Forum focus

"How much green space is enough in a context where there is pressure for land, where there is pressure for urban densificatio and for sustainable transport? How much is enough for human health, and what should its qualities be?"

Professor Catharine Ward Thompson,
Director of the OPENspace Research Centre at the University of Edinburgh

Putting green spaces at the heart of cities

How is the sustainability of a city and its surroundings affected by integrating ecosystem functions in green and blue 'natural urban spaces'? How do green spaces influence our health and wellbeing?

By **Rosamunde Almond** *and* **Simon Patterson**

At a glance

Cities contain many kinds of green urban spaces ranging from tree-lined roads, gardens, parks and playing fields to 'blue', or water-related, spaces such as ponds, lakes, wetlands, rivers and canals. A growing body of research suggests that such spaces are not only crucial to supporting a wide range of ecosystems, plants and animals, they are also essential to our wellbeing, having a positive impact on physical and mental health, on safety and on local economies. The environmental benefits they bring include cooling urban 'heat islands', reducing pollution, providing habitats for animals and plants and absorbing excess rainfall.

Using this evidence as a starting point, a rich mixture of policy and decision makers from government and business, technical experts and researchers were invited to be 'witnesses' at the Cambridge Forum for Sustainability and the Environment's monthly meetings. They each provided their perspective on the gaps in our knowledge about green spaces and these were used to as a springboard to identify key 'unknown unknowns' and to formulate 'burning' questions in need of more research.

Connectivity and flow were two recurring themes examining how resources, people and goods link and influence each other and move from one part of a city to another (or out into the surrounding countryside). This included the way green and blue spaces affect the flow of air through cities and how different kinds of spaces can be combined to make a city more environmentally sustainable, more resilient to changes in climate and more socially attractive. Individual spaces may be isolated from each other or they may be linked using corridors, even stretching from central areas out into the rural area surrounding the city in continuous 'green and blue wedges'. This led us to ask how do the interactions between these connections bring environmental benefits and how does this process affect the communities and people living nearby?

As part of a year-long series of meetings centred on connections between health, wellbeing and sustainability, witnesses from a range of research fields and policy perspectives presented evidence for the positive effects of green spaces. Forum members, witnesses and guests were drawn from 27 University of Cambridge departments, centres and initiatives and 20 other universities, NGOs, companies and local and national government departments and a box at the end of the article contains all their names and affiliations. They triggered broader discussions about some fundamental and yet still unanswered questions. Are the benefits of green and blue spaces simply a function of the amount of space created or does the shape or form of that space matter too? If so, how much green space is 'enough' for human wellbeing? What qualities should it have and how natural – or even green – should it be? What kinds of features or spaces can provide benefits for both biodiversity and for people? This article explore these questions in more detail and highlights some of the most promising research questions stemming from the discussions.

Key questions

Through discussions, we identified three questions which require further examination:

- **How do different kinds of green and blue spaces make a city more environmentally and socially sustainable and resilient to changes in climate?**
- **How does connecting such spaces – for example along corridors – affect their environmental and social benefits?**
- **How 'natural' does a green space need to be to have a positive impact on people's wellbeing and how important is 'greenness' in providing these benefits?**

Cambridge Forum for Sustainability and the Environment

UNIVERSITY OF CAMBRIDGE

Box 1: Catalyzing a new EPSRC cities research programme

At the core of this new EPSRC funded project lies the question: Can we develop a city with no air pollution and no heat-island effect by 2050? While this goal is probably not strictly attainable, it is critically important that it remains the target as a 'holy grail': something to be strived for and to provide a beacon for decisions.

Traditional approaches to urban environmental control rely on heating, ventilation and cooling (HVAC) systems, which produce an unsustainable cycle of increasing energy use and greenhouse gas emissions. The aim of MAGIC is to break this vicious cycle by employing a different engineering solution, which uses green and blue spaces coupled with natural ventilation in buildings to reduce demand for energy and ensure air pollutants are diluted below levels that cause adverse health effects.

Part of a patchwork

Individual green and blue spaces within cities undoubtedly provide benefits within their boundaries, but they also have a broader impact on the city as a whole. One example of this is in reducing the 'urban heat-island effect' where cities tend to become hotter than the surrounding countryside. The temperature of a city and the way in which heat is dispersed within it depend on a number of factors, including weather, the layout of the streets and the form and construction materials of the buildings. Buildings raise the temperature of the surrounding area by reducing airflow and trapping warm air between them, as well as producing heat themselves.

This effect is magnified in densely populated areas. For example, the centre of London is, on average, 5°C warmer than surrounding rural areas, and this difference was as much as 10°C during the heatwave in 2003. Overheating in cities is therefore predicted to become more frequent as the climate changes and urban areas grow and become denser. In contrast, green and blue spaces lower air temperatures in surrounding urban areas. Modelling by the SCORCHIO Project based in Manchester indicates that increasing the amount of green space by only 10% in an area could reduce the daily maximum temperature by 2.2°C.

Much of the research on heat-flows in urban areas is concentrated within or around individual buildings, parks and water bodies. However, green and blue spaces influence the airflow between groups of buildings and from one side of a city to another. How does this city-wide airflow affect the rate at which buildings, streets and neighbourhoods heat and cool? How could these effects be quantified and added into existing models to better design green and blue infrastructure?

Building on this idea, the Forum considered the role that green and blue spaces could play in the 'patchwork' of different kinds of buildings, neighbourhoods and common spaces in cities and this led to the following questions: What happens when such spaces are connected together rather than being in isolated 'patches'? Are such connections essential to the effectiveness of such spaces in mitigating the heat-island effect or the incidence of flooding or do they simply provide incremental value? Discussions during and after Forum meetings formed the basis of a new £4.1 million research programme on 'Managing Air for Green Inner Cities' (MAGIC). This 5 year EPSRC-funded project is being led by the University of Cambridge together with the University of Surrey and Imperial College London (See Box 1).

Water drainage and flooding present a particular challenge as cities are often made up of a number of interconnected water catchment areas. A number of witnesses argued that combining the physical characteristics of cities, such as the capacity of the rivers, sewers and drains within a catchment, with climate models can be used to generate future scenarios to explore the effects of climate change, population growth and development.

Alex Nickson, from the Greater London Authority (GLA), outlined an example of taking this approach within London. They are using models and scenarios to consider a number of questions about green space within the capital: How can green spaces and vegetation be used to absorb rainfall? Where could parks, street trees and green spaces make the most difference and what would be the best way to combine them? Every city has to balance their budget and weigh up the short and long-term costs of taking particular actions. How do the costs of creating or maintaining these spaces compare to other measures that would need to be taken, such as enlarging existing sewers or repairing damage from regular flooding? Is there a minimum area needed to realise these benefits at city scale, so solutions do not simply transfer the problem (of flooding for example) from one part of the city and towards another? Projecting alternative 'futures' with and without extra green spaces can help people to picture what measures could be taken, but also to understand what other costs there may be if no changes are made.

Connections to our health and wellbeing

The Forum focused a series of meeting on forging connections between health, wellbeing and sustainability. The majority of these discussions centred on where we live and work and, naturally, many related to green spaces. Across all of these evidence was drawn from fields such as neuroscience, epidemiology, economics, sociology, geography, biology and psychology in order to demonstrate the diverse impact green space has on our mental and physical health.

The **Cambridge Forum for Sustainability and the Environment** was established in 2013 in the University of Cambridge. Chaired by Lord Martin Rees, it meets once a month, bringing together thought leaders from the worlds of research, policy and industry to talk about some of the great sustainability challenges the world faces in the future and the research pathways which will help to prepare for and address those challenges.

In order to determine relationships between wellbeing and the natural environment and the urban environment, it is essential to be able to both define and quantify what 'wellbeing' is. Dr Dimitris Ballas, a Senior Lecturer at the Department of Geography, argued that although using the word 'happiness' may seem to be more intuitive, wellbeing is a much more holistic concept which is much deeper than the emotion people feel at a particular moment in time. Professor Felicia Huppert, Director of the Well-being Institute in Cambridge, agreed and she argued that true wellbeing goes beyond pleasure, enjoyment and the emotion happiness. Instead, it is about fulfilling our potential, having meaning in our lives and leading a good life. This is called the eudaimonic view, the 'eu' meaning good and the 'daimon' or 'spirit' is our true self.

In a brief review of current literature, Felicia found very few, if any, experimental studies which looked at the direct effect of the natural world and the urban environment on wellbeing as defined in this way. Instead of trying to find a single metric or indicator, she recommended using measures across five broad categories representing different facets of wellbeing, including:

1) Engagement and interest
2) Competence, capability and self-esteem
3) Optimism and hope
4) Resilience and emotional management
5) Relationships, including a sense of connectedness, of belonging, empathy and our ability to be compassionate and kind

All of these aspects of our wellbeing may change over time. Thus, longitudinal studies should be carried out in addition to examining the effects of space at a particular point in time. It has been suggested that the benefits of green space on our wellbeing may not diminsih over time. Tom Armour, Global Landscape Architecture Leader at Arup, agreed with this and argued that the green environment is currently undervalued in urban design and should be an intrinsic part of our approach to building healthier cities.

Professor Catharine Ward Thompson, Professor of Landscape Architecture and Director of the OPENspace Research Centre at the University of Edinburgh, focused on the quantity and quality of green space in relation to the benefits they provide: Are the benefits of green and bluespaces simply a function of the amount of space created, or does the shape or form of that space matter too? If so, how much green space is 'enough' for human wellbeing? What qualities should it have and how natural – or even green – should it be? What kinds of features or spaces can provide benefits for both biodiversity and for people?

> ***"There is an urgent need to 'green' cities and reconnect people to nature, not only through green spaces and trees but also knowing where their food comes from and how their actions affect the environment around them."***
>
> Dame Fiona Reynolds, Emmanuel College

How people use green spaces varies between age groups, gender, ethnic groups and socio-economic background. This makes it difficult to predict their effect on the health and wellbeing of a whole community. What are the differences between how different groups of people use the spaces and want them to look like? What discourages certain people from using these spaces and how can they be improved to bring both social and environmental benefits?

As cities expand, children are increasingly growing up in urban rather than rural environments. Dame Fiona Reynolds, the former Director General of the National Trust and now Master of Emmanuel College, argued that this shift means that there is an even greater need to reconnect children with the natural world, both in terms of what is around them and their impact upon it. Such connections begin to be forged when children are young and the effects of early experiences may be long-lasting. According to recent research conducted by the Centre for Diet and Activity Research (CEDAR) in Cambridge, there are initial indications that children who are active when they are young and have a good and positive interaction with nature are more likely to continue being active as adults and maintain the associated health and wellbeing benefits. Teasing such complex interactions apart is incredibly difficult. Is it important for children to have contact with nature as they grow up in order to value it and gain benefits from it in adulthood? Does this contact have to be associated with where they live, or is travel out into nature just as effective? As yet, there is no clear answer.

How can we encourage children to interact with nature and what role could green spaces play for those living in cities?

How can city governance models be scaled to encompass networks of connected green spaces that bridge multiple local councils or areas of jurisdiction?

comprehensive database for urban plants and animals. He called for further research into ways of incorporating the spontaneous dynamics of nature into urban planning and into biodiversity at a city level, harnessing approaches such as citizen science to monitor changes and to forge closer relationships between people and the natural world.

The value of gardens for enhancing biodiversity in cities has long been recognised. Together with nearby parks and other green and blue areas, they provide habitats for a broad range of species that would otherwise find no home within the highly engineered spaces of cities. However all species require some amount of natural land and/or water before a space can serve as a habitat. This can be a single area or one made up of a 'chain' of spaces with connetcins which allow movement between them. The latter will require city landscapes to be designed and green/blue spaces to be connected at a scale necessary to encourage biodiversity.

Putting these ideas into practice is challenging, not least in England where 'every man's home is his castle'. How can people be encouraged to look beyond their own garden fence and think of their own gardens as part of a larger neighbourhood-wide or city-wide network? How could that 'big picture thinking' be built into what people decide to grow or to leave in a more wild state, and what could catalyse such changes in thinking? Would community-level activities help to stimulate this as spontaneous action, or would top-down initiatives at a city scale be more effective?

Green and blue spaces also support another kind of biodiversity: the cultural diversity of societies. They make it possible for the 'nature lover' to remain in the city rather than migrating to the countryside. They allow for the very British passion for gardening and bird watching, even where the landscape is otherwise framed by buildings and streets. They provide communal spaces for those who want to gather. Carefully and imaginatively created spaces allow diverse lifestyles and cultures to co-exist, giving residents the option to immerse themselves as deeply as they wish in nature.

Catalyzing change

The most effective way to incorporate green space into cities needs more research but there are creative ideas already being implemented. For example, Stockholm has continuous green spaces or 'green wedges' that stretch from the edge of the city to the centre. On a smaller scale, similar green areas are being added to housing developments, including the University of Cambridge's North West Cambridge Development. These have the potential to both connect and protect green spaces and bring greenery to the heart of a city or a development. They also have the potential to reduce people's exposure to air pollution by providing alternative, non-motoring routes across and out of the city.

As yet, the importance of green spaces and linking them together into 'green networks' is not generally reflected in policy or in city priorities, or even particularly well studied. A number of witnesses argued that in any local or national agenda, green spaces may be seen as a lower priority than other issues such as schools or housing and consequently might be seen as a luxury rather than a necessity. Cities also have to construct, manage and fund their green spaces and, for them to work and be sustainable in the long term, governance needs to be in place to support them.

There are some examples of 'joined up' governance across multiple green spaces and networks. Many individual cities have green infrastructure development plans which may involve the creation of new green spaces or improving existing sites. For example, the All London Green Grid is a policy framework that is designed to promote the design and delivery of green infrastructure across the city. On a larger scale, the Central Scotland Green Network aims to connect green and blue spaces in towns and cities with the wider countryside and coast across the country from Ayrshire and Inverclyde in the west, to Fife and the Lothians in the east.

Initiatives like this are a step forward but city governance models are often based on managing a single, isolated area. How can these be scaled to encompass networks of connected spaces that bridge multiple local councils or areas of jurisdiction? What governance mechanisms could be used to support these networks? How can communities both take ownership of their green spaces and play an active role in deciding what happens to them? Reflecting questions already raised in relation to biodiversity in cities, would

community-level activities or top-down, city-scale initiatives be more effective?

Finding ways to measure the positive impact of green spaces on both the environment and on people's health and wellbeing was agreed to be a key part of framing a business case to policymakers and decision makers. Catalyzing change in policy is difficult even when the benefits of an approach are obvious. However, there are opportunities for change. Dr Gillian Petrokovsky, James Martin Fellow in the Oxford Long-Term Ecology Lab, emphasised the need for multidisciplinary work and cross-sector partnerships by demonstrating the value of neglected forestry knowledge in an urban context. Additionally, the public's increasing awareness of terms such as wellbeing and sustainability and the current tumultuous political landscape is an opportunity to impress different ideas on policymakers and the public. Ellie Robinson, Assistant Director of External Affairs at the National Trust, described some of the work done in this area by her organisation, which uses natural capital accounting to demonstrate the value of green space. However, the dangers of monetising value as a result of the push to influence policy were acknowledged, as was the risk of ratings tools preventing a holistic approach to project design. In addition, Dr Peeter Pärt, Advisor in Environment and Human Health Interactions at the Joint Research Centre of the European Commission, warned of the dangers of colliding policies and suggested that finding ways to combine sustainability and wellbeing needs further research.

Two barriers were consistently identified with regards to policy change. The first was that the political and democratic system often precludes long-term planning and focuses on short-term thinking, particularly with regards to major projects in the built environment. The other was the need to improve public engagement with the environment and environmental issues. This is particularly important when it comes to protecting invisible or unglamorous assets such as biodiversity or insect species. Craig Bennett, CEO of Friends of the Earth (England, Wales and Northern Ireland), advocated a greater democratisation of resources, improved public consultations and increased levels of education to help reduce inequality and overcome incumbencies in the way we think. Improved education and public outreach is also a core part of the work of Dr David Cope, Director of Strategy and External Affairs at the Royal Botanical Gardens, Kew. He advocated the need for resilient cities to connect people to nature by design and in so doing help deepen the connection and awareness with green spaces and promoting environmental issues politically.

From theory to reality

Two witnesses provided practical examples of an urban setting which incorporates green space and environmental considerations. Ron Bakker, Founding Partner of PLP Architects, described his work on The Edge in Amsterdam, which is an example of a private investment that recognised a business model that valued sustainability, incorporated long-term thinking and engaged with the public. As a building, The Edge is sustainable and efficient in its use of space and is adaptable, creating opportunities for its users to interact with and alter the environment through daily communicative connections. Ron advocated this design approach for cities.

> ***When designing the 'supertrees' in Singapore, we aimed to bridge art, science, function and experience and, as a result, the language we used drew on vocabulary from engineering, aesthetics and biology as well as architecture."***
>
> Andrew Grant,
> Founding Director of Grant Associates

In a similar vein, Andrew Grant, the Founding Director of Grant Associates, presented a vision for green spaces in cities based on his experience of leading the design of a series of 'supertrees' in the Gardens by the Bay nature park in Singapore (see photo on page 4) He suggested that a key reason for the success of the park has been that the trees stimulated a sense of wonder, both in the structures themselves and because of the community of animals and plants which has developed on and around them. People are also able to come to the park and simply enjoy the pleasure of being there and being close to animals and plants. Such large-scale projects not only require a lot of physical space but also sizable budgets to support them. Andrew argued that similar design principles can also be applied to smaller-scale projects. He has worked on the development of spaces in cites such as Bath which provide people with a refuge and moments of stillness in a busy urban environment. Changes in the use of space can also provide the opportunity for

The 'supertrees' in Gardens by the Bay in Singapore are designed to provoke a sense of awe and wonder and to provide a habitat for a range of plants and animals – how can similar principles be applied to gardens and parks in other cities?

inserting green spaces in unlikely places. For example, the High Line in New York is a public park built on a historic freight rail line elevated above the streets on Manhattan's West Side. Thinking creatively is a key part of the success of such spaces and a number of witnesses agreed that bringing together a range of expertise and perspectives can help to catalyze this process.

As part of the pressing need to assess the value of green spaces, two speakers presented their innovative research into connecting happiness and wellbeing in relation to space. Dr Dimitris Ballas, a Senior Lecturer at the Department of Geography, explores the connection between wellbeing and social spaces by comparing objective measures with social survey data and then using multi-level modelling and simulations to create a contextual picture that can help inform social policy regarding incorporating wellbeing into urban planning. Laurie Parma, a researcher based within the Policy Research Group at the Department of Psychology, examines the relationship between biodiversity and human wellbeing by gathering quantitative demographic and survey data through an app, Naturebuzz, and then mapping the results to help us understand whether some green spaces are more valuable than others. Professor Felicia Huppert, Director of the Well-being Institute in Cambridge, emphasised the need for more data in this area, particularly as wellbeing is not a static concept, and different populations will respond in various ways to the natural environment.

Research challenges on the horizon

When thinking about the role that green and blue spaces play in future cities, the largest missing piece of the conceptual puzzle is an understanding of where they must be created, in what form and at what scale. Ignoring the issue of 'where' raises the possibility that only the wealthy will have access to these spaces. Proper consideration of the form of green and blue spaces will increase the potential role of such spaces to provide benefits for people's health and wellbeing and for the environment. For example, creating connections between these spaces, and with the surrounding city, will allow them to provide alternative paths for mobilityfor both residents and the plant and animal species we want to attract. A mantra of 'the larger the better' ignores pressures to create more housing and the impacts on land values. It also ignores the possibility that there may be some minimal amount of green and blue spaces that will suffice for the services we seek.

The theories and methods applied so effectively in ecosystem studies of the countryside and of analyses of catchment areas are a first step in this direction. This in turn requires a richer understanding of the roles of scale, location and form of green and blue spaces in regulating temperature, air quality, water, biodiversity, health and wellbeing and how they may help make cities and the communities living within them more resilient.

Further reading

All London Green Grid Area Framework: GLA website

Arup: Cities Alive report

Managing Air in Green Inner Cities (MAGIC) project: website

OpenSpace Reseach Centre in Edinburgh: website

Grant Associates: Designing the Supertrees

PLP Architecture: Designing the Edge

For more information about this report or the Forum, please contact Dr Rosamunde Almond (reaa2@cam.ac.uk)

The **Cambridge Forum for Sustainability and the Environment** first discussed urban green spaces as part of our first topic, 'sustainable cities, ' in November 2013. We then built on these meetings and focused on forging connections between health, wellbeing and sustainability and green spaces took place between October 2016 and June 2017.

Secretariat: Lord Martin Rees (Chair); Prof. Paul Linden (Director); Dr Rosamunde Almond (Deputy Director); Dr Konstantina Stamati (Head of Partnerships and Development); Simon Patterson (Content Writer and Editor).

Forum members for these two topics were drawn from 27 University Departments, centres and institutes, including**:** Prof. Alan O'Neill (Cavendish Laboratory); Prof. Alison Smith, Dr Mariana Fazenda and Prof. Howard Griffiths (Dept. of Plant Sciences); Prof. Andy Hopper and Prof. Ian Leslie (Computer Laboratory); Prof. Carol Brayne (Dept. of Public Health and Primary Care, Institute of Health); Prof. David Dunne (Dept. of Pathology and Cambridge Africa); Dr David Pencheon (NHS Sustainable Development Unit); Professor Doug Crawford-Brown (Dept. of Land Economy); Dr Emily Shuckburgh (British Antarctic Survey); Dr Erwin Reisner (Dept. of Chemistry); Dr Helen Curry (Dept. History and Philosophy of Science); Dr Hildegard Diemberger (Dept. of Social Anthropology); Dr Jake Reynolds, Dr Nicolette Bartlett and Polly Courtice (Cambridge Institute for Sustainability Leadership); Dr Julian Huppert (Jesus College Intellectual Forum); Prof. Koen Steemers (Dept. of Architecture); Prof. Larry Sherman (Dept. of Criminology); Dr Mike Rands (Cambridge Conservation Initiative); Prof. Nick Wareham (UKCRC Centre for Diet and Activity Research); Prof. Peter Guthrie (Dept. of Engineering); David Cleevely, Dr Rob Doubleday, Dr Moira Faul and Dr Miles Parker (Cambridge Centre for Science and Policy – CSaP); Prof. Roderic Jones (Dept. of Chemistry); Dr Shailaja Fennell (Centre of Development Studies); Dr Simon Beard (Centre for Existential Risk – CSER); Prof. Simon Redfern (Dept. of Earth Sciences); Dr Stephen Cave (Leverhulme Centre for the Future of Intelligence); Prof. Susan Owens and Dr Bhaskar VIra (Dept. of Geography); and Dr Tiago Cavalcanti (Faculty Economics).

We would like to thank everyone who took part in Forum meetings related to this topic, especially the expert witnesses and guests who joined us from across and outside Cambridge:

Witnesses: Andrew Grant (Grant Associates); Dr Britt Baillie and Prof. Marcial Echenique (Dept. of Architecture); Prof. Catharine Ward Thompson (University of Edinburgh); Craig Bennett (Friends of the Earth); Dr David Cope (Royal Botanical Gardens Kew); Dr Dimitris Ballas (University of Sheffield); Ellie Robinson (National Trust); Prof. Felicia Huppert (Wellbeing Institute in Cambridge and the Institute for Positive Psychology & Education at Australian Catholic University); Dr Gillian Petrokofsky (Oxford Martin School, Oxford University); Laurie Parma (Dept. of Psychology); Prof. Matthew Gandy (Dept. of Geography); Dr Peeter Part (Joint Research Centre, European Commission – JRC); Ron Bakker (PLP Architects); Dr Ross Cameron (University of Sheffield); Simon Marsh (RSPB); Dr Scott Hosking (British Antarctic Survey); and Tom Armour (Arup).

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