The role of green infrastructure in climate change adaptation in London

Author(s): SARAH JONES and CAROL SOMPER

Source: *The Geographical Journal*, June 2014, Vol. 180, No. 2 (June 2014), pp. 191-196

Published by: Wiley on behalf of The Royal Geographical Society (with the Institute of British Geographers)

Stable URL: https://www.jstor.org/stable/43868604

The Geographical Journal, Vol. **180**, No. 2, June 2014, pp. 191–196, doi: 10.1111/geoj.12059

Commentary

The role of green infrastructure in climate change adaptation in London

SARAH JONES AND CAROL SOMPER
Temple Group Ltd, London SE16 4TQ
E-mail: sarahjones@cantab.net; carol.somper@templegroup.co.uk
This article was accepted for publication in October 2013

Climate change may create risks that, without sufficient adaptation measures in place, endanger lives and damage natural, semi-natural and designed landscapes. This article explores the use of green infrastructure in climate change adaptation in London. A review of the current literature identifies how and where green infrastructure can deliver climate adaptation services and considers the benefits of taking a green infrastructure (or ecosystems services) approach to development. Selected examples are used to demonstrate how green infrastructure is being integrated into London's urban landscape. The article considers how existing mechanisms are facilitating the growth of green infrastructure in the capital and identifies three key focus areas for future research and policy. It concludes by suggesting that a more collaborative and imaginative approach to optimising the potential for green infrastructure benefits is needed.

KEY WORDS: green infrastructure, climate change adaptation, ecosystem services

Climate change in London

UK Climate Projections (Defra 2009) indicate that by 2080 there is likely to be around 20% less precipitation in summer and 20% more in winter in London compared with the baseline period 1961–90, whilst both mean summer and winter temperatures are likely to increase by 3–4°C[1]. As well as seasonal changes, there are likely to be more frequent extreme weather events, such as heat waves and intense downpours. Heavy rain will increase the risk of flooding in low-lying places and areas close to waterways; increase pressure on freshwater resources as rainfall patterns change and temperatures increase; and introduce or exacerbate issues related to rising air temperatures (Defra 2012a). Climate changes are likely to also bring new opportunities to London; milder winters should reduce cold-related health problems and decrease the city's heating demands, whilst warmer annual temperatures will open up opportunities for the tourism industry and encourage Londoners to take up outdoor recreational activities (Defra 2012a).

Green infrastructure in urban climate change adaptation

Green infrastructure is defined by social and environmental researchers and practitioners in different ways, although there is general agreement that green infrastructure is multi-functional and delivers both ecological and social benefits. For a discussion of definitions of green infrastructure and its links to the concept of ecosystem services, see Lafortezza *et al.* (2013). For the purposes of this commentary, we use the definition by Naumann *et al.* (2011) which proposes that green infrastructure refers to natural or semi-natural networks of green (soil-covered or vegetated) and blue (water-covered) spaces and corridors that maintain and enhance ecosystem services[2]. As such, green infrastructure includes biofiltration swales, green walls, green roofs, brown roofs, rain gardens, shrubbery fences, vegetated parks and private gardens, trees and hedgerows, as well as ponds, canals, rivers and other water bodies.

Current research indicates that the climate adaptation services provided by urban green

infrastructure can be substantial (Foster *et al.* 2011; Gill *et al.* 2007; Naumann *et al.* 2011; UK National Ecosystem Assessment 2011, 362–3). Examples of green infrastructure adaptation services appropriate to London's urban landscape include:

- decrease in risk of flooding through use of water storage and retention areas (e.g. ponds, canals, rain gardens), and use of soil-covered surfaces over hard surfaces to facilitate drainage, which reduce surface runoff, discharge and slow tidal surges of the River Thames;
- temperature regulation provided by evapotranspiration and shading from vegetation and air flow through open spaces;
- maintenance of freshwater quality and supply where sediments and pollutants are filtered through dense vegetation and soils (e.g. biofiltration swales);
- increase in thermal performance of buildings through use of green roofs and walls; and
- enhanced species resilience through provision of varied habitats and green corridors, which allow species to move easily to new climate spaces.

London's green infrastructure landscape

An estimated 35.1% of London was classified as built on in the most recent survey (i.e. contains buildings, roads, rail, paths, and other/unclassified land uses) with the remaining 64.9% constituting what might be considered green infrastructure (greenspace, open water or domestic gardens) (Communities and Local Government 2005). These figures are not entirely representative of the percentage of green infrastructure across the capital (for example, they do not distinguish buildings or structures with green roofs in place, nor do they distinguish domestic gardens which are paved rather than grass covered), but are used here for indicative purposes. Although London is one of the world's greenest cities, the challenge is how to fully utilise the ecosystem services potential of London's green infrastructure and its rural hinterland. This includes extending a green network across parts of London that are currently lacking. The proportion of grey and green infrastructure varies significantly between local authorities; just 18.2% land area in the City of London is classified as greenspace, open water or domestic gardens compared with 81.4% in Bromley (Communities and Local Government 2005). In some parts of London, further expansion of the green infrastructure network within the existing city fabric requires integrated urban design strategies and an increasingly multi-functional network of green spaces (GLA 2011a, 2.86). This means changes to conventional urban design strategies and changes to the management of built assets and spaces.

Plate 1 Green roof garden in Cardinal Place, Victoria; part of the Victoria BID green infrastructure expansion project
Source: Sarah Jones, 14 April 2013

In recent years, there have been some inspiring initiatives in this respect. The Green Roofs scheme being piloted on four London buildings, where offices convert their roofs into gardens by planting fruit and vegetables in recycled pots, is expected to reduce heating and ventilation costs by up to 10% (BusinessGreen 2013). The CEEQUAL award winning 700 m^2 'living roof' on Farringdon Station, installed as part of the station redevelopment to provide new foraging habitat for bats, black redstart and other bird species found roosting in the area, has saved an estimated £40 000 compared with installing a zinc roof (Costain 2013). In inner-city Islington, the council enhanced one barely used green space surrounded by tower blocks – Radnor Gardens – into an attractive landscaped park, leading to increase in community use and improved habitat quality (Green Alliance 2012). A project to expand the green infrastructure network across the Victoria Business Improvement District will result in the creation of more than 25 ha of green roofs (see Plate 1). Natural England report that this initiative will have the potential to divert an estimated 70 000 m^3 of storm water runoff each year, amounting to around £12 000 in averted CO_2 emissions and £17 500 in energy savings per annum. It could further result in a 5°C decrease in peak surface temperatures during summer months (Natural England 2013).

Mechanisms facilitating the growth of green infrastructure

Current local and national policy documents provide a framework for London's response to climate change and recognise the role of green infrastructure in meeting this objective. The Greater London Authority (GLA) published a climate change adaptation strategy that focuses on (GLA 2011b):

The Geographical Journal 2014 180 191–196 doi: 10.1111/geoj.12059

- retrofitting existing buildings to reduce energy and water usage;
- greening London to reduce pollution, build a network of multi-functional green spaces, and lessen the impacts of increased flood risk and extreme weather events; and
- reducing air pollution by focusing on green technology transport systems.

Green infrastructure provides many of the adaptation actions identified in the GLA's climate adaptation strategy and the strategy therefore provides a launch pad for expansion of green infrastructure across the city. A GLA guidance document on developments for a changing climate contains a checklist for designing buildings and infrastructure resilient to climate change, including the use of green infrastructure (GLA 2005). The All London Green Grid Supplementary Planning Guidance (ALGG SPG) outlines the vision and framework for London's green infrastructure landscape in more detail (GLA 2012). The ALGG SPG aims to encourage London boroughs, developers and communities to deliver high-quality open spaces and green corridors, and to promote the use of footpaths and cycleways. These objectives tie into policy 2.18 of The London Plan which specifies that 'enhancements to London's green infrastructure should be sought from development' and therefore development proposals should incorporate elements of, and linkages between, green infrastructure (GLA 2011a).

Specific planning and policy mechanisms that encourage stakeholders to work together to incorporate green infrastructure into development include local nature partnerships (LNPs), the Community Infrastructure Levy, Section 106 agreements, strategic environmental assessments (SEAs) and environmental impact assessments (EIAs). LNPs are stakeholder partnerships that drive local development decisions by helping decision makers to positively manage the environment. The London LNP provides a platform for communities and conservationists to promote biodiversity and green spaces across the city. At the local authority level, the Community Infrastructure Levy enables adjacent London boroughs to work together on large-scale initiatives to incorporate green infrastructure, by charging major infrastructure developers a levy, using this money to fund strategic green infrastructure projects. Smaller, more locally specific initiatives could be channelled through Section 106 agreements. These require that the developer appropriately offsets adverse impacts. For example, delivery of a Biodiversity Action Plan for the Olympic Park was a planning condition and Section 106 legal requirement for the 2007 Olympic and Legacy Facilities planning application, thus ensuring the instatement of new habitats during and after the Games (Olympic Delivery Authority 2011).

Under European Directive 2001/42/EC, SEAs are required to assess the effects on the environment of, and of realistic alternatives to, proposed public plans or programmes. SEAs set the design strategy for developers to take forward through the EIA process. During screening and/or consultation, the environmental authorities, public and other stakeholders have a clear opportunity to bring green infrastructure onto the agenda as a way of improving design, mitigating environmental effects and adding value to projects, that is, using an ecosystems approach. The EIA Directive (2011/92/EU) applies to both public and private projects and requires a more in-depth environmental assessment. For large developments, such as the London to West Midlands High Speed 2 link, SEA is vital as it provides a framework for the EIA, drilling down into the detail of how small cumulative changes might have a significant effect overall. EU guidance on integrating climate change and biodiversity into the EIA (and SEA) processes recognises the challenge of biodiversity loss and its impact on ecosystem services (European Union 2013, 16). Proposals to change the EIA Directive were launched on 26 October 2012 by the European Commission and, if implemented, the changes to Article 3 would make it mandatory for EIA to consider biodiversity and climate change factors (European Commission 2012), a positive step towards encouraging developments to take an ecosystems approach.

Challenges and next steps

We suggest three areas of focus for researchers and policymakers to further enable the use of green infrastructure in delivering climate adaptation actions in London.

First, actors influencing the perception of green infrastructure amongst investors need to use their position to clearly communicate the economic value and planning and community opportunities it offers. This includes national government, the GLA, local authorities, sustainable design assessors (e.g. BREEAM, CEEQUAL), sustainable construction working groups (e.g. within Construction Industry Research and Information Association (CIRIA)) and environmental think-tanks (e.g. Green Alliance, International Institute for Environment and Development (IIED), World Resources Institute (WRI)).

Turning policy into practice requires that stakeholders understand the multi-functional value of green infrastructure. Its value may be poorly understood and perceived as difficult to quantify because benefits are traditionally discussed in qualitative terms. Furthermore, the benefits of valuing ecosystem services have been hotly debated by environmental scientists. Advocates of the concept argue that valuation and market solutions are key tools with which to address environmental problems, whilst opponents reject the idea that there should be a utilitarian rationale behind sustainable environmental management (Gómez-Baggethun and Pérez 2011).

Nonetheless, there is a growing body of research showing that the ecosystem services provided by green infrastructure have a measurable worth (Boyd 2006; Defra 2013b; Juniper 2013; Vandermeulen *et al.* 2011). Ecosystem services provided by natural and semi-natural ecosystems, including soil services, pollination services and avoided health costs, are estimated to save billions each year (Juniper 2013, 268). Such is their value that James Boyd proposed that flows of ecosystems services should be used to measure a country's green GDP, that is, the 'benefits that arise from public goods provided by nature' (Boyd 2006, 2). A business-led review of opportunities arising from correct evaluation of nature concludes that using development to deliver biodiversity offsetting (i.e. securing net gain of habitat area) would 'save developers time and money' by reducing risks and increasing the likelihood of a smooth planning approval process (Defra 2013b, 11). Vandermeulen *et al.* (2011) indicate that green infrastructure can provide substantial economic gains at both project and regional scales. More specific research focusing on green roofs show considerable monetary savings when comparing a green roof's net present value against that of conventional roof materials, due to the increased roof longevity, benefits to air quality, decreases in storm-water runoff, and reductions in building energy consumption (Clark *et al.* 2008; Niu *et al.* 2010).

However, as yet, there is no widely accepted, robust method for valuing ecosystem services and this may be making it harder for decision makers in industry to understand and apply existing tools. The World Resources Institute is working to overcome this limitation and to improve communication of what ecosystem services metrics mean with the aim of integrating the ecosystem services concept into planning and decision-making processes for both the private and public sectors (World Resources Institute 2013). Similarly, the Department for Environment, Food and Rural Affairs (Defra) is focusing efforts on developing an ecosystem services valuation tool for UK-wide use, based on economically valuating the changes to ecosystem services impacted by a development (Defra 2013a). The results of these efforts will be important; as major corporations start to grasp the value of ecosystems services and voluntarily commit to taking an ecosystems approach to design, they are likely to win a larger market share. A snowball effect could ensue as competitors fear being left behind. Some large corporations are already taking action, such as Nestlé who has pledged to safeguard ecosystem services in their Commitment on Natural Capital released in 2012.

Second, there is a need for stronger planning policy and government initiatives to steer developers towards integrating green infrastructure into their design as standard practice. Part of the problem in terms of securing business buy-in is that the savings and benefits posed by green infrastructure are generally long term. Some businesses with a pivotal position in construction design, such as property developers, are primarily interested in short-term gain. Effective legislation is critical in order to bring sustainable design to the forefront of this sector. Existing planning documents provide a solid framework and vision for London's green spaces/corridors, but generally lack sufficiently explicit policy requirements and regulatory standards to ensure delivery.

Planning policy such as Supplementary Planning Guidance to the London Plan, or local authority local development plans, could be used to set specific borough-wide targets to increase the quantity and quality of green infrastructure, or to make it mandatory to use green infrastructure on developments in certain areas, particularly where there is a low amount of green space compared to neighbouring areas. This would strengthen the ALGG SPG and planners could use these policies as part of the criteria to assess development proposals. Developers in other cities around Europe are already required by planning policy to actively use green infrastructure. For example, where new roofs are flat or gently sloped, it is mandatory in the City of Copenhagen for them to be vegetated (GreenRoofs 2013).

Market-based instruments, such as lower taxation or reduced utility bills for companies using green infrastructure, could be used by the government to encourage industry action. In Germany, 13 cities already reduce utility fees by 50–80% for buildings where a green roof is installed (GreenRoofs 2013).

It is also worth considering how tools such as the BREEAM Communities 2012[3] sustainable master-planning standard can be used alongside EIAs to encourage the creation of greener, more biodiverse developments. By making this a local policy requirement that developers must comply with, London-wide planning authorities could drive up the sustainability and green infrastructure performance of new developments without creating additional work for planners because the responsibility for meeting design thresholds is firmly with the developer. Local authorities who have already taken this step elsewhere include Eastleigh Borough Council and Bristol City Council.

It is important, however, that any policy or market-based approaches to promoting green infrastructure are integrated with other local policies to avoid a negative trade off between green infrastructure and other local infrastructure requirements such as affordable housing. The nature of green infrastructure is such that, provided there is a cohesive approach to spatial planning, it can be used to enhance and complement grey infrastructure rather than conflict with it. Planning policy and incentives need to be designed with this in mind for better outcomes.

Third, it is important that stakeholders involved in managing and developing London's urban landscape,

The Geographical Journal 2014 180 191–196 doi: 10.1111/geoj.12059

such as London boroughs, businesses and communities, work together to ensure funding of green infrastructure projects is channelled efficiently and the project helps realise shared goals. London's Business Improvement Districts (BIDs) provide one forum for streamlining industry, government and NGO efforts. Several BIDs are now actively promoting green infrastructure in their local area using funding from the GLA, Natural England, local business contributions and other donors. For example, Vauxhall One BID announced an international design competition to connect the New American embassy with the South Bank using sustainable green links (Royal Institute of British Architects 2013).

Local authorities have an important role to play in facilitating cooperation between stakeholders by enabling knowledge sharing and steering actions to maximise the effectiveness of green infrastructure. A good example is already being set by a few borough councils, including Camden and Islington. Camden Council are encouraging community engagement with green issues through initiatives such as their Green Camden zones programme, where residents meet online to plan and coordinate green initiatives. The borough of Islington, one of the most densely urbanised areas in London, adopted an Environmental Design SPD in October 2012 to provide guidance on new development. This advocates the use of sustainable drainage systems to manage flood risk (e.g. biofiltration swales, green roofs, detention ponds) and passive design techniques to minimise overheating (e.g. vegetation shading, green roofs and maximising wind-driven ventilation) to help adapt to climate change. The Islington Council website has a wealth of information and guidance on green design, including a number of inspiring case studies showing good practice for design of green buildings.

Conclusion

There is potential for more effective use of green infrastructure across London to deliver climate adaptation functions and other ecosystem services. Investors may be hesitant to invest in green infrastructure without a clear understanding of the economic and wider benefits it offers compared with conventional solutions to design challenges. Therefore, groups holding influence over the evolution of London's urban landscape need to impress on businesses the value of integrating green infrastructure into design. Existing mechanisms could be strengthened by more explicit planning policy and market-based incentives to encourage incorporation of green infrastructure into new and existing developments. Finally, businesses, government and communities need to work together to maximise the usefulness of green infrastructure within design and realise its full potential.

Overcoming these challenges is not only key to London's successful delivery of climate adaptation services, but will also prevent missed opportunities for economic growth. London is one of the world's leading twenty-first century cities with a thriving development sector and intensive investment in iconic urban design and regeneration. The challenge for leading developers, planners and investors is to grasp the opportunities and make London the greenest city in the world in the most literal sense.

Acknowledgements

The authors would like to thank Peter George for his valuable review comments.

Notes

1 Based on the 2080 medium emissions scenario. For more information on assumptions and limitations of UK climate projections, see Defra (2012b).

2 'Ecosystem services' is a term used to describe the regulating, provisioning, cultural and supporting functions that ecosystems perform in terms of goods produced and services delivered for the benefit of people and the environment.

3 For details of the BREEAM Communities 2012 scheme see www.breeam.org/communities-2012-video.jsp (Accessed 24 April 2013).

References

Boyd J 2006 *The nonmarket benefits of nature* Resources for the Future, Washington

BusinessGreen 2013 Green roofs could grow energy savings for London firms (www.businessgreen.com/bg/news/2233089/green-roofs-could-grow-energy-savings-for-london-firms) Media release 2 January 2013, Accessed 13 February 2013

Clark C, Adriaens P and Talbot F B 2008 Green roof valuation: a probabilistic economic analysis of environmental benefits *Environmental Science and Technology* 42 2155–61

Communities and Local Government 2005 Generalised land use database (http://data.gov.uk/dataset/land_use_statistics_generalised_land_use_database) Accessed 20 April 2013

Costain 2013 'Green' awards for Farringdon (www.costain.com/news/news-releases/2013/4/2/green-awards-for-farringdon.aspx) Media release 2 April 2013, Accessed 5 April 2013

Defra (Department for Environment, Food and Rural Affairs) 2009 *UK climate projections 2009* (http://ukclimateprojections.defra.gov.uk) Accessed 15 April 2013

Defra 2012a *UK climate change risk assessment: government report* HMSO, London

Defra 2012b *UK climate change risk assessment 2012: evidence report* HMSO, London

Defra 2013a *An introductory guide to valuing ecosystem services* Defra, London

Defra 2013b *Realising nature's value: the final report of the Ecosystem Markets Task Force* Defra, London

The Geographical Journal 2014 180 191–196 doi: 10.1111/geoj.12059

European Commission 2012 (628) *Proposal for a Directive of the EU Parliament and of the Council amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment* European Commission, Brussels

European Union 2013 *Guidance on integrating Climate Change and Biodiversity into Environmental Impact Assessment* Publications Office of the European Union, Luxembourg

Foster J, Lowe A and Winkelman S 2011 *The value of green infrastructure for urban climate adaptation* The Centre for Clean Air Policy, USA

Gill S E, Handley J F, Ennos A R and Pauleit S 2007 Adapting cities for climate change: the role of the green infrastructure *Built Environment* 33 1 115–33

GLA (Greater London Authority) 2005 *Adapting to climate change: a checklist for development; guidance on designing developments in a changing climate* GLA, London

GLA 2011a *The London plan: spatial development strategy for Greater London* GLA, London

GLA 2011b *Managing risks and increasing resilience: the Mayor's climate change adaptation strategy* GLA, London

GLA 2012 *Green infrastructure and open environments: the all London green grid supplementary planning guidance* GLA, London

Gómez-Baggethun E and Pérez M R 2011 Economic valuation and the commodification of ecosystem services *Progress in Physical Geography* 1–16

Green Alliance 2012 *A better place to live: a toolkit for high rise green living* Green Alliance, London

GreenRoofs 2013 Industry support (www.greenroofs.com/Greenroofs101/industry_support.htm) Accessed 20 April 2013

Juniper T 2013 *What has nature ever done for us?* Profile Books, London

Lafortezza R, Davies C, Sanesi G, Konijnendijk C C 2013 Green infrastructure as a tool to support spatial planning in European urban regions *iForest* 6 102–8

Natural England 2013 Green shoots appear for London's economy and environment with support from Natural England (www.naturalengland.org.uk/ourwork/planningdevelopment/greeningforgrowthfeature.aspx) Media release 28 February 2013, Accessed 4 April 2013

Naumann S, Davis M, Kaphengst T, Pieterse M and Rayment M 2011 Design, implementation and cost elements of Green Infrastructure projects Final report to the European Commission, DG Environment, Contract 070307/2010/577182/ETU/F.1 Ecologic institute and GHK Consulting

Niu H, Clark C, Zhou J and Adriaens P 2010 Scaling of economic benefits from green roof implementation in Washington, DC *Environmental Science and Technology* 44 4302–8

Olympic Delivery Authority 2011 Learning legacy Olympic Delivery Authority, London

Royal Institute of British Architects 2013 *New RIBA international design competition: London Vauxhall the missing link* (www.architecture.com/NewsAndPress/News/CompetitionNews/Press/NewCompetitions/2012/VauxhallJan13.aspx) Media release 14 January 2013, Accessed 15 February 2013

UK National Ecosystem Assessment 2011 *UK National Ecosystem Assessment technical report* UNEP-WMCM, Cambridge

Vandermeulen V, Verspecht A, Vermeire B, Van Huylenbroeck G and Gellynck X 2011 The use of economic valuation to create public support for green infrastructure investments in urban areas *Landscape and Urban Planning* 103 198–206

World Resources Institute 2013 Ecosystem services tools and indicators (www.wri.org/project/ecosystem-services-indicators) Accessed 24 April 2013

The Geographical Journal 2014 180 191–196 doi: 10.1111/geoj.12059