © Arup

CASE STUDY: BENEFITS OF GREEN INFRASTRUCTURE

Environmental Benefits	Economic Benefits	Social Benefits
Improved Visual Amenity	Increased Property Prices	Encouraging Physical Activity
Enhanced Urban Microclimate	Increased Land Values	Improving Childhood Development
Improved Air Quality	Faster Property Sales	Improved Mental Health
Reduced Flood Risk	Encouraging Inward Investment	Faster Hospital Recovery Rates
Better Water Quality	Reduced Energy Costs via Microclimate Regulation	Improved Mental Health
Improved Biodiversity	Improved Chances of Gaining Planning Permission	Improved Workplace Productivity
Reduced Ambient Noise	Improved Tourist and Recreation Facilities	Increasing Social Cohesion
Reducing Atmospheric CO ₂	Lower Healthcare Costs	Reduction in Crime

- **Provide shade and reduce temperature:** Our urban forest in the form of large species trees, street trees, parkland and open space of our urban forest are hugely important as they provide shade and protection from UV radiation and localised cooling and shading in towns, cities, and especially streets.
- **Wind speed reduction:** Trees can help to reduce local wind speeds and provide shelter for buildings, thereby reducing fuel bills for heating.
- **Water attenuation:** Urban trees and forests are now being regarded as important and cost effective way of reducing flood risks and reducing the impact of rain storms. One study has estimated that for every 5% increase in tree cover area, run-off is reduced by 2%.
- **Reducing atmospheric pollutants:** Research on the health and economic benefits of air-cleansing urban forests in 10 U.S. cities has shown that trees save lives, reduce hospital visits and reduce the number of days taken off work. They do this mainly by reducing pollutants from the air.



Large-species trees (*Fraxinus angustifolia*) create substantial street features, whilst generating effective shading, reduced temperatures and a better microclimate for city dwellers on a hot summer's day in central London

“With careful planning and technical advancements in planting techniques urban landscape can successfully accommodate large species trees as an essential part of the urban forest.”

—“THE BENEFIT OF LARGE SPECIES TREES IN URBAN LANDSCAPES: A COSTING, DESIGN AND MANAGEMENET GUIDE” CIRIA (2012)

A more recent proliferation of smaller ornamental trees replacing mature stock has been a response to a fear of issues like structural damage and subsidence. Outcomes from research clearly demonstrate that it makes sound financial sense to plant large species trees in urban areas given their stature and the clear benefits that can be achieved over smaller species: this is especially important given the resilience required to combat climate change.

At present some cities have or are in the process of undertaking a proper assessment of their urban forests. For example the Greater London i-Tree project led by the Forestry Commission and the Greater London Authority will be launched in 2014. The combined performance indicators of natural solutions and conventional architecture will need to become commonplace as we look to innovative solutions to address climate change.

CASE STUDY: GREEN BELTS



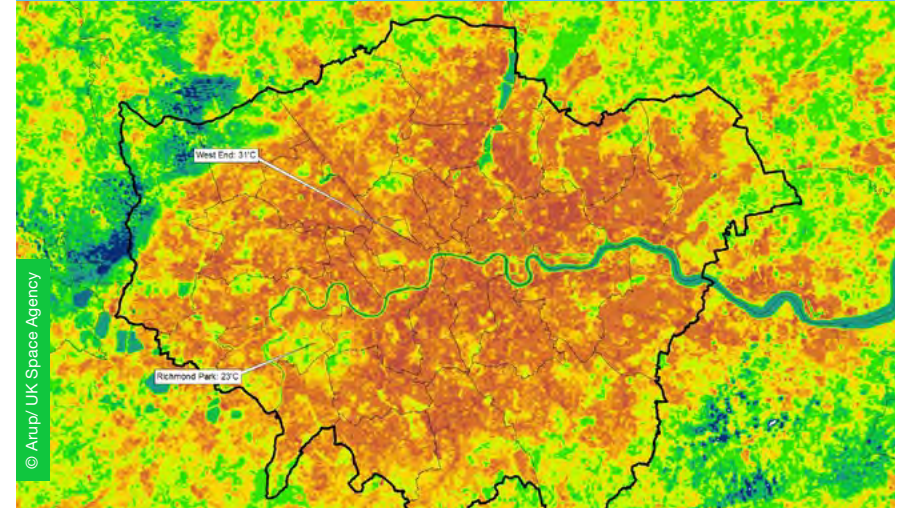
London's green belt

“Releasing this land en masse for housing is far too simplistic a solution.”

—CORINNE SWAIN, ARUP FELLOW, ARUP THOUGHTS (2013)

Green belts are a long-established planning policy, first adopted in the UK in the 1930s to keep unrestricted urban sprawl in check. There are now 14 green belts around major urban areas in England. The mayor of London is predicting that the capital will need one million new homes in the next 22 years. In 'Debating London's Options for Growth' Arup Fellow Corinne Swain suggests that radical growth options could consider making more productive use of green belt land for recreational access, local food production, climate change resilience and nature.

CASE STUDY: URBAN HEAT RISK MAPPING AND VISUALISATION IN LONDON



Visualisation of land surface temperature across Greater London on a summer's day based on satellite data. Note that the West End with very little green space is 8°C hotter than Richmond Park.

Following a project to map and visualise how heat risk can affect urban areas and communities, Arup is undertaking further research to understand how this data can be used to help plan for and mitigate the risks of hot weather in cities.

Cities heat up more than surrounding rural areas because of the urban heat island effect. The phenomenon occurs because the materials used to construct buildings and streets — as well as waste heat and pollution from traffic — have a significant impact on the storage and release of heat in urban environments. Local authorities and others wish to understand the effect this can have on people, especially the elderly and disabled.

Using the latest data from the UK Space Agency and University College London, Arup has mapped both the land temperature and air temperatures for Greater London and the surrounding counties using geographic information systems (GIS). The result is a series of striking images which show how both air and land temperatures in urban areas are significantly higher than their rural surroundings, and how they vary within the urban fabric.

The images have the potential to form the basis of spatial priorities in Greater London and are relevant to a range of areas, including planning for climate change, health and retrofit for sustainable buildings.

Key partners are Arup, the London Climate Change Partnership, the Greater London Authority, University College London, The University of Leicester and the London Borough of Islington.

CASE STUDY: ALL LONDON GREEN GRID



A series of heat waves at the beginning of the 21st century had an adverse impact on the London economy and was the starting point of the All London Green Grid Project. It is predicted that by 2050 the average summer temperature in the capital will be regularly as hot as in the summer heat waves of 2003. The difficulties and damage that were experienced included adverse effects on health, problems with the production of drinking water, drought, loss of urban vegetation through heat stress and an increase in animal pests. The purpose of the green grid is to create natural urban systems that support and permit growth by creating links between places where people live and work, the public transport hubs, the green belt and the River Thames. In terms of urban GI, this spatial planning initiative is important for its scale, comprehensive integration and scope in addressing climate change. It provides recognition that urban ecosystems are a vital part of providing an effective solution in increasing the long-term resilience, appeal and health of a major city.

CASE STUDY: BEAM PARKLANDS, EAST LONDON



Part of the All London Green Grid, Beam Parklands in Dagenham is a multi-award-winning 53ha wetland park designed by Arup in collaboration with the Environment Agency and backed with an inventive funding model provided by the Land Trust. It incorporates areas of new recreation and wetland habitat and 8km of new foot and cycle-paths to link previously separated communities. This project demonstrates how a GI approach not only enhanced the site's primary function as a flood defence, but also created a high quality community facility and enhanced wildlife habitat and biodiversity. Local communities were involved from the start, which ensured that the park is a local asset where people can socially interact within the wetland environment.

CASE STUDY: BIOTOPE AREA FACTOR, BERLIN



© Shutterstock

Bird's eye view of Berlin

Many urban planners struggle to protect green spaces against development. The city of Berlin has introduced an effective landscape program for countering this issue. With one of the strongest ecological traditions in Europe, Germany has a widespread appreciation of the benefits of nature in towns and cities. As a response to the shortage of green space in the city, Berlin developed the 'Biotope Area factor (BAF)' which is a regulation that measures the proportion of green space to the entire development to create more green space within densely built up urban locations. The BAF was formulated for inner-city districts of Berlin by a large number of experts who agreed on the necessary proportion of green space areas for different development types based on the layout of buildings. The key aim of the BAF is to ensure that a given proportion of a particular site is left undeveloped, ie, covered by vegetation. The strategy therefore aims to retain high densities of development whilst also developing the city's GI. Whilst the BAF has been introduced into spatial planning as a nature conservation measure, it also improves the microclimate, air quality and impacts of climate change such as the occurrence of heat and the risk of flooding from more intense rainfall.

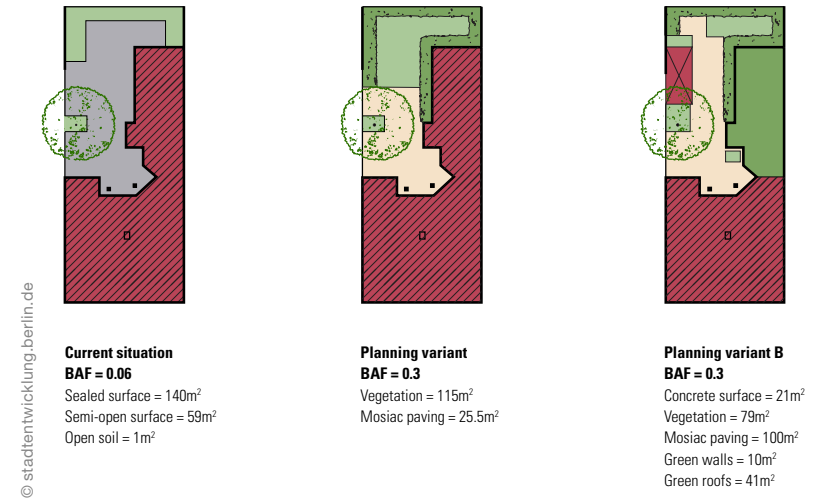
The Case for GI

$$\text{BAF} = \frac{\text{Ecologically - effective surface areas}}{\text{Total land area}}$$



© Lebalto Architects / Biotope-City.net

Green courtyard in a dense six-storey high built district, Berlin by Lebalto Architects



© stadtentwicklung.berlin.de

Example showing different methods of achieving a BAF of 0.3

The BAF Initiative is implemented through Landscape Plans, and their binding nature as statutory instruments gives the plans a strong political, administrative and public mandate. The BAF covers all forms of urban land use — residential, commercial and infrastructure — and formulates ecological minimum standards for structural changes and new development. The objective 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 individuality, creativity and flexibility. The ease of use of the system has made it popular with developers, architects and the public.⁵⁰

The Case for GI

CASE STUDY: ROBERT TAYLOR HOUSING PROJECT, CHICAGO



In 2001, researchers at the University of Illinois studied how well residents of Chicago's Robert Taylor Housing Project (the largest public housing development in the world, comprising 28 tower blocks) were doing in their daily lives based upon the amount of contact they had with nature. The case study investigated whether shared green spaces, particularly those with trees, helped to strengthen social ties among neighbours. The study examined 59 of the public outdoor spaces in the residential area; 27 of the neighbourhood spaces were relatively green, whereas 32 were relatively barren. The green spaces were mainly grass with trees and the trees tended to be mature, ranging from 25 to 50 years old. The results were so significant that the city government spent \$10m on planting 20,000 trees, as a result of Kuo's and Sullivan's research,²⁷ according to the *Chicago Tribune*.

The research found that residents who had contact with nature had significantly better relations with and stronger ties to their neighbours meaning that those residents who lived with trees nearby socialised with their neighbours more, felt safer and suffered 52% fewer crimes. They also felt emotionally and physically healthier than those in treeless blocks.

- There were fewer reports of physical violence in homes that had trees outside the buildings. Of the residents interviewed, 14% of residents living in barren conditions have threatened to use a knife or gun against their children versus 3% for the residents living in green conditions, ie, an 11% reduction.
- Trees have the potential to reduce social service budgets, decrease police calls for domestic violence, strengthen urban communities and decrease the incidence of child abuse, according to the study.
- Fewer crimes against both people and property occur in tower blocks surrounded by trees and greenery than in identical blocks surrounded by barren land; 48% fewer property crimes and 56% fewer violent crimes. The greenery was found to make people relax more and reduced aggression and the green spaces helped bring people together outdoors so increasing surveillance and discouraging criminals.

CASE STUDY: CHEONGGYEcheon RIVER, SEOUL



Mayoral candidate Lee Myung-bak focused his mayoral election campaign on restoring the Cheonggyecheon River in Seoul. The river was erased by a three-lane stretch of elevated highway creating one of the most congested and polluted areas of the city. Following his election the area was completely transformed with the return of the river bringing with it 3 miles of fresh running water with open space and tree-lined pedestrian walkways. The park now attracts 64,000 visitors a day. Whilst the beauty of the park is a major draw, this landscape lowers ambient temperatures to 3°C lower than city average, land prices have soared and biodiversity increased by 639% along this new blue-green corridor. Summing up this transformation in his book "What Has Nature Ever Done for Us?", the environmentalist Tony Juniper suggests it reflects a growing appreciation of the essential role that GI and nature play in city design.

"An approach to planning and development that recognises the social, environmental and economic value of green infrastructure [could] not only increase access to public green space, but help make urban areas more resilient to climate change."

—TONY JUNIPER, "WHAT HAS NATURE EVER DONE FOR US?" (2013)

CASE STUDY: ROBERT TAYLOR HOUSING PROJECT, CHICAGO

City of Chicago: iTree Assessment (2010)⁵¹

Number of trees	33,600,000
Canopy cover	17.2%
Air pollution removal	753 tons / year (\$6.4m / year)
Carbon storage	716,000 tons (\$14.8.4m / year)
Carbon sequestration	removes 25,200 tons of carbon per year (\$521,000 / year)
Building energy reduction	\$360,000 / year
Structural value (cost of replacement)	\$2.3bn

Local authorities and developers routinely assess the financial value of their building stock, infrastructure and assets. In the same way if a monetary value is attached to a city's GI (defined as the system of street trees, parks and gardens, woodlands, wild areas and urban green that lie within the physical networks of cities themselves and their hinterlands — in USA this tends to be called the urban forest) the tangible social, environmental and economic benefits can be understood. This understanding will allow better planning of a city's natural resources and will, in turn, help provide a commitment to better retention and enhancement of this resource.

There are a number of systems for the financial valuation of GI. The iTree system developed by the US Department of Agriculture Forest Service is becoming widely used. The iTree system places monetary value on factors such as energy savings, atmospheric CO₂ reductions, improved air quality, stormwater runoff and aesthetic and amenity considerations. Some of the criteria of the survey also recognise the social benefits of trees, assuming the greater the number of people who interact with them, the greater their value and hence monetary value.

Understanding the true benefits of a city's GI or urban forest (in this case) establishes a baseline from which informed decisions can be taken on its future care and development for the benefit of city dwellers and in combating climate change. As recently as five years ago it was calculated that less than 2% of local authorities in the UK had undertaken any form of cost benefit analysis of the whole or part of their GI or urban forest.⁵²

CASE STUDY: GRÜNES NETZ GRAZ



© Antoine Thévenet

In response to increasing development pressure, urban heat island effect and air quality issues, the City of Graz, Austria has set out a vision for a GI network that brings the quality of life benefits of its lush hinterland into the city. The Grünes Netz Graz (Green Net) identified a range of complementary delivery mechanisms from its existing resources which allowed maximum GI benefits to be achieved in a context of economic austerity.

Incremental implementation and monitoring

GIS data was collected across local authority departments to monitor existing green infrastructure assets, planned local authority interventions and forthcoming developments. Opportunities to deliver and adapt the Green Net were identified and negotiated as proposals came forward, for example as part of the design of new residential development or during planned road improvement works. This allowed the Green Net to be implemented step by step, taking advantage of new opportunities as they arise. It also prevented the creep of GI, ensuring that existing assets are not lost to incremental development.

Proactive mitigation and flexible financing

Part of the city's main GI corridor, the River Mür, was jointly implemented with the utility provider at Gössendorf hydraulic power station. A coordinated masterplan of mitigation measures associated with the Environmental Impact Assessment for the power station was developed with the City of Graz to secure partial funding for the delivery of the Green Net from the utility provider. The result is improved ecology, recreation, travel and education as well as the energy generation of the power station itself.

Each of these mechanisms was enhanced first by the collaboration of local authority disciplines working towards a shared goal and secondly by the local authority's drive to demonstrate the value of green infrastructure. Emphasis was placed on the importance of successful negotiation and collaboration with developers, landowners and the community to enhance understanding of the benefits of GI and to secure buy-in to delivery. Within five years of its launch in 2006, 12 projects in the vision had been implemented, with more in development and the potential to extend the Green Net beyond the city boundaries to neighbouring communities.

5

Achieving Cities Alive



© Darren Soh for Arup

Gardens by the Bay, Singapore

“Urban design is changing, and it is changing fast. Due in large part to environmental and climatological crises that are translating directly into quality of life issues, cities are focused on their urban landscapes as perhaps never before.”

—MARK HOUGH, “URBANISM AND THE LANDSCAPE ARCHITECT” (2013)

Once we begin to understand the trends shaping and influencing the future of cities, we can start to look at the implications and a way forward. How does a city need to adapt or change to deal with the coming decades? What do practitioners need to consider in new projects and developments?

The idea of bringing GI-led design into a more influential role in the design of cities is a significant opportunity to influence the structure and design of the urban environment to respond to future needs. It can introduce a new ideology based around an ecosystems approach that can contribute to the health, resilience and prosperity of a city.

It is interesting to investigate why some cities are more successful in embracing sustainable design. Courageous environmental projects — like the Manzanares River Park in Madrid or Cheonggyecheon River in Seoul — deliver at a scale that realises 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 High Line in New York and Promenade Plantée in Paris effectively reuse old city infrastructure to create valuable new community space and redefine the possibilities. Some cities have begun to encourage integrated design of city infrastructure by encouraging collaboration among different authorities, each with their own agendas. The question is, why do some cities embrace action, collaboration and sharing, whilst others don't?

In some cases success is down to enlightened individuals, city mayors or city officials. In others it is driven by large-scale events — the unification of Germany encouraged Berlin to regulate the Biotopo Area Factor to

“Environmental problems may seem overwhelming and insurmountable. But landscape architects offer solutions to improve our roofs, our blocks, our neighborhoods, a nearby waterway, or the city at large. If that sounds patronizing, it's not meant to be. In the absence of aggressive federal (let alone global) environmental action to address the myriad of challenges we face, these interventions take on a critical, if piecemeal, significance.”

—ALAN G. BRAKE, “LANDSCAPE ARCHITECTURE'S ASCENDANCE” (2012)

address climate change and loss of biodiversity; a series of heat waves encouraged the Greater London Council in the UK to adopt the All London Green Grid.⁵³

Though contexts may vary, approaches to implementing new GI and urban landscape should always use the resources, delivery mechanisms and policy context available today. In the UK for example, the value of GI has been pushed by the adoption of the National Planning Policy Framework (2012), which recognises the potential of GI in relation to climate change, as well as the need for local authorities to plan positively for networks of biodiversity. More recently, studies have also highlighted benefits for economic growth, by creating attractive environments for investment, as well as positive impacts on tourism, environmental cost savings, health improvements, employment generation, and food production. Moving forward, we should not expect that investment will be aimed at GI in its own right, but that it will have to compete with and should be integrated with other priorities.

Design of GI must always be appropriate to its context. Delivery mechanisms will differ depending on the underlying goals: improving the quality of existing spaces or creating new assets which contribute to the wider network; large-scale investment or smaller incremental projects; temporary, phased or permanent interventions. In all of these scenarios, multifunctionality and connectivity are crucial.

Delivery of GI has been somewhat piecemeal in the past. In the future, we should consider GI from the outset of any urban project or strategy. It should not be an independent driver for development, but a solution to a range of issues. Connecting multiple functions and securing benefits will meet a range of existing and future needs.

Recommendations to more consistently deliver such a vision are set out below.

Vision

All delivery should be underpinned by and contribute to a large-scale strategic vision. This vision should identify the assets, opportunities, risks and vulnerabilities for a given context.

This vision should...

- Be driven by what is required in that particular city and context rather than by arbitrary standards,
- Consider what should be delivered where, and how the needs of different users and delivery agencies can be satisfied spatially,
- Set priorities and achieve an optimal balance of complementary functions,
- Be a core planning policy requirement and integrated into all planning policy themes, rather than a separate initiative or strategy,
- Contribute to housing, transport, employment, climate change and other policies,
- Address the needs of a range of stakeholders who have contributed to its development,
- Be clear how different interests can benefit and play a role in delivery, and
- Set an appropriate scale, considering the network of existing and future assets.

Collaboration

Increasingly, GI is being seen as a concept which unites a range of disciplines and interests, and that facilitates collaborative working. Crucially, in the context of green infrastructure, competing priorities can often complement each other.

- Strengths, priorities, opportunities, and requirements of different actors must be considered in order to acknowledge the political nature of delivery, in particular across local boundaries.
- Local authorities, developers, clients, landowners, utility providers, the community and built environment professionals should communicate, share knowledge and educate others in the benefits of GI.
- All actors should contribute to the vision for GI, with the aim of identifying interventions that are able to adapt to changing contexts and the needs of the different actors involved.
- Planners should always negotiate, allowing new opportunities to be delivered as they emerge. Crucial to any negotiation is the ability to promote the case for GI to those responsible for delivery in a way that is appropriate to their needs.

Evidence

Preparation of a GI framework should be underpinned by evidence. The aim is to ensure that interventions are appropriate to their context. Evidence is particularly important to understand the value of a city's natural resources to enable future planning for enhancement potential.

- Existing studies and local information should be used, including relevant planning policy evidence.
- Evidence should identify what functions and connections are needed, and where to strike an effective balance in the delivery of the network.
- Data relating to GI should be collected and shared to inform future projects, including surveys of existing assets, new connections and functions, assessment of the quality, and what other functions could be integrated.
- Variables of interest to the quality of the external environment, eg, air temperature, surface temperature, air pollution and levels of comfort, should be monitored. Monitoring can be carried out over time to gauge the progress of improvements to the urban environment.
- The use of GIS should be considered as an increasingly effective tool to identify spatial priorities for an area and to understand and respond to a range of issues such as heat risk, flood risk and development pressures.
- GIS should act as a tool to monitor assets and track the implementation of the vision.

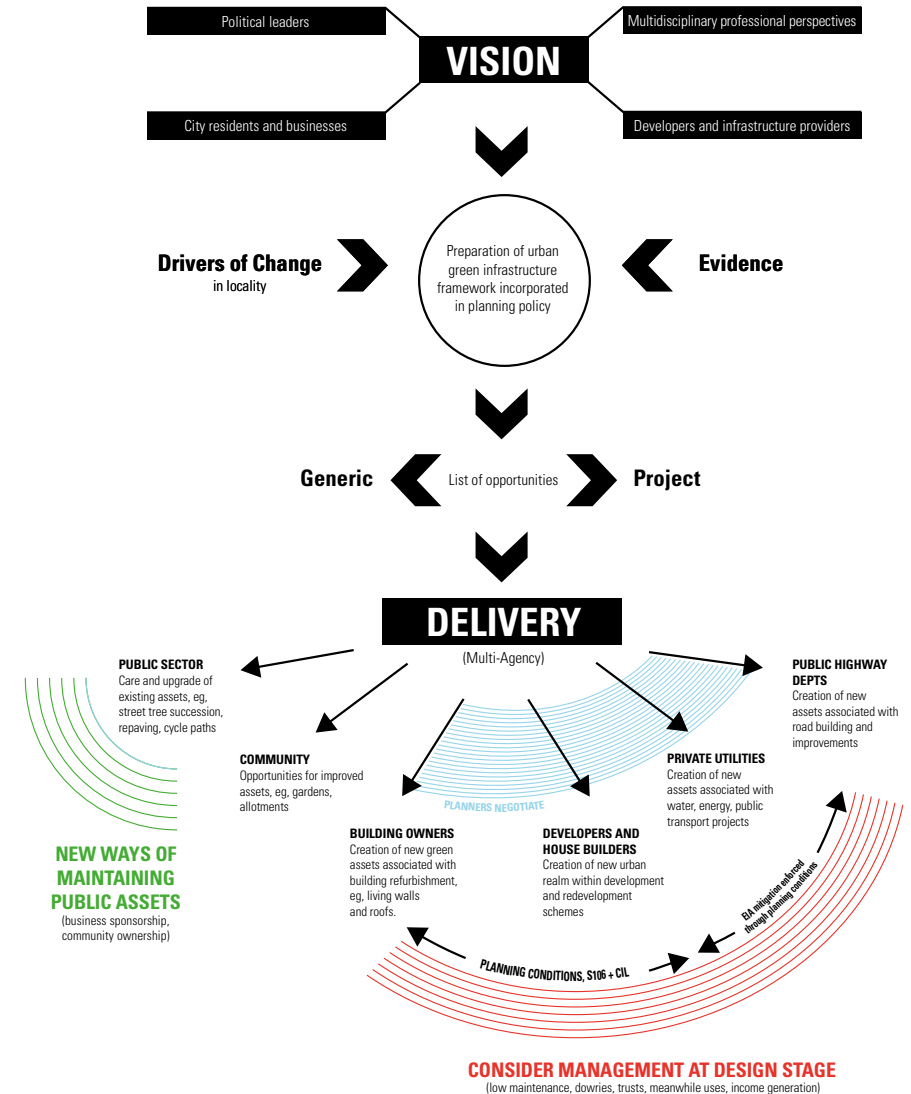


Figure 4: Delivery diagram © Arup

Tools

Planning plays a vital role in the delivery of projects, and will be triggered in many interventions involving new and existing development. Mechanisms which should be considered include the following:

- GI should be a core requirement for local authorities, including a clear strategic vision and policy considerations that are integrated throughout spatial objectives and planning themes.
- Developer obligations should include mechanisms that contribute directly to the delivery of the overarching vision. Planning agreements could also secure long-term funding for the management of projects.
- Mitigation should be linked to delivering the strategic vision and locked in through the use of planning conditions.
- Where a strong GI framework exists, it is possible for planners to respond to opportunities as they arise both with new development and redevelopment projects, and with building refurbishments. A robust evidence base will be key to securing effective contributions to the vision.

Management

Management and maintenance of GI should always be a key consideration from the outset of a project. This is crucial for the longevity of a project and for securing the full potential of interventions.

- Clear responsibilities for maintenance and management should be set to ensure their effective operation and durability.
- For smaller developments or infrastructure projects, it is important to avoid “leftover” spaces that do not have clearly defined management responsibilities. While local authorities might once have taken over this management role, there are now other models, as described in the following section.

Funding

Traditionally, local authorities provided funding for the delivery and management and coordination of GI. Increasingly this type of funding is more difficult to secure, leading to new, creative and innovative ways for funding and use of available resources. Here, considering funding for maintenance and management from the outset will help deliver long-term benefits. Cost reduction and recognition of the value of existing assets are also important. Examples include the following:

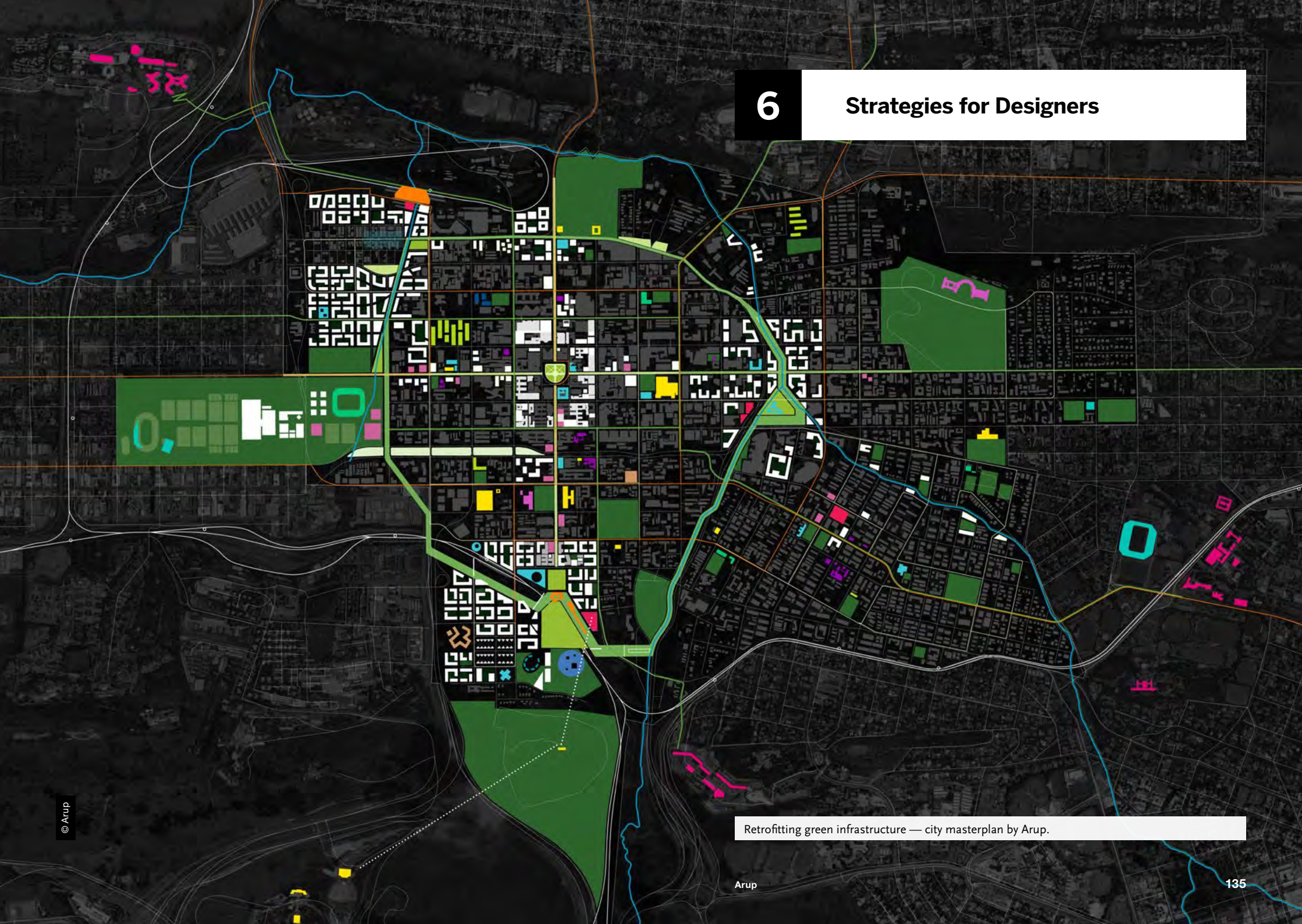
- Local social enterprises set up by residents and local bodies to provide long-term management — Bolstering social capital can be a powerful funding mechanism. Potential for further benefits should be considered such as training and education opportunities, school involvement, apprenticeships — and building community cohesion.
- Involving the voluntary sector this sector could apply for funding, where other actors are not eligible.
- Funding and delivery by third-party organisations — that can implement new ways of maintaining open space and identify appropriate solutions dependent on the approach needed for a particular project. Risks and liabilities associated with projects can also be better managed, something that community groups may be concerned about when delivering projects.
- Self-funded initiatives that can pay for themselves — This could include temporary interventions such as local festivals or events, food production, energy production, childcare facilities or commercial use of a development.

Importance of city leadership

Throughout all of these recommendations, demonstrating the value of GI and the variety of scales and types of interventions possible is crucial. Political champions will be important in setting and promoting a vision whereby GI adds to the quality of a city and differentiates its offer by attracting investment. Professionals negotiating to achieve new or improved assets should understand the economic context in which they are working and promote the multiple benefits of green infrastructure to applicants. Designers working in multidisciplinary teams should seek to ensure that GI and its subsequent maintenance are integral to individual projects, and always linked into the wider vision and framework for that city.

6

Strategies for Designers



6.1 Multipurpose and Multifunction Spaces

“[Planners and developers] address landscape as just one of many components that make up a larger urban whole, an additive piece that may be needed, but is not required to make things work. Landscape architects, on the other hand, don’t see it as a stand-alone thing; we understand that it is the underlying and unifying framework upon which everything is built. It is not about buildings and landscape, but buildings within landscape — an important distinction to recognize.”

—MARK HOUGH, “URBANISM AND THE LANDSCAPE ARCHITECT” (2013)

From the beginning of the design process, it’s important to bear in mind the multiplicity of end users. The design process must attempt to anticipate and if possible incorporate future functions of a space for years and decades to come. The changing demographics of the city, coupled with its changing needs, drive a demand to frame new landscape projects in a wider, multipurpose and multifunctional context.

The end user is no longer a single model-able urban citizen. With the widening cultural bounds of the city, its shifting demographics and accelerating technologies, the designer now must consider a whole host of possible end users and their demands on the space. Not only this, but by considering nature itself as an end user, the integration of biodiverse and climate-proof design becomes infinitely easier. Competing demand on ever-tightening urban space can also be mitigated if multipurpose design is introduced from the beginning and use of the space is left open enough to allow adaptability. The designer must also consider who has agency and control over the finished space. Large open spaces can provide an excellent



© Arup / John Robertson Architects

opportunity for community-building around events and community-led initiatives. Removing the delineation between buildings and landscape will also help encourage a more fluid multipurposing of space. Buildings and green space should not be separate but share the same ecosystem, sense of adaptability, resilience and community as they share the same space.

Not only the user and purpose of the space should be considered but also its function. A wall or roof need not simply be a supporting structure but can also become part of the GI of the city, using greening to absorb pollution, or space for produce or for encouraging wilding for biodiversity. Already, the direction in which building technology is heading will make multifunctioning spaces the cheaper and more desirable option for both new builds and rebranding projects. By working with designers from the beginning of the project, planners and developers can help to oversee and encourage embedded multifunctionality in the project.

6.2 More Than Just a Pretty Place

“For the public, my hunch is that landscape architects offer something that architects typically do not. Parks and gardens have always engaged our Edenic fantasies. In a world under strain these places must also do considerable work, absorbing stormwater, filtering air pollution, and providing refuge in an increasingly urbanized world.”

—ALAN G. BRAKE, “LANDSCAPE ARCHITECTURE’S ASCENDANCE” (2012)

The urban environments of the city need to deliver more than a pleasant greening which may be employed as an afterthought to development. Hosts of studies and research have shown that if implemented well and from the beginning of the design process, GI can play a multifunctional role and deliver gains for the benefit of the health of citizen, the climate footprint of the city and the economic vitality of the area.

A growing body of global research has provided compelling, measurable evidence of the immense social, environmental and economic benefits that well-designed and integrated GI can have on property prices, community vitality, climate change mitigation, resource efficiency and desirability, longevity and health of a city. These facts need to be commonly understood so that GI can be considered as essential as hard architecture, utilities and engineering infrastructure, and therefore play a more influential role at the very beginning of the development process.

As outlined, landscape can be used to enhance as well as perform vital infrastructure services that may otherwise require vastly more expensive, complex and inefficient solutions. It also has significant and quantifiable benefits to the health, wealth and wellbeing of citizens. The proper balance of function and aesthetics can make a space vital to the city and to the community. To aid this, landscape

spaces need to be permeable, both to nature and urban citizens. The recognition of green space as infrastructure that is essential for sustaining viable and healthy environments for urban populations and city ecosystems should lead to new approaches in planning and design that bring nature and GI into a more central and influential design role.

Investing in well-designed green urban space needs to be seen as highly valuable in terms of improving the social capital of urbanites where there might be inequality. Green space provides a common ground for sharing, social interaction, building community links and encouraging aspiration. Even portable technologies like augmented reality present the opportunity for landscapes to have an embedded digital functionality on top of their physical appearance.

By framing a GI design approach for cities in the context of the myriad economic, health and climate benefits, an appreciation of the practice as vital to the wellbeing and growth of the city may become pervasive in new developments.

6.3 How and for Whom?

“Making linkages and connections between policies must be the norm not the exception, reinforced by incentives and new structures and systems. We must, borrowing from the law enforcement’s adoption of ‘community’ policing’, focus on the ‘co-production of solutions’ across disciplines and professions. The vertical, silo-driven bureaucracies of the past century need to be laid horizontal.”

—THE ENDLESS CITY (2007)

Many landscape architects and designers of urban environments struggle to protect existing green space against development, or they battle to get a successful balance of public realm or open space area within new development when the argument is purely about amenity or environmental benefits. Without new policy frameworks that will legally enforce greener practices, the route may be to demonstrate (using facts and numbers) the essential social and economic services that GI can provide in urban environments: a common ground for sharing; building community links; inward investment; a healthier population, reducing the economic burden on health services; reduced crime; flood storage reducing pressure on city infrastructure; encouraging aspiration where there may be inequality.

One way to do this would be in the implementation of more user-driven design processes. Potential users can be more than considered — they can be consulted directly. This process has already gone on to lead to great successes in landscape projects. Another worry of clients, developers and governance is the cost of maintenance for green spaces as well as their inheritance. Again, by engaging community enthusiasm from the beginning of a project, there is an opportunity for involving them directly in the maintenance of an area that they feel belongs to them.

These practice-led projects can go on to be used as testing grounds for new materials, ideas and processes that can later be used as case studies for bigger, client-led projects. It’s here that designers have the opportunity to begin to influence the stature of the wider practice.

Important to this is that the project is sold to the user as well as the client. If the users are dissatisfied or even just disinterested with plans, then they will almost definitely fail.

The identity of the users themselves also needs to be considered. When taking into account the planned lifespan of a new development or rebranding, designers need to consider how the demographics and other makeups of the city will shift over time and whether the space will suit the changing user base in decades to come.

The most vital tool in all of these processes is education. It is only in case studies where there are elements of inclusion and literacy in the built environment on the part of the community that a project has really succeeded and been a boon to governance, the developer, the public and the city itself.

Planners and developers also need to look outside the accepted working business model for opportunities to expand and experiment. New models of crowd-sourced funding, loans for a profitable investment, philanthropy and grants can be used to pay for projects in neglected areas where the architects have the opportunity to write the brief instead of responding to a client.

6.4 Future-Proofing

“Regrettably, cities seem to underestimate the urgency of adaptation strategies — no known legally binding climate related urban design guidelines have been adapted yet.”

—JENA MILOSOVICOVA, “URBAN DESIGN FOR THE CLIMATE CHANGE”, IFLA JOURNAL #2 (2012)

Designers need to consider the shape and flavour of the future to come and the changes and challenges that it will bring. Ideally, the lifespan of projects should be infinite as the perfect project will be able to adapt, change and mitigate. In reality, this may be more difficult, but projects should still engage with strategic long-term thinking for the sake of security and prosperity.

The primary threat to the urban landscape is climate change, and projects should already have this as one of the highest priorities in the process. The city should be seen as an ecosystem, and where some parts are wasteful, thoughtful planning has the opportunity to act as GI — buffering and supporting the health of the city. A balanced and resilient ecosystem will last much longer than one based on irresponsible growth and short-term gains.

In order to secure this future, designers again need to consider who will be using and maintaining their creations in decades to come. By educating users and clients about the role that nature can play in the city, they can begin a trickle-down mechanism which will ensure the wellbeing and security of valuable, urban green and functional space.

Another large part of future-proofing is in adaptability. Spaces that are too fixed or concrete will struggle to change and grow as their users and the city around them change. Integration with the wider built environment, open planning and maintenance, and well-considered succession plans will help to mitigate this problem. Again, designers here have the opportunity to cite the numerous positive effects that greening has on economic and social vitality in securing and guaranteeing a prosperous future for an area.

6.5 New Techniques

“Technology has come such a long way in such a short time, that I wonder if we’re in the final stages now of ‘the old way’ of doing things in the design business. I think we’re on the cusp of a new paradigm in spatial design.”

—DAN WOOD, “PARADIGM SHIFT FOR LANDSCAPE ARCHITECTURE?” (2012)

Advances in technology using GPS, satellite imagery and GIS amongst others, as well as the availability of more and more audited and public data provide a fantastic opportunity for planners and developers to utilise “big data” and model behaviours in the planning of a project. Although this is a tremendous boon and will provide valuable insights, it is important to remember more holistic techniques and ideas bred from experience.

Technology also provides new ways for designers to hold dialogues about work through the utilisation of 3D visualisation and augmented reality. As well as designer-led approaches, there is a need to consider a more engaged and active community and the many positive benefits of bringing in users to a design process from early stages.

Designers and architects can also act as curators between different bodies and parties in a project. Almost all elements of a development can be threaded through landscapes — here there is an opportunity to encourage coherence and collaboration between the parties of a project.

Coherence between projects will also help. Grand projects are often coveted as harbingers of change, but smaller-scale, direct interventions in the built environment

Designers and architects can also begin to reach out beyond client-led briefs, building their own visions and experiments.

can have an equal if not stronger effect, building ties with communities and lending a real sense of uniqueness to a project. This must be done coherently, however; otherwise the city will not be able to identify with disparate and scattered spaces.

Designers and architects can also begin to reach out beyond client-led briefs, building their own visions and experiments from alternate funding sources to test and study techniques that can be applied to larger-scale projects. It is here that there is a space to challenge convention and set visionary precedents that can reshape the identity of commercial architecture and lead real to change.

The city landscape is a complex organism, and just like the human body its good health is dependent on general awareness and specialist intervention when necessary. For GI-led design to be effective it needs new and evolving techniques applied through collaborative endeavor in both research and professional practice. With understanding and experience of natural processes the landscape architect is ideally placed to provide leadership in developing cities that are alive.

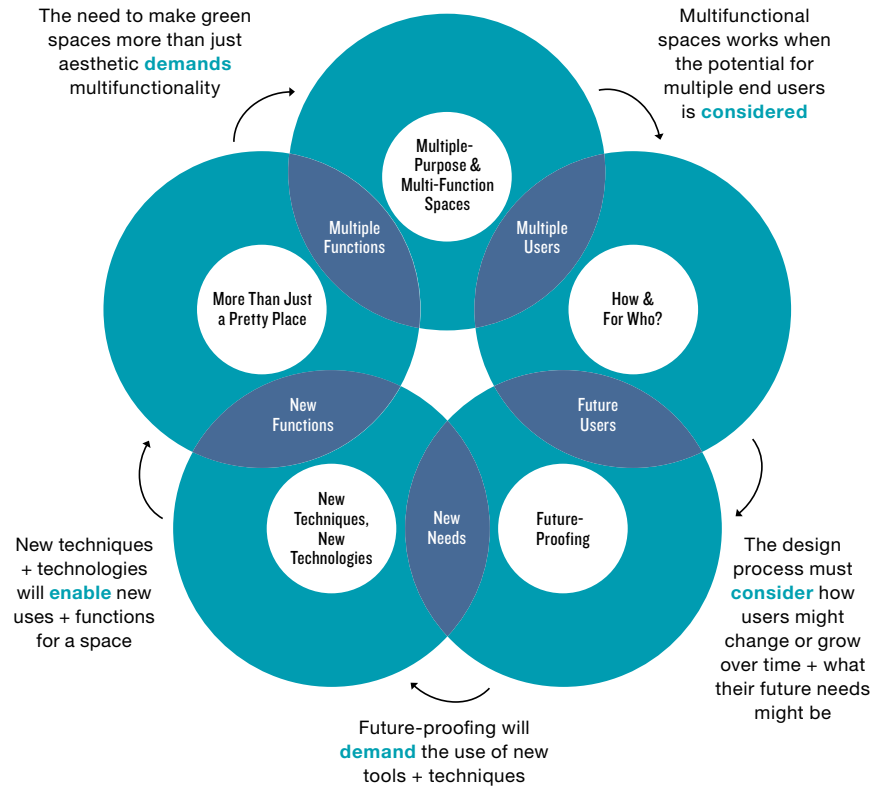


Figure 5: Strategies Diagram This chart maps the relationships and flow between the design strategies outlined in this report. The strategies not only affect and are affected by each other, but also have identifiable crossover points where more specific needs can be drawn out. © Arup

Appendix 1

CHECKLIST FOR LANDSCAPE ARCHITECTS AND CITY DESIGNERS

LANDSCAPE CONTEXT AND ASSETS

- Acknowledge geographic setting and landscape characteristics
- Take account of water catchment/supply
- Note current land uses and design responses to locality
- Consider ecosystem services and implications for biodiversity
- Review history of area and any heritage implications
- Note social and economic factors influencing landscape
- Review implications of climate change, energy needs, population growth
- Consider plans and any design proposals to date
- Review similar projects/case studies and project approaches

SUSTAINABLE MASTERPLANNING

- Conserve historic landscape, built form and significant aesthetic features
- Prioritize development on disturbed land wherever possible
- Protect natural heritage and enhance biodiversity of site
- Reuse redundant structures and adapt existing landscapes for new uses
- Design for socially inclusive community and neighbourhood safety
- Plan compact development to optimize land development potential
- Cater for wide spectrum of users and communities
- Site buildings to minimize energy use
- Ensure site is part of green and blue infrastructure
- Develop design rooted in local context
- Encourage local use through ease of access

Appendix 1 (cont'd)

CHECKLIST FOR LANDSCAPE ARCHITECTS AND CITY DESIGNERS

- Design networks for walking and cycling and permeable space
- Ensure connections to public transport
- Respond to the ecology of the place
- Design social gathering spaces and active frontages
- Integrate overall vision with detail design
- Engage local community/stakeholders
- Enhance biodiversity
- Incorporate productive landscapes
- Create unique, comprehensible and memorable places
- Plan for the inclusion of public art
- Encourage local business opportunities
- Design for multiuse and range of uses
- Sustain landscape from economic and social perspectives
- Design for health of all ages
- Connect people to places/destinations
- Include information and interpretative facilities
- Provide amenities for diverse range of users
- Provide for flexible space for future change of uses
- Provide shelter and shade with large trees

Appendix 1 (cont'd)

CHECKLIST FOR LANDSCAPE ARCHITECTS AND CITY DESIGNERS

ECOLOGICAL SITE DESIGN

- Generate green energy on-site
- Use indigenous and/or non-invasive plant species
- Use ecosystem services and enhance site ecology
- Minimise night light pollution
- Incorporate homes for wildlife
- Extend local plant communities
- Balance cut and fill of soil on-site
- Minimise floodplain development
- Use water-sensitive urban design
- Maximize water retention on-site
- Restore and create wetlands
- Reduce impervious surfaces
- Take measures to reduce air pollution

Appendix 1 (cont'd)

CHECKLIST FOR LANDSCAPE ARCHITECTS AND CITY DESIGNERS

GREEN TECHNOLOGIES

- Use recycled materials
- Green structures/buildings
- Use timber from sustainable sources
- Use durable products
- Minimize mowing/use of machinery
- Use organic compost, fertilizers and mulches
- Decompose waste on-site
- Use phytoremediation on contaminated sites
- Use porous paving
- Procure local construction products

LANDSCAPE MANAGEMENT

- Facilitate education for sustainability
- Establish a landscape management plan
- Incorporate site nursery and composting
- Ecological monitoring to inform change
- Ongoing design and conservation
- Minimize use of pest/herbicides
- Site-based maintenance/park manager

This guide/checklist was developed initially with particular reference to the Sustainable Sites Initiative developed by the Lady Bird Johnson Wildflower Center / American Society of Landscape Architects in 2007.

List provided courtesy of Chris Royffe, Leeds Metropolitan University

Appendix 2

GREEN INFRASTRUCTURE: SELECTED FACTS AND FIGURES

“Green infrastructure” is defined as open spaces, natural areas, urban woodland and parks; green streets, squares and public realm; sustainable drainage systems and healthy waterways, cycleways and pedestrian routes within our city environments; and smaller scale green roofs, walls and facades.

SOCIAL BENEFITS

“A study in New York states that asthma rates among children age four and five fell by a quarter for every extra 343 trees per square kilometre. The presence of street trees was linked with a 29% reduction in early childhood asthma.”

—GS LOVASI, JW QUINN, KM NECKERMAN, MS PERZANOWSKI, AND A. RUNDLE, CHILDREN LIVING IN AREAS WITH MORE STREET TREES HAVE LOWER ASTHMA PREVALENCE (2008)

“Residents in ‘high greenery’ environments were 3.3 times more likely to take frequent physical exercise than those in the lowest greenery category.”

—FORESTRY COMMISSION, THE CASE FOR TREES IN DEVELOPMENT AND THE URBAN ENVIRONMENT (2010)

“Researchers from the University of Exeter, using data from 5,000 households over 17 years, found that people reported lower levels of mental distress and higher degrees of life satisfaction when they were living in greener areas. Researchers agree that the body of evidence is sufficient for urban planners to factor in the benefits derived from green spaces when designing new developments.”

—MARK KINVER BBC NEWS (2013), BBC.CO.UK/NEWS/SCIENCE-ENVIRONMENT-24806994

Appendix 2

GREEN INFRASTRUCTURE: SELECTED FACTS AND FIGURES

“Dutch scientist Joland Maas gathered data from more than a quarter of a million people — in areas where 90% of the local space was green, 10.2% of residents felt unhealthy. In areas where 10% of the local space was green, 15.5% felt unhealthy. When scaled up to the population of cities (or countries) this 5+% can mean millions people feeling less healthy with considerable consequences in terms of strain on health services and lost days at work.”

— TONY JUNIPER, “WHAT HAS NATURE EVER DONE FOR US?” (2013)

“Desk workers who can see a green environment from their desks experience 23% less time off sick than those that have an entirely urban view. Similarly, these workers also report greater job satisfaction.”

— KL WOLF, HUMAN DIMENSIONS OF THE URBAN FOREST, URBAN NATURE BENEFITS, PSYCHO-SOCIAL DIMENSIONS OF PEOPLE AND PLANTS (1998)

ENVIRONMENTAL BENEFITS

“An 80-foot beech tree has been shown to absorb the daily carbon dioxide output of two family homes”

— DAVID TIBBATS, YOUR PARKS, THE BENEFITS OF PARKS AND GREEN SPACE, URBAN PARKS FORUM (2002)

“Trees are more effective than buildings in providing shade, as they continue to provide shade at midday when buildings are less effective. This shade reduces the temperature of surfaces and to some extent air.”

— M HOUGH, CITIES AND NATURAL PROCESS AS BASIS FOR SUSTAINABILITY; RD BROWN AND TJ GILLESPIE, 1995. MICROCLIMATIC LANDSCAPE DESIGN: CREATING THERMAL COMFORT AND ENERGY EFFICIENCY (2004)

“A pilot study on a hot summer’s day in Manchester city centre found surface temperatures in a paved public open space reduced by 13°C under a mature canopy, compared to full sunlight”

— SE GILL, JF HANDLEY, AR ENNOS, AND S PAULEIT, ADAPTING CITIES FOR CLIMATE CHANGE, THE ROLE OF GREEN INFRASTRUCTURE (2007)

Appendix 2

GREEN INFRASTRUCTURE – SELECTED FACTS AND FIGURES

“Trees and parks can reduce local air temperatures by 0.5 to 5°C resulting in cooler air that can lessen the need for air conditioning.”

— UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE ENERGY-SAVING POTENTIAL OF TREES IN CHICAGO, (1994)

“Research in Tel Aviv has shown that the presence of trees resulted in a cooling of the air temperature of between 1°C in a heavily trafficked street to 4°C in the smallest (0.15ha) garden. The Tel Aviv study also found that the shape of the green area had an impact on cooling, and that the cooling effect could be felt up to 100m from the site.”

— L SHASHUA-BAR, AND M.E. HOFFMAN, VEGETATION AS A CLIMATIC COMPONENT IN THE DESIGN OF AN URBAN STREET, ENERGY AND BUILDINGS VOL. 31 (2000)

“Cooling can be facilitated by even a small space – parks of only one or two hectares have been found to be two degrees cooler than surrounding areas.”

— H UPMANIS, THE PARK HAS ITS OWN CLIMATE, SWEDISH BUILDING RESEARCH NO. 2 (2000)

“Scattered trees throughout a neighbourhood increase surface roughness, thereby reducing wind speeds by as much as 50%.”

— GM HEISLER, MEAN WIND SPEEDS BELOW BUILDING HEIGHT IN RESIDENTIAL NEIGHBORHOODS WITH DIFFERENT TREE DENSITIES, US FOREST SERVICE (1990)

“Existing urban tree cover can reduce storm water runoff by 4 to 8%, and modest increases in tree cover can further reduce runoff.”

— HERRERA ENVIRONMENTAL CONSULTANTS, INC. THE EFFECTS OF TREES ON STORMWATER RUNOFF (2008)

“For every 5% increase in tree cover area, run-off is reduced by approximately 2%.”

— RD CODER, IDENTIFIED BENEFITS OF COMMUNITY TREES AND FORESTS (1996)

Appendix 2

GREEN INFRASTRUCTURE – SELECTED FACTS AND FIGURES

“Urban particulate air pollution is a serious health issue. Trees within cities can remove fine particles from the atmosphere and consequently improve air quality and human health. Tree effects on PM2.5 concentrations and human health are modelled for 10 U.S. cities. The total amount of PM2.5 removed annually by trees varied from 4.7 tonnes in Syracuse to 64.5 tonnes in Atlanta, with annual values varying from \$1.1 million in Syracuse to \$60.1 million in New York City. Most of these values were from the effects of reducing human mortality.”

– DAVID J. NOWAKA, SATOSHI HIRABAYASHI, ALLISON BODINE, ROBERT HOEHNA, MODELED PM2.5 REMOVAL BY TREES IN TEN U.S. CITIES AND ASSOCIATED HEALTH EFFECTS, US FOREST SERVICE AND DAVEY INSTITUTE

ECONOMIC BENEFITS

“Increasing people’s access to green spaces could cut billions of pounds from the NHS healthcare bill. Sue Holden, the chief executive of The Woodland Trust said it had been calculated that the NHS could save £2.1bn a year if everyone had access to green spaces — the link between ‘healthy woods and healthy lives’ was a ‘connection that really has to be made much more and much more often.’”

– MARK KINVER, BBC NEWS (2013), BBC.CO.UK/NEWS/SCIENCE-ENVIRONMENT-24806994

“Between 1988 and 1996 in Chattanooga, Tennessee, new parks, greenways and street trees have injected an estimated \$500m into the city through encouraging inward investment.”

– S LERNER, AND W POOLE, THE ECONOMIC BENEFITS OF PARKS AND OPEN SPACE: HOW CONSERVATION HELPS COMMUNITIES GROW SMART AND PROTECT THE BOTTOM LINE (1999)

“\$12m – saving in healthcare costs as a result of 10% more cycling in Copenhagen. This leads to increased productivity of \$31m and an extra 61,000 years of life.”

– TONY JUNIPER, “WHAT HAS NATURE EVER DONE FOR US?” (2013)

Appendix 2

GREEN INFRASTRUCTURE – SELECTED FACTS AND FIGURES

“Well planned improvements to public spaces in town centres can boost trade by up to 40% and generate significant private sector investment.”

– DEFRA AND THE ASSOCIATION OF TOWN CENTRE MANAGEMENT (2007)

“City trees have been shown to have the potential to raise property prices by between 5 and 18% by a series of international studies.”

– CABE SPACE (2005) AND DJ MORALES, THE CONTRIBUTION OF TREES TO RESIDENTIAL PROPERTY VALUES, JOURNAL OF ARBORICULTURE VOLUME 6, NO 11 (1983)

“Planted windbreaks have been found to reduce annual heating costs by 10 to 30%.”

– DR DEWALL, GM HEISLER, USES OF WINDBREAKS FOR HOME ENERGY CONSERVATION (1988)

“The New York City Parks Department used the iTree assessment to determine that the 600,000 street trees in its five boroughs provide an annual benefit of \$122m – more than five times the cost of maintaining them.”

– STRATUM I-TREE EVALUATION, NEW YORK (2012)

“Undoubtedly, the growth of future cities depends upon how well we are able to plan for the ‘unplanned’. The generic theme evolving from Asia, Latin America and Africa is that as cities expand, the ‘informal’ sector grows faster than the ‘formal’ sector. This means that our plans will need paradigmatic change to deal with the heterogeneous housing and mobility needs of growing city populations. We will have to plan spaces for activities that cannot always be well-defined and predicted. It is better to plan for what is inevitable than to turn a blind eye to the future.”

– THE ENDLESS CITY (2007)

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The ideas being developed by Arup in *Cities Alive* seek to capture not only the beauty of nature but also the sustainability of balanced ecosystems. These are challenges for landscape designers creating new cities that meet our increased expectations for access to clean water, cheap and plentiful supply of food, and fast and effective transport systems, with the need to reduce the impact on natural resources. Cities Alive provides an important opportunity for ecosystem specialists to work closely with landscape professionals to optimise how we build for our future.

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