Introduction

Landscape research — exploring ecosystem processes and their relationships at different scales in space and time

Land management and its impact on environmental quality requires adequate analytical tools and an adapted experimental design and significant progress has been made by measuring and analyzing on-site processes. Issues associated with landscape research can reach far beyond those of empirically driven studies that are limited to specific experimental conditions and assume an average effect of (or response to) a specific treatment across the landscape. Moreover, inherent variability by which biotic and abiotic processes occur along a continuum across the landscape should also be taken into consideration.

Over the past decades, ample soil related field research has been conducted to study the impact of land use on landscape resources and their quality. To derive knowledge for sustainable land management, crop yield, soil structural status, water infiltration, soil erosion, solute leaching, and other landscape attributes were studied under different nutrient management intensities, crop rotations, among other variables. In such investigations a broad range of intensities was imposed in order to identify a “response” to the treatments that were expected to cause an effect that differed significantly from the mean. Or if, for example, the impact of soil type on nitrate leaching or crop yield was studied, point measurements were taken at various sites where soil type conditions differed considerably. Empirical relations derived from such investigations a broad range of intensities was imposed in order to identify a “response” to the treatments that were expected to cause an effect that differed significantly from the mean. Or if, for example, the impact of soil type on nitrate leaching or crop yield was studied, point measurements were taken at various sites where soil type conditions differed considerably. Empirical relations derived from such investigations provided, in such cases, the basis for some general expectations. Largely based on comparisons, physiological interpretations were made, all with different levels of success. These empirical relations that were obtained from either a wide range of different soils or from a large range of artificially induced variation, frequently became obsolete or unreliable because they could not be validated within landscapes or their sub-domains.

As we conduct applied landscape research, our knowledge obtained in soil science and related disciplines in agro-ecology is immediately probed with a gamut of questions:

1. Can the knowledge be validated by predicting a system’s status at any point within the landscape?
2. Is our knowledge sufficient to understand ecosystem processes across different spatial and temporal domains within the landscape? If not, do we know what key processes would need to be sampled or studied to achieve such an understanding?
3. Do we have adequate measures for the state variables in an ecosystem that can be sampled across space and time which can help us to understand the inherent variability without inducing any variation caused by a range of imposed treatments?
4. What is necessary to identify the underlying processes that occur in a sub-domain of the landscape? In general, researchers from different disciplines do not study identical factors to explain the cause of the same variability pattern of a state variable.
5. Is our collective understanding from several disciplines adequate to quantify the meaning of different factors and to integrate those factors across the landscape?
6. How do we sample in the vicinity of a boundary between two domains so as to gain an understanding of the transition and development of different processes that occur from one domain to another?
7. How can quantitative analyses of landscape processes be transformed between different space–time-scale combinations?

8. And finally, how do we compensate for our insufficient deterministic knowledge of landscape processes?

These sort of questions motivated this special issue on landscape research. With the research approach and aspects of landscape research to be so diverse, what do the different disciplinary approaches have in common? Without searching for the effects of different empirical treatments, the commonality is to understand the cause of a system change in space and time. This commonality already exists in other disciplines (for example, hydrology, geology, atmospheric science, and economics) where intrusion of various treatments is irrelevant. If we can adapt approaches from these disciplines, and gain the skill to integrate the different aspects and appropriate factors within the landscape, we will be able to contribute to a more profound understanding of landscape processes which will coincide with a better recognition of the quality and the management of the agro-ecosystem.

The contributions to this special issue reflect the diversity of aspects and the multiplicity of approaches comprised in landscape research. We thank each of the authors who collectively provided a compendium of information and opportunities that should stimulate and challenge others to pursue additional ecosystem research for improving the management of landscapes regardless of their size, location and eventual use.

Chris van Kessel*
Department of Agronomy and Range Science
University of California, 1 Shield Avenue
Davis, CA 95616, USA

Ole Wendroth
ZALF Müncheberg, Müncheberg, Germany

*Corresponding editor
E-mail address: cvankessel@ucdavis.edu
(C. van Kessel)