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Research Paper

Ecology of urban green spaces: The way forward in answering major research questions

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HIGHLIGHTS

- I present research questions and discuss future directions of urban ecology with special emphasis on urban green spaces.
- Research questions are many, including climate change and ecosystem services.
- A framework for advancing urban ecological research should include concepts from natural and social sciences.
- Internationally comparative research using the ecosystem services concept could form a core of such an approach.

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ABSTRACT

I use a two-tier approach to structure future research challenges in urban green space ecology. First, questions that are too large for a single country or discipline to address revolve around two issues: (a) how urban green spaces will be affected by socio-demographic and environmental drivers, such as climate change, and (b) how to plan and manage urban green spaces for the benefit of urban dwellers and biodiversity in the face of these changes. Second, questions that have a local origin, but are of international interest deal with, e.g. ecosystem services, urban resilience and human health as well as planning, management and governance of urban green spaces. A research framework for studying these issues should incorporate concepts from natural and social sciences. Ecosystem services approach could form a core of such an framework also integrating the spatial dimension (landscape ecology). Comparative research at the global scale is important to increase our understanding of the variation in urban green spaces and the ecosystem services they provide. To foster collaboration between researchers and stakeholders, international platforms, such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the City Biodiversity Index (Singapore Index), could be used.

1. Introduction

Most people today live in cities but we have far from complete understanding of how they interact with and benefit from urban green spaces. To address these issues urban ecology is gaining importance as a discipline integrating natural and social sciences. At present, however, urban ecology represents frontier science in which hypotheses, models and theories have not been widely tested yet. General frameworks for the study of social–ecological systems (e.g. Collins et al., 2011) could be followed to develop approaches for urban ecological research. A theory or a framework of urban ecology should integrate human–social systems with ecological systems, use the landscape approach and have the ecosystem services concept as a core (Niemelä et al., 2011a).

The frontier science nature of urban ecology is reflected in debates about its current conceptual state and its future directions (e.g. McDonnell, Hahs, & Pickett, 2012; Ramalho & Hobbs, 2012a, 2012b). This debate echoes the relative youth of the discipline and fairly recent interest among ecologists towards built environments. While focussing on wilderness environments, ecologists largely ignored urban areas for the first half of the twentieth century (Grimm et al., 2008). Although urban ecology has made significant progress both in terms of empirical work and conceptual maturation since the WWII (McDonnell, 2011), ecological research in cities is still not at par with the long traditions of research on more pristine environments. For the scientific advancement and practical use of urban ecology it is important to identify the main research challenges, and ways forward as regards the theoretical development of urban ecology.

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There is no scarcity of specific research questions in urban ecology. For instance, Jim (2011) listed 100 research questions related to urban woodlands only, and Wenger et al. (2009) presented 26 key research questions in urban stream ecology. More broadly, two interconnected grand challenges for urban ecological research can be identified: (a) how urban green spaces will be affected by socio-demographic, technological and environmental drivers and changes, and (b) how to plan and manage urban green spaces for the benefit of urban dwellers and biodiversity in the face of these changes (James et al., 2009). It is evident that to tackle these 'grand challenges' and the associated more specific research questions a transdisciplinary research agenda and an improved scientific basis for urban ecology is needed (Niemelä et al., 2011b).

In this paper, I will discuss the future research challenges of urban ecology – with particular emphasis on urban green space – on two scales: (1) questions that are too large for a single country or discipline to address and (2) questions that have a local origin but are of international interest. Thereafter, I outline a set of transdisciplinary research approaches for urban ecology integrating ecology, social sciences and the practitioners with the aim that these approaches contribute to the development of a framework for future urban ecological research.

2. Future research questions for urban ecology

2.1. Research questions that need a global approach

The world is facing unprecedented social-demographic, technological and environmental challenges. These will have substantial consequences for cities and their development, and hence for the ecological functioning of urban areas. Thus, there is a need to find ways in which these challenges and their consequences can be studied in a collaborative and comparative fashion across the world to inform decision-makers for sustainable development of the urban environment (Childers, Pickett, Grove, Ogden, & Whitmer, 2013). In the face of these changes an important set of questions relates to how to plan and manage urban green spaces for the benefit of both urban dwellers and biodiversity. The diversity and quality of urban green spaces and human well-being are tightly linked as urban green provides a number of benefits (ecosystem services) for people. For instance, visiting green spaces improves the physical and physiological health of residents (Tzoulas et al., 2007; Tzoulas & Greening, 2011).

One of the major environmental challenges facing humankind – also in cities – is climate change. Climate affects both biotic and abiotic elements of a city but mitigation and adaptation measures of climate change are also an issue for the governance of cities. For instance, climate change will affect the provisioning of ecosystem services in cities (Niemelä et al., 2010). Thus, climate change research needs to be transdisciplinary including both natural and social sciences, and involving stakeholders (e.g. decision-makers). James et al. (2009) identified the broad question of integrating natural and social sciences in studying the effects of climate change on urban green spaces and the way these changes impact people's well-being (quality of life) in urban areas as a major issue. This question has already prompted cities to assess and define their approaches to mitigation and adaptation measure, including the role of urban ecology and green spaces. For instance, the city of Helsinki's assessment of the potential effects of climate change concluded that the city's green infrastructure (including the greenbelt network, street trees, and other green spaces) has a significant function in climate change adaptation measures (Yrjölä & Viinanen, 2012).

The Helsinki assessment on climate change also concluded that there are several research needs. For instance, it is necessary to prioritize the identified adaptation needs and adaptation measures, to conduct cost-benefit analyses on climate change impacts and adaptation measures, and to map the best adaptation practices and their prerequisites (Yrjölä & Viinanen, 2012). In addition to questions dealing primarily with adaptation, cities need to consider how to plan and manage urban green spaces so that they can contribute to the mitigation of climate change. Green spaces are important in this respect, although the amount of carbon sequestered by urban green is smaller than carbon dioxide emissions produced in cities (Nowak, 1994; H. Setälä pers. comm.). Trees shading buildings also reduce carbon dioxide emissions indirectly by ameliorating temperatures and thereby reducing the need for air conditioning in the summer and for heating in the winter (McPherson, 1994).

Concomitantly with climate change cities are facing demographic and social changes which have consequences for planning and management of green spaces. Several research questions are related to these issues. For instance, James et al. (2009) asked how can the resilience and adaptability of urban areas to future economic, housing and environmental demands be enhanced through design and management of urban green spaces. Furthermore, a relevant question is how changing social values and behaviours guide the provision and maintenance of urban green spaces in the future (James et al., 2009). Another topical research question is what global competitive gains for, e.g. skilled workers, are delivered to cities through the provision of high-quality green spaces and how can these gains be sustained and increased through green space planning and management (James et al., 2009).

Many research issues that have a global dimension are related to the management and governance of urban green spaces in the face of the profound changes ahead. In this respect, the knowledge base for informed decisions is still not solid enough. It would be useful to conduct international, comparative work on how different governance and management systems of urban green space influence the planning for delivery of ecosystem services (James et al., 2009). Furthermore, we know too little about the appropriate indicators for comparative assessment, monitoring and prediction of the state and trends of urban green spaces and their ecosystem services across the world (James et al., 2009). Useful comparative work could be also done by examining which models of governance facilitate participation in decision-making as regards urban green spaces and how the power relationship between local authorities, developers and local communities is changing as communities are encouraged to become more involved in the decision-making process about development and adaptation of green spaces (James et al., 2009).

2.2. Local level research questions with international interest

Urban green spaces generate services that are crucial for the well-being of urban dwellers (Alfsen, Duval, & Elmqvist, 2011). The provision and maintenance of such ecosystem services is to a great extent dependent on appropriate urban planning (Colding, 2011). However, as the provision and enhancement of services by urban ecosystems is still relatively poorly understood (Niemelä et al., 2010), the knowledge base for land-use planning that considers ecosystem services is currently insufficient (Gómez-Baggethus & Barton, 2012).

There are several angles to the research of urban ecosystem services ranging from basic mapping to their valuation and management (McDonald & Marcotullio, 2011). In particular, methodologies and approaches of quantification and valuation of ecosystem services in urban areas require more research attention (Gómez-Baggethus & Barton, 2012). It is also important to find ways of integrating ecosystem services more equitably alongside other urban system functions into governance and funding decisions (James et al., 2009). Furthermore, as provision of urban