Landscape ecology: an integrated science for sustainability in a changing world

Diane M. Pearson · Clive A. McAlpine

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Origins of the special issue

Human pressures on the world's landscapes are accelerating at unprecedented rates. Global climate change is compounding these pressures, making the need for sustainable landscape management and planning even more urgent. Landscape ecology is uniquely placed to address this challenge—its charter is to provide the science underpinning sustainable landscape management (Wu 2006; Musacchio 2009). The aim of this special issue is to advance landscape ecology as a science able to rise to the challenges of environmental sustainability we face this century. The special issue originated from a symposium titled 'Landscape ecology: An integrated science for sustainability in a changing world' at the 10th International Congress of Ecology (INTECOL) August 16th–21st 2009 in Brisbane, Australia. The theme of the Congress was "Ecology in a Changing Climate, Two Hemispheres, One Globe". Ecologists

from both hemispheres explored how global change has impacted, and will further impact, ecosystems and their vital services to human communities. The Congress explored unique features of ecosystems in the southern and northern hemispheres, with discussions on: long term monitoring, incorporating ecological knowledge into policy, integrating indigenous knowledge into conventional science, and on communicating ecological information to a broader community. These issues arising out of the Congress are highly relevant to landscape ecology and represent a timely opportunity for this special issue of Landscape Ecology.

Core themes

The papers in this special issue originate from four continents, and consist of a mixture of conceptual, theoretical and applied approaches to addressing landscape sustainability issues. Core themes are:

How can landscape ecology contribute towards sustainability?

How can landscape ecology contribute towards sustainability is the cross-cutting theme of the special issue. Landscape ecology as a multidisciplinary and transdisciplinary science offers a way of working towards finding solutions to landscape sustainability problems (Wu 2006; Termorshuizen et al. 2007).

D. M. Pearson (✉)
School of Environmental and Life Sciences,
Faculty of Education, Health and Science,
Charles Darwin University, Darwin 0909, Australia
e-mail: diane.pearson@cdu.edu.au

C. A. McAlpine
Centre for Spatial Environmental Research,
School of Geography, Planning and Environmental
Management, The University of Queensland,
St Lucia, Brisbane 4068, Australia
e-mail: c.mcalpine@uq.edu.au

Despite widespread recognition of the importance of this issue, Naveh (2007) claims the impact of landscape ecology on sustainable landscape management and planning is still limited. McAlpine et al. (2010) propose that by adopting a formal problem-solving approach, landscape ecologists can make a valuable contribution towards achieving sustainable landscapes. The approach involves making explicit the management objectives and management actions, and the system understanding required to inform sustainable landscape planning decisions. Pearson and Gorman (2010) expand on this theme by recommending a new landscape paradigm which recognizes that landscape sustainability and livelihoods are inextricably linked, especially in underdeveloped but rapidly changing regions such as northern Australia. They outline a forward looking landscape ecological paradigm, which focuses on understanding and designing the space in which biophysical, socio-cultural and economic processes operate in order to ensure ecosystem goods and services valued by people are maintained. Building on the recognition of the need for greater interconnections between landscape ecology, socio-economics and policy, Spies et al. (2010) conclude that current ecosystem-based approaches to forest management in the Pacific North West region of the United States provide a good foundation for conserving biodiversity under climate change. However, this requires developing collaborative partnerships to promote adaptive management to deal with uncertainty and complexities.

People, culture and communities also matter. Landscape ecology cannot realize its full contribution to landscape sustainability without becoming more involved with the communities and landscape managers who live in and interact with landscapes. The special issue highlights the need for better knowledge exchange and participatory planning as a way of working towards the goal of sustainable landscapes. Bohnet (2010) presents a social–ecological planning framework for planning sustainable land and seascapes which recognizes the importance of people–landscape interactions and the need for greater knowledge integration from a variety of stakeholders. Her social–ecological framework provides opportunities for the community to engage in participatory planning and work towards a consensus of issues and joint development of strategies. Sherren et al. (2010) also recognise the importance of integration of

scientific and community knowledge within a trans-disciplinary approach to identifying sustainable pathways for rural landscapes. Their case study in rural New South Wales, Australia, investigates management options for building reciprocity between farming systems and ecosystems which is crucial in the context of global agricultural intensification. Both Sherren et al. (2010) and Bohnet (2010) highlight the challenges and tensions associated with building effective multiple stakeholder relationships. O’Farrell et al. (2010) continue along this theme by suggesting that it is important to consider the role of people in building sustainable landscapes by creating future economies and livelihoods that support sustainable use of ecosystem services. As a way of dealing with the challenges associated with knowledge integration, O’Farrell et al. (2010) suggest that it is essential to have a forum where scientists and stakeholders can interact to exchange knowledge.

Understanding complexity and detecting change

Landscapes function as complex adaptive systems in a constant state of change. Recognising and quantifying the multiple drivers of change and their interactions, including existing land-use pressures, plus emerging drivers of change (e.g., heat and moisture stress, altered fire regimes, new land use pressures) is an important challenge for landscape ecologists. If we are to adapt, modify behavior and rethink our landscape management practices to ensure sustainability in the future, it is important to question: Are there early signals of climate change impacting on landscapes? How can we detect these changes and attribute causal processes?

Bowman et al. (2010) focus on these questions, discussing how a landscape ecological approach can be used to separate the impacts of climate change on the tropical monsoon rainforests in Australia. Their study highlights the need for a rigorous landscape ecological methodology, including spatial and temporal analysis, for providing an historical context for understanding current and future change. Jones et al. (2010) continue with this theme by examining riparian ecosystems in the United States. They quantify the spatial and temporal pattern of change in riparian ecosystems in association with drivers of change and discuss the implications for critical ecosystem services that riparian zones provide.

Managing and redesigning landscapes for an uncertain future

Landscapes provide multiple functions and ecosystem services which often require quite different landscape configurations. Identifying integrated landscape designs which can maintain these multiple functions and services is a major challenge for landscape ecology (Lovell and Johnston 2009). How do we redesign and restore landscapes for maintaining multiple functions and ecosystem services in a changing climate where the future is uncertain? Maintaining and restoring multiple landscape functions and ecosystem services are critical to sustainable landscapes and are mentioned in several of the papers in this special edition (O'Farrell et al. 2010; Ryan et al. 2010; Verboom et al. 2010).

Ryan et al. (2010) discuss the need to adapt semi-arid agricultural landscapes to offset the risks associated with changes to water availability, climate and biodiversity under future global environmental change. They propose an integrated landscape design that maintains belts of native vegetation in the landscape, thereby preserving important landscape functions and ecosystem services whilst maintaining agricultural production. Verboom et al. (2010) also discuss the need to adapt landscape designs to buffer against climate change. They illustrate how landscape ecology can provide a framework for ensuring greater heterogeneity and connectivity to maintain viable fauna populations under climate change. They argue that adopting a landscape ecological approach to landscape redesign can be useful for collaborative planning needed for sustainable landscape management and can also provide opportunities for developing multifunctional landscapes.

Closing remarks

In summary, the papers in this special edition of Landscape Ecology present an insight into the role that landscape ecology can play in providing the scientific understanding of what is happening to the world's landscapes in response to global environmental change, mitigating some of its effects and working towards the goal of landscape sustainability. If landscape ecology is to be more effective in terms of contributing towards sustainability, there needs to

be stronger emphasis put on bridging the gap between science and practice. This special edition presents some possible frameworks and tested approaches for achieving this. We hope that this edition will stimulate greater discussion amongst landscape ecologists on these important themes and encourage more research for advancing landscape ecology as a science able to rise to the challenges of global change we face this century.

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