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Preface

1. Managing landscapes at multiple scales for sustainability of ecosystem functions

The science of landscape ecology is a rapidly evolving academic field with an emphasis on studying large-scale spatial heterogeneity created by natural influences and human activities. These advances have important implications for managing and conserving natural resources. At a September 2008 IUFRO conference in Chengdu, Sichuan, P.R. China, we highlighted both the challenges and solutions to managing forested landscapes for a variety of values and benefits. In this special issue of Forest Ecology and Management, we present selected papers from the conference to examine a central issue in landscape-scale management: the need to consider sustainability in the context of multiple spatial and temporal scales.

1.1. Remote sensing and scaling issues in forest landscapes

During the past few decades, technological advances in remote sensing coupled with theoretical advances in landscape ecological modelling have contributed to a better understanding of forested landscapes and dynamics at multiple scales. However, for practical and scientific applications in forest management, conservation and sustainable utilisation, there is still the requirement to effectively integrate, communicate and transfer this knowledge. Presentations at the conference summarized some recent research on the retrieval and scaling of forest attributes (e.g., species type, structure, volume, biomass and change) from both airborne and spaceborne remote sensing data and discuss how the knowledge gained can be used, either singularly or in combination with ecological models, for practical application. Remote sensing can provide insights into forest structure, function and dynamics and ecosystem response to both natural and anthropogenic change, and how these new sources of information can be best integrated to enhance our understanding of biodiversity distributions and species interactions at different spatial and temporal scales.

1.2. Carbon science and landscape ecology: estimation of ecosystem carbon dynamics across multiple spatial and temporal scales

The combustion of fossil fuels and deforestation have increased atmospheric carbon dioxide (CO_2) concentration and radiative forcing of climate change. There is widespread interest in improving knowledge of the global carbon cycle in the context of climate change, and in developing strategies for reducing atmospheric CO_2. Carbon cycle processes operate at spatial scales from cellular to global, and over time scales from seconds to millennia. However, there is a confluence between the carbon cycle and landscape ecology involving ecological processes and patterns at intermediate scales where land management, natural disturbance, and policy formulation intersect. Because of the system complexity and multiple spatial and temporal scales, we know little about key processes at landscape scales that control carbon fluxes and storage: how ecosystem carbon dynamics might respond to climate and disturbances, and how the changes in terrestrial ecosystem carbon dynamics might feed back on atmospheric CO_2 and climate. It remains a great challenge for the research community to provide critical understanding of major uncertainties in causes and magnitudes of ecosystem CO_2 fluxes and to improve the accuracy of landscape and regional scale carbon estimates. Various approaches have been developed, such as monitoring observations of eddy flux networks, remote sensing and land inventories, manipulative experiments, ecosystem models, and model-data integration. However, there is a lack of consensus about how different natural and human-caused factors contribute to the evolving global carbon budget, and the relative importance of factors in different geographic regions. The papers of this section report progress and methodologies in estimating terrestrial carbon fluxes and storage, at multiple scales, for different ecosystems. The papers demonstrate a broad interdisciplinary perspective and reflect the state-of-the-art in estimation of terrestrial sources and sinks of carbon in the context of climate change and landscape-scale management and disturbance.

1.3. Cumulative effects of forest management and climate change on hydrologic and sediment balances at the watershed landscape scale

Clean water is often a key goal for forestation-based landscape restoration. The general forest–water relationships are well documented in forest ecology and hydrology literature at the small watershed scale. However, few empirical data are available at a large watershed scale showing the same effects as documented at smaller scales. Little is known about the cumulative effects of forestation practices used in landscape restoration (e.g. reforestation or afforestation) on streamflow at larger spatial and temporal (large watershed and long-term) scales. Model and field experimental studies show that climate warming affects forest evapotranspiration at small scale, but little hard evidence is available that shows it alters the hydrologic cycle at a large scale. Papers in this section present 5 case studies in distinct geographic regions from the semiarid loess plateau in northwestern China to the humid lower coastal plains in southeastern U.S. These papers demonstrate how forest

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management affects water balances across a climatic regime, and how ecohydrological principles must be followed in order to achieve the goals of large-scale reforestation of degraded lands.

1.4. Managing landscapes for natural resource sustainability

The mandate to manage natural resources sustainably has become ubiquitous in the developed world and is increasingly recognized as important in developing countries. Stable human societies and an adequate standard of living cannot be realized unless adequate supplies of natural resources can be ensured, including ecosystem services. Landscape ecologists have long argued that a landscape perspective can improve the effectiveness of natural resource management. Papers in this section provide evidence and illustrations to support this view. A broad spectrum of the world's ecosystems and societies are featured to provide a comprehensive, diverse and synthetic view of the application of landscape ecology principles to the management problems facing human societies around the world.

This section will inform managers of the need for a landscape-scale perspective about managing natural resources, and some of the emerging approaches for applying the latest scientific knowledge to complex problems of resource sustainability in a rapidly changing world. Sustainable management of forests in the face of multiple global changes is a growing global concern that is most effectively practiced at the landscape scale. The papers in this special issue will be of great interest to managers who must increasingly address resource issues at larger spatial and temporal scales than ever before.

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