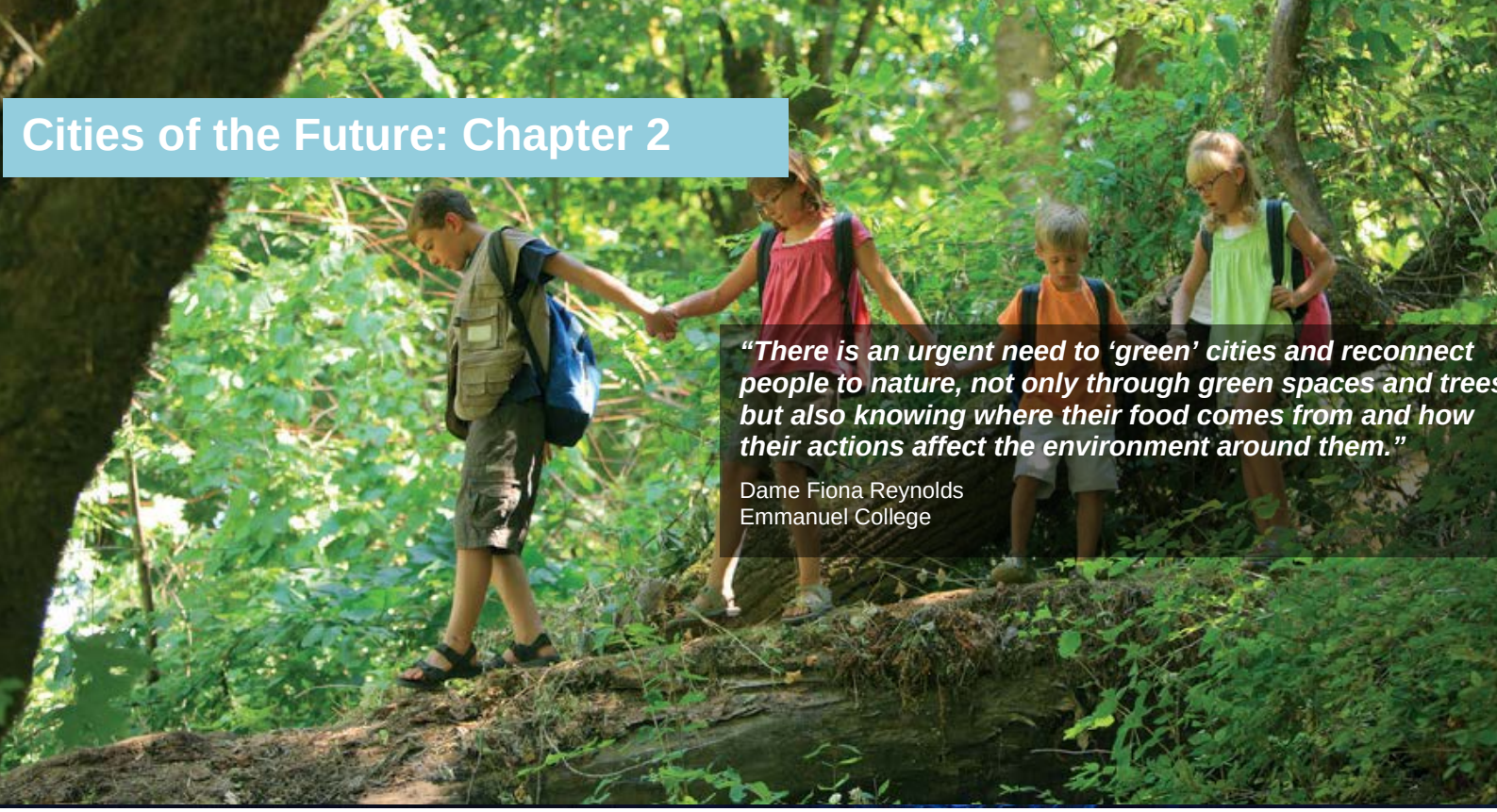

"There is an urgent need to 'green' cities and reconnect people to nature, not only through green spaces and trees but also knowing where their food comes from and how their actions affect the environment around them."

Dame Fiona Reynolds
Emmanuel College

Urban green spaces

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

At a glance

Cities can contain tree-lined roads, gardens, parks, playing fields, ponds, lakes, wetlands, rivers and canals, collectively referred to as 'urban green and blue infrastructure'. A growing body of research suggests that this urban green and blue infrastructure provides environmental services such as cooling, reducing pollution and absorbing excess rainfall, improves local economies and has a positive impact on physical and mental health.

All cities are made up of a 'patchwork' of different types of buildings, neighbourhoods and open spaces. We considered the role that green and blue spaces could play in this patchwork, and what might happen if these spaces are connected rather than isolated. Are these connections, which may require creating new green and blue spaces, essential for providing environmental services, or would they only add incremental value? Might such connections provide new benefits? Are green and blue amenities or services simply a function of the amount of space created, or does the shape or form of that space matter too?

Green and blue environmental services

Individual urban green and blue spaces have an impact on the surrounding city that goes beyond their localised amenity benefits. One example is in reducing the 'urban heat island effect' where cities tend to become hotter than the surrounding countryside. 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 expand and become denser.

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. 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 a particular area could reduce the daily maximum temperature by 2.2°C.

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 would such connected spaces encourage biodiversity as well as the cultural diversity of residents?

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Much of the research on urban heat-flows is focussed within or around individual buildings, parks or water bodies but 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 air flow affect the rate at which buildings, streets and neighbourhoods heat and cool? How could these effects be quantified and added into existing models to foster better designs of green and blue infrastructure?

Green and blue infrastructure can be combined with engineered infrastructure to provide environmental services. This gives rise to a number of questions based on the connections between them. For example, given the current capacity of the rivers, sewers and drains within a drainage catchment, how much more would be needed to service population growth, increased run-off from new development and increased rainfall? If there is insufficient capacity or flexibility in the system, what solutions could be provided by green infrastructure? Where should street trees and green spaces be located and how should they be combined to provide shade and cooling and to absorb the most rainfall?

Quantifying the costs and benefits of these different types of infrastructure would help people to picture what measures could be taken and also to understand what other costs there may be if no changes are made. For example, how do the costs of creating or maintaining green and blue spaces compare to enlarging existing sewers or repairing damage from regular flooding? Is there a minimum area needed to realise these benefits on a city-wide scale, so that local solutions do not simply push the problem (e.g. flooding) from one part of the city to another? And how can we ensure that engineering solutions for one problem, such as mitigating flood risks, do not increase other problems, such as the heat island effect?

"Combining climate projection models and models of heat and air flow within cities can build up a picture of which areas might be most vulnerable to changes in climate."

Professor Alan Short
Department of Architecture, University of Cambridge

Green and blue social benefits

Although studies generally agree that green and blue spaces provide, both environmentally and socially, a range of short and long term benefits, how people use them varies between age groups, gender, ethnic groups and socioeconomic 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? Carefully and imaginatively created green and blue spaces may also allow diverse lifestyles and cultures to co-exist thereby improving the cultural diversity of urban societies. They allow the 'nature lover' to remain in the city rather than migrating to the countryside and provide communal spaces for those who want to gather and enjoy the natural world, even where the landscape is otherwise framed by buildings and streets. However, the poorest areas of cities often have the worst quality green and blue spaces. Which aspects discourage people from using these spaces and how can they be improved so as to bring the desired social and environmental benefits?

As cities expand, children are increasingly growing up in urban rather than rural environments. 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. Does this contact with nature have to be associated with where they live, or is travel out into nature just as effective? The most effective way to incorporate green space into cities needs further 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 continuous 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 exposure to air pollution by providing alternative, non-motoring routes across and out of the city.

The value of gardens for enhancing urban biodiversity has also long been recognised. Together with neighbouring green and blue spaces, they allow diverse species to exist in a highly engineered city habitat. As many species require a minimum area to persist, we need to decide how biodiverse we wish our cities to be and design urban landscapes that connect green and blue spaces on a large enough scale. 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 can that 'big picture thinking' be built into what people decide to grow and what to leave in a more wild state. Finally, what could catalyse these changes in thinking and the way that green spaces and gardens are planned and maintained? Would community-level activities or top-down city-scale initiatives be more effective?

The research challenge on the horizon

The largest missing piece of the conceptual puzzle is an understanding of the scale at which green and blue spaces must be created, where and in what form. 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. 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 alternative paths for mobility, both for residents and the species we want to attract. 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 and wellbeing and the follow-on effects for energy use or flooding.

What does the future hold?

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.