

Educating a new generation of landscape ecologists

M. G. Turner and R. H. Gardner: *Landscape ecology in theory and practice: pattern and process*. Springer, New York, USA, 2015, 482 pp

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Some few decades ago, landscape ecology was considered a juvenile and immature discipline, navigating multiple (and sometimes, contradictory) definitions, criticized for not having a strong and general theoretical framework, and thus of being ineffective to predict the future of landscapes and their species. Nowadays, the situation has changed, as we can see with the second edition of the book “Landscape Ecology in Theory and Practice”, written by Monica Turner and Robert Gardner.

Despite all theoretical uncertainties and difficulties with definitions, the field of landscape ecology grew quickly since the 1980s, when the first textbooks on landscape ecology were published (Naveh and Lieberman 1984; Forman and Godron 1986), and some seminal papers appeared and pioneer meetings occurred (Risser et al. 1984). Since then, the number of manuscripts published annually with the term “landscape AND ecology” jumped from about 30–80 in 1980 to 1500–1600 in the last years, as observed in the Scopus database. Considering only the last 15 years, since the first version of Monica Turner and colleagues book (Turner et al. 2001), more than 15,000 manuscripts related with landscape ecology

were published. The growth of landscape ecology was not only in quantity, but also in diversity, with the flowering of new fields of knowledge such as landscape epidemiology, landscape genetics, and landscape sustainability, among others. Landscape ecology principles became fundamental to sustain policy decisions in different fields, specially related with species conservation, landscape planning, and management. All this fast growth, diversification and wide application make the task of writing a landscape ecology textbook a huge challenge that few dared (and succeeded) to undertake. Monica Turner and Robert Gardner achieved this task with mastery. It is thus with great pleasure that we receive this expanded and updated second edition of the book “Landscape Ecology in Theory and Practice”.

The book keeps the quality of the writing, with well-organized syntheses, written in didactic, clear language and captivating style, making reading easy and pleasant. Turner and Gardner also maintain most of the original structure of the book. A first group of chapters presents the core concepts (theoretical foundations, scale issues, main drivers of structural patterns), followed by methodological chapters (introduction to models, landscape metrics and spatial statistics), to then develop in detail pattern-processes relationships at different organization levels (from organism to ecosystem processes), including temporal dynamics, and finally to finish with a more applied

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chapter, introducing topics such as climate change, ecosystem services and landscape sustainability.

This second edition incorporates recent advances in landscape ecology, with updated knowledge for topics that have been extensively studied in recent years. For example, the importance of landscape history and legacies to understand the structure and functioning of contemporary landscapes is now discussed in the landscape pattern chapter. The emergence and recent advances in landscape epidemiology, landscape ecology of species invasion, and landscape genetics were also incorporated in the text, explaining how diseases, invasive species or gene flows can be affected by (and, in some cases, can affect) landscape composition and configuration. One of the most extensive modifications is the inclusion of a complete new chapter devoted to spatial statistics, reflecting the recent tendency of representing and measuring landscape patterns not as categorical entities, but as a continuous space. This chapter also highlights the importance of considering the spatial dependency in landscape data, a task that has not always been done correctly, particularly with categorical spatial data. The chapter dedicated to ecosystem processes was also considerably modified, and now presents a more general conceptual framework to relate ecosystem processes with landscape pattern. Finally, the topics considered in the application of landscape ecology principles were also expanded, including now issues related with landscape scenarios, ecosystem services, and landscape sustainability. Turner and Gardner highlight brilliantly the importance of understanding the mechanisms by which landscape connectivity and heterogeneity can help to support the provision of ecosystem services, their spatial synergies and trade-offs, as well the importance of using this knowledge to design and shape landscapes that can guarantee human well-being at the long term. This is clearly one of the most pressing challenges of landscape sustainability.

This new edition presents also some interesting inputs for those who are beginning their education in landscape ecology, particularly syntheses in each chapter that summarize the main messages, tables with usual landscape ecological terms' definition and explanation (to avoid or reduce terminology confusion) and, in the "methodological" chapters, with the presentation of important caveats and tips for using models, landscape metrics, and spatial statistics. Given the current ease of calculating landscape

metrics and developing spatial models, it is necessary to make clear that metrics and models are instruments to answer ecological questions and not ends in themselves. In this sense, the book's tips are very welcomed to educate a new generation of landscape ecologists, which should make good use of all available spatial technology (without becoming mere technicians). As said by Turner and Gardner, the next generation of landscape ecologists should know to ask and answer good questions.

The book is thus a nice synthesis of the landscape knowledge accumulated in the last decades, providing clear explanations and illustrations of core concepts and theory. But the education of future landscape ecologists will depend also on other types of knowledge. These ecologists must be trained on how research is developed, including formulation of questions or hypotheses, design of experiments or sampling protocols, data analysis and results communication, and work in teams with an interdisciplinary approach (an ability particularly highlighted by Turner and Gardner). This "procedural knowledge" is better developed with an inquiry-based approach, where learning of both declarative (theory and concepts) and procedural knowledge occurs during the process of investigation (Almeida-Gomes et al. 2016). This inquiry-based approach can be stimulated through computer labs (such the ones presented in Gergel and Turner 2002), but is more effective with field-oriented labs. In addition to the "discussion questions" and "further reading" presented at the end of each chapter, future versions of the book would benefit from some suggestions of field-practices that could be done in short field excursions or even within or around University campuses.

One main personal reservation that can be shared with those who teach landscape ecology in the Southern Hemisphere and tropical regions, is that the book seems mostly be written for students from the Northern Hemisphere, especially for North Americans, Canadians, and Europeans. Turner and Gardner extensively use examples or case studies from those countries (particularly from USA), emphasizing disturbance processes from temperate and not from tropical regions. Although the authors highlight that examples are illustrative, not comprehensive, and that ca. 36% of the publications in the field are from North American authors, in the last 15 years landscape ecology has spread around the world, including

regions with socioeconomic and environmental conditions completely distinct from those observed in North America or Europe. Understanding pattern-processes relationships, scaling, flows, or boundary effects in different regional contexts can help to consolidate more general concepts and theories in landscape ecology. It would have been great to see in this book a wider range of examples or processes that could help to better understand how distinct regional contexts (e.g. tropical versus temperate, high versus low biodiversity, high versus low land cover loss) affect landscape ecological processes. Furthermore, given the quality of this book, I would suggest that it should be translated to other languages (e.g. Spanish, Chinese, Portuguese), possibly including some adaptations to make this translation more appealing for this wider audience, as previously done with the textbook “Essentials of Conservation Biology” from Richard Primack.

“Landscape Ecology in Theory and Practice” is probably the most comprehensive and updated textbook in landscape ecology available today. It will provide a wonderful introduction to the core landscape principles and concepts for graduate and undergraduate students, but also for more experienced researchers and practitioners that need a review of the most relevant and recent knowledge in the field. This book

will be useful not only to ecologists, but also for students from other fields, such as architecture, urban planning, geography, and landscape management. The contribution of this book goes beyond the education of a new generation of landscape ecologists—it provides a solid synthesis and important tips on future research directions that can leverage the research and application of a landscape perspective in multiple disciplines and applied fields.

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