



Collaborative landscape-scale ecological research: Emerging trends in urban and regional ecology

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Introduction

Long-term environmental changes in urban ecosystems in the United States such as habitat loss and fragmentation, drastic modifications of local and regional climate, and contamination and depletion of water resources have raised concerns among researchers across many disciplines, such as ecology, geography, anthropology, sociology, planning, and design. Certain disciplines, such as landscape architecture, urban planning, and urban design, can help determine how policies, plans, designs, and management strategies respond to the long-term environmental changes in urban environments. New research initiatives in urban and regional ecology in the United States represent an unprecedented opportunity for a broader dialogue between ecologists, social scientists, planners, and designers about the future of cities worldwide. However, the integration of ecological research into urban policy, planning, design, and management strategies is complex, but it is one of the key issues and research priorities in landscape ecology (Musacchio and Wu, 2002; Wu and Hobbs, 2002). In order to address this challenge, ecologists, social scientists, planners, and designers will need to work collaboratively to develop interdisciplinary approaches for understanding the effects of long-term changes in urban spatial patterns, landscapes, and environmental quality. Landscape architects, urban planners, and urban designers will need to be able to utilize such interdisciplinary information in the development of sustainable human settlements.

In the United States, important examples of interdisciplinary approaches are occurring at emerging centers of urban ecological research and application such as Baltimore (MD), Detroit (MI), Phoenix (AZ), Seattle (WA), and Willamette Valley (OR). These groups are performing large-scale ecological studies of urbanized and urbanizing regions and are funded by recent initiatives of the National Science Foundation (e.g., Long-Term Ecological Research and Biocomplexity), Environmental Protection Agency (e.g., Science To Achieve Results), NASA (e.g., Land Use and Land Cover Change research), United States Geological Survey, and United States Department of Agriculture. The researchers include ecologists, geologists, social scientists, planners, and designers who investigate how ecological research

about changing urban environments can be integrated into policy, planning, design, and management strategies. Despite these significant efforts, we have only begun the process of developing a comprehensive knowledge base for building more sustainable cities and regions.

This special issue highlights some of the important contributions from these studies, together representing one of the current frontiers in ecology: interdisciplinary studies of changes in human-dominated landscapes and their ecological and socioeconomic consequences. The special issue provides insights into the status of research and applications from the leading centers of urban and regional ecological research in the United States. The goal of these studies is to improve knowledge about the environmental performance of future cities and regions through the development of new theories, concepts, and principles about the ideal urban form for human-dominated landscapes. Such studies are a critical part of the emerging sustainability science, which focuses on understanding and improving the dynamic interactions between nature and the human society (Kates *et al.*, 2001; Clark *et al.*, 2003). Unlike traditional ecological studies, this type of research is highly interdisciplinary or transdisciplinary, so the investigators on the teams include a wide range of natural scientists, social scientists, planners, designers, and policymakers.

Contents of the special issue

The opening article by Steiner provides a synthesis of eight concepts for improving the environmental performance of urban form at multiple scales (community, landscape, and region) and the resilience of cities in the face of changing social demographics and environmental conditions. The eight concepts are systems thinking; language, culture, and technology; structure, function, and change; edges, boundaries, and ecotones; interaction, integration, and institution; diversity; adaptation; and holism. These concepts were drawn from a broad range of disciplines including arts, sciences, design, and planning and together provide a conceptual foundation for the rest of the articles in the special issue.

The next six articles represent different approaches to landscape-scale ecological research in urbanized or urbanizing regions of the United States. The article by Grimm and Redman reports on the research developments of the Central Arizona—Phoenix Long-Term Ecological Research project (CAPLTER). Major activities include historic land use and urban fringe growth studies, continuous monitoring of permanent plots, and landscape models. These activities are contributing to a broader understanding of interdisciplinarity in long-term ecological research. In addition, we refer the readers to a related article by Pickett, Cadenasso, and Grove (in press) of the Baltimore Ecosystem Study as another example of this type of study.

The next two articles are concerned with landscape change, urban patterns, and ecosystem function at the scale of the metropolitan region. Berling-Wolff and Wu explore the patterns and processes of urbanization with the Phoenix Urban Growth Model (PHX-UGM). They

describe the model calibration and evaluation methods as well as examine a series of scenario-based simulation analyses for future development patterns in Phoenix. The paper provides insight into the past and future urban dynamics in this region, and also innovative ways of testing land use models at multiple scales. In contrast, Alberti and Martzluff present a conceptual model for resilience that links urban patterns to human and ecosystem functions. In addition, they reflect on the implications of their conceptual model for planning and design. The study is an example of how scientists and planners are trying to bridge the gap between science, design, and planning.

The next three articles in the special issue focus on impacts of landscape change, ex-urban patterns, and ecosystem function in the urban fringe. Nassauer, Allan, Johengan, Kosek, and Infante examine how alternative residential designs affect aquatic ecosystems and public perception in agricultural watersheds in the Detroit metropolitan region. The study is concerned with evaluating ecologically beneficial subdivision design versus conventionally designed subdivisions. The study directly contributes to knowledge about how human settlements can be designed so that they are more ecologically beneficial and publicly acceptable. In a similar vein, Quay presents his work with the North Sonoran Collaborative, which is a partnership of professionals and scientists at the City of Phoenix, Arizona State University, Maricopa County, and other organizations. The project site is an undeveloped area in northern Phoenix, which is a classic example of the Upper Sonoran desert ecosystem. The project is an example of how science and planning were linked to develop alternative public policy response for conservation of the site. In the last article, Hulse and Gregory attempt to link regional landscape modeling to aquatic ecology by proposing alternative restoration scenarios for the historical floodplain of the Willamette River, Oregon. Three scenarios are proposed for the year 2050, and each scenario is evaluated for water availability, stream condition, and terrestrial wildlife. The article recommends spatially explicit restoration strategies for the Willamette River and demonstrates how landscape models can be used in restoration of degraded riparian landscape.

The articles in this special issue are examples of how urban and regional ecology can play a crucial role in developing new theories and methodologies about how humans and their actions change urban landscapes. The researchers are especially interested in why certain urban and regional patterns are more resilient and persistent than others. Some of the studies focus on humans as 'disturbance factors' or 'socio-economic drivers' in urban ecosystems while other studies are interested in the relationships between landscapes and humans. This latter characteristic emphasizes applying ecological knowledge to the public realm, especially in land-use planning, policy, and management. In addition, the contents of the special issue represent important trends at the international level. The contents are reflective of the quantitative tradition in American ecology and the holistic problem-solving ecological approaches in European ecology. Both types of research are needed, and the emergence of both types represents a significant advancement in urban and landscape ecology in the United States in recent years (Naveh, 2000; Palang *et al.*, 2000; Wu and Hobbs, 2002).

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