Environmental Research 156 (2017) 97–107

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Challenges for tree officers to enhance the provision of regulating ecosystem services from urban forests

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ARTICLE INFO

Keywords:
Ecosystem services approach
Disservices
Climate change
Air pollution
Local authorities

ABSTRACT

Urbanisation and a changing climate are leading to more frequent and severe flood, heat and air pollution episodes in Britain's cities. Interest in nature-based solutions to these urban problems is growing, with urban forests potentially able to provide a range of regulating ecosystem services such as stormwater attenuation, heat amelioration and air purification. The extent to which these benefits are realized is largely dependent on urban forest management objectives, the availability of funding, and the understanding of ecosystem service concepts within local governments, the primary delivery agents of urban forests.

This study aims to establish the extent to which British local authorities actively manage their urban forests for regulating ecosystem services, and identify which resources local authorities most need in order to enhance provision of ecosystem services by Britain's urban forests.

Interviews were carried out with staff responsible for tree management decisions in fifteen major local authorities from across Britain, selected on the basis of their urban nature and high population density. Local authorities have a reactive approach to urban forest management, driven by human health and safety concerns and complaints about tree disservices. There is relatively little focus on ensuring provision of regulating ecosystem services, despite awareness by tree officers of the key role that urban forests can play in alleviating chronic air pollution, flood risk and urban heat anomalies. However, this is expected to become a greater focus in future provided that existing constraints – lack of understanding of ecosystem services amongst key stakeholders, limited political support, funding constraints – can be overcome.

Our findings suggest that the adoption of a proactive urban forest strategy, underpinned by quantified and valued urban forest-based ecosystem services provision data, and innovative private sector funding mechanisms, can facilitate a change to a proactive, ecosystem services approach to urban forest management.

1. Introduction

Urbanisation (particularly densification) is increasing the risk of flooding (Eigenbrod et al., 2011) and extreme heat episodes (Lemonsu et al., 2015) in Europe's cities due to the loss of urban greenspace (Davies et al., 2011). In Britain, the government's latest Climate Change Risk Assessment reveals the greatest climate change threats to the country to be flood and heat-related risks to communities and businesses (Committee on Climate Change, 2016). Air pollution is also a problem in many densely populated cities, particularly in more deprived areas (Netcen, 2006), and is forecast to be an increasing public health concern as the climate warms (De Sario et al., 2013).

Concern about the impacts of climate change on urban environments has led to a growing interest in regulating ecosystem services, which can pose an effective solution to some of the negative impacts of urbanisation (Andersson et al., 2014). Ecosystem services, or "the benefits people obtain from ecosystems" (MEA, 2005), are categorised into provisioning services (such as provision of food and timber), regulating services (such as air purification, heat amelioration and stormwater attenuation), cultural services (such as public amenity and opportunities for recreation) and supporting services (such as soil formation and habitats for wildlife) (MEA, 2005). This paper focuses on regulating services, which are of particular relevance to combating climate-related impacts on urban environments.

Within urban areas, regulating ecosystem services are provided predominantly by the urban forest (Davies et al., 2017), defined as "all

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http://dx.doi.org/10.1016/j.envres.2017.03.020
Received 13 September 2016; Received in revised form 7 February 2017; Accepted 15 March 2017
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forest and tree resources in (and close to) urban areas" (Konijnendijk, 2003: 177). This is because, in comparison with other forms of green infrastructure, trees and forests are particularly effective at alleviating summer heat through evaporation, photosynthesis and shading (Doick and Hutchings, 2013); reducing stormwater run-off by intercepting and absorbing water and improving infiltration (Armson et al., 2013); and enhancing air quality by intercepting and/or absorbing gaseous pollutants and particulate matter (Escobedo and Nowak, 2009). On this basis, urban forests could be posed as a 'nature-based solution' for sustainable urbanisation and climate change adaptation in European cities (European Commission, 2015).

The urban forest can also have adverse effects on society – these 'disservices' are defined as "functions of ecosystems that are perceived as negative for human well-being" (Lyytimäki and Sipilä, 2009: 311). Some of the most frequently reported disservices provided by urban forests are increased ground-level ozone through the emission of biogenic volatile organic compounds, the blocking of light and heat, tree root-induced damage to infrastructure, a risk of injury or damage from tree or branch fall, and pollen-associated allergic reactions (Roy et al., 2012). Trade-offs between the ecosystem services provided by urban forests can also occur, particularly between regulating and cultural services, leading to a reduction in expected benefits (Bennett et al., 2009; Davies et al., 2017). Handley and Gill (2009) suggest that for urban forests to better help British urban society, it is necessary to address the information gap on the nature and extent of each local authority's urban forest, and to conduct further research on decision support systems which improve understanding of ecosystem services and associated economic benefits.

Matthews et al. (2015) reveal that there has been a wealth of literature published on the biophysical capacity of green infrastructure to help cities adapt to climate change, but that socio-political factors (including governance, funding and public involvement) are poorly understood. 'Path dependence', whereby decision-makers favour fixed patterns of thinking and lack motivation to respond meaningfully to new problems and solutions, is identified as a significant constraint to embracing green infrastructure (Matthews et al., 2015). Surveys of urban forest professionals in England (Trees in Towns II) and Scotland (TWIST) suggest that urban forest management is reactive to human health and safety concerns (Britt and Johnston, 2008; Van der Jagt and Lawrence, 2015); these studies did not consider the extent to which local authorities also target ecosystem service delivery or climate change adaptation.

The purpose of this study is to identify constraints and drivers to British local authorities adopting an ecosystem services approach to urban forest management. To this end, four research questions are posed:

a) What are the main objectives for urban forest management in Britain*
b) Do tree officers in British local authorities manage their urban forests for regulating ecosystem services and, if so, why and how*
c) What are the opportunities and constraints for British local authorities to move from a risk/reaction approach to an ecosystem services approach*
d) How might tree officers in British local authorities promote an ecosystem services approach going forwards*

2. Materials and methods

2.1. Data collection

Telephone interviews were carried out with a staff member responsible for managing local authority-owned trees (hereafter referred to as 'tree officer', actual job title varied) in each of 15 urban local authorities from across Great Britain. This figure represents a response rate of 54%, with 28 local authorities having been contacted by email (generally via their 'parks departments'). These local authorities were selected on the basis of them meeting three criteria:

a) Unitary authorities or metropolitan districts, i.e. those responsible for all local government functions within their area under a single-tier administrative system.
b) Classed as being urban – in England this includes authorities in classes 4, 5 and 6 of Defra's Rural-Urban Classification system (Defra, 2014), whilst for Scotland and Wales 'urban' refers to settlements of at least 3000 and 10,000 people respectively (ONS, 2005; Scottish Government, 2014).
c) A high population density to reflect the densification of urban areas being associated with environmental problems (this was set at a minimum of 25 persons per hectare).

The interviews were semi-structured, with tree officers answering 32 open and closed questions that they were provided with in advance. The full list of questions is provided in Appendix A. Questions were grouped into five categories: urban forest resource; approach to urban forest management; ecosystem services provided by urban forests; governance; and urban forest funding. Prompts and follow-up questions were employed where the response was considered incomplete or unclear, or if a point of particular relevance to the study was raised (following: Foddy, 1993). Interviews were recorded and lasted for 54 min on average, ranging between 33 and 83 min. Where available, local authority policies relating to trees were analysed for specific mentions of ecosystem services.

2.2. Data analysis

The interview recordings were transcribed verbatim and edited to remove repetitions, stop words and habitual irrelevant phrases, whilst retaining accuracy. The transcripts were then analysed in the software package 'Nvivo v.10' (QSR International, 2012) using a thematic approach, following the process outlined by Braun and Clarke (2006). A full list of themes, codes and their descriptions is provided in Appendix B. Direct quotations were then selected to illustrate the key points being made within each theme, as suggested by Braun and Clarke (2006). Comments from participating tree officers have been anonymised; as such, they are identified as 'TO1' up to 'TO15' rather than ascribed to particular named local authorities.

Quantitative analysis was also performed where appropriate, and is presented in the form of frequencies and percentages. For example, in Tables 1–4, 'No. of refs' refers to the number of times the particular sub-theme (i.e. Nvivo code) appeared throughout the entire dataset, allowing comparison of code frequencies (Guest et al., 2012). In order to give an indication of the proportion of participants who addressed each sub-theme, the number and/or percentage of the 15 tree officers who commented on a particular topic at any point during the interviews is also provided in the tables, as well as elsewhere in the text (Toerien and Wilkinson, 2004). Whilst high frequencies or percentages are not necessarily a measure of significance (Toerien and Wilkinson, 2004), they offer an indication as to which concepts or situations experienced by tree officers are most commonly reported, and may therefore be expected to be shared amongst other tree officers.

Geographic, population and tree-related data (i.e. geographic location, geographic size, population size, population density, adoption of a tree strategy, tree canopy cover, and tree budget per head of population) were also collected for each of the interviewed local authorities. This was to enable identification of city characteristics that may have influenced the tree officers' responses with regards to particular themes. Local authorities were grouped into those strongly representing a theme, and those representing the opposite (some authorities fell outside of these extremes and so were removed from further analysis). Detail on the process of the (non-statistical) analysis is provided in Appendix C.

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