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Complex Rangeland Systems: Integrated Social-Ecological Approaches to Silvopastoralism

Tobias Plieninger [a,b], Lynn Huntsinger [c,*]

[a] Faculty of Organic Agricultural Sciences, University of Kassel, Germany
[b] Department of Agricultural Economics and Rural Development, University of Göttingen, Germany
[c] Environmental Science, Policy, and Management, University of California, Berkeley, USA

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ABSTRACT

Crossing disciplinary boundaries, particularly between social and ecological sciences, challenges those seeking to contribute to solving complex and multidimensional environmental problems on rangelands. In this Special Issue we present a set of 13 papers that to varying degrees attempt to integrate, or bring together, diverse approaches across disciplines to understand silvopastoral systems. The papers are about rangelands in numerous countries and regions, including Spain, Estonia, Greece, Germany, Hungary, Italy, Portugal, Romania, the United States, Latin America, and Sweden. Silvopastoral systems provide ecosystem goods and services important to communities, cultures, and society. Management deliberately exploits the diversity fostered by rangeland systems that mix woody species with a well-developed herbaceous understory, offering a greater diversity of products, species, vegetation structural characteristics, and habitat components than either grassland or forest. Biodiversity often peaks at the intermediate levels of tree and shrub cover characteristic of silvopastoral systems. We introduce the papers grouped by four overarching topics: 1) typologies and scales, 2) social-ecological interactions, 3) integrated management, and 4) multiple knowledge systems. Unfortunately, silvopastoral systems often run afoul of ongoing intensification and simplification trends in agricultural production that reduce their economic and ecological resilience. Privately owned systems, the most common in this issue, are subject to the need for owner income. Finding ways to support the benefits of these systems for the public is difficult, as management traditions must be conserved as well as the land. We hope this issue illustrates the value of multifunctional systems and offers insights into how they work.

Introduction

Crossing disciplinary boundaries challenges those who would like to solve complex and multidimensional environmental problems on rangelands. This Special Issue attempts to integrate, or bring together, diverse approaches across disciplines and countries to understand silvopastoral systems. In particular, it aims to explore the added value of integrated social-ecological perspectives for the analysis and management of silvopastoral systems. Insisting on dialogue between social and ecological sciences, the contributions in this Special Issue largely draw on the concept of social-ecological systems. The studied settings are predominantly outside of the United States and include numerous countries and regions, including Spain, Estonia, Greece, Germany, Hungary, Italy, Portugal, Romania, Latin America, and Sweden, offering an opportunity to draw insights from diverse international experiences, and to potentially apply what has been learned in the research and management of rangelands abroad to those in the United States. Most of the papers focus on silvopastoral systems, in which trees and grass, human needs and ecological outcomes, and traditional and current-day agriculture interact, creating many tradeoffs that must be navigated by the manager. Almost all the articles are about privately held land, woodlands created or manipulated to provide income and amenities for their owners. Ideally, however, these working landscapes offer more than "food and fiber," they are rangelands that produce ecosystem services of considerable value to society. One of the reasons silvopastoral systems were chosen for this exploration of integrated social-ecological systems is because the outcomes of the relationships between people and the ecosystem are often blatantly obvious, writ large in the pattern, species composition, and ages of the trees. Here we introduce the concept of a silvopastoral system, confess to difficulties with translation and use of terms, discuss common themes that emerge in the issue, and introduce each contribution.

Silvopastoral Systems

Silvopastoral systems are a form of agroforestry that include grazing by livestock as an important component of the agroecosystem.

* Correspondence: Dr. Lynn Huntsinger, University of California, Environmental Science, Policy, and Management, Berkeley, CA, USA.
E-mail address: huntsinger@berkeley.edu (L. Huntsinger).

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Figure 1. Portuguese montado (Photograph courtesy of Lynn Huntsinger).

Agroforestry deliberately integrates woody vegetation (trees or shrubs) with crop and/or animal production and benefits from the resulting ecological and economic interactions (Mosquera-Losada et al., 2009). Wood and livestock are the two main commodity products. Silvopastoral systems manage trees to maintain a developed understory providing livestock forage (Cubbage et al., 2012). A classic example, which features prominently in this Special Issue, is the dehesa and montado of the southwestern Iberian Peninsula (Bugalho et al., 2011; Campos et al., 2013) (Fig. 1). In this Mediterranean climate zone woodlands are managed with a well-spaced oak overstory producing multiple products and abundant mast, and an annual grassland understory is grazed by several kinds of livestock. But silvopastoral woodlands occur in multiple geographies around the world and can include everything from northern conifer woodlands to southern tropical savanna when managed for livestock production.

We hope our readers recognize the difficulties of translating across so many boundaries, and accept a necessarily diverse and possibly imprecise use of terms. In Europe, silvopastoral systems are now most commonly referred to as wood pastures (Bergmeier et al., 2010; Plieninger et al., 2015), perhaps because of their two main products, wood for fuel and wood products, and pasture for livestock. For practitioners in the United States, pasture suggests an improved site, often irrigated, with intensively managed livestock, at times referred to as "tame pasture." Further confounding the definition, wood pastures are commonly part of what is called "farming" in Europe. Wood pastures are in fact not irrigated, grazing is extensive, and a major source of income is livestock products. As a result, in the United States they would be called ranches that use woodland or savanna rangelands. "Rangelands," as defined in the United States, are not necessarily used for grazing but most simply are grasslands, woodlands, and savannas (Booker et al., 2013). Historically, the wooded rangelands of Europe have been more intensively managed than those in the United States. It is our contention that what is termed in Europe wood pasture could in the North American context be translated as grazed wooded (or hardwood) rangelands, grazed semi-open woodland rangelands, or woodland and savanna rangeland used for grazing. In each, herbaceous vegetation growing seminaturally is the fundamental resource of livestock production. Both in the Old World and the New supplemental feeding, mechanical interventions, and periodic use of tame and even irrigated pastures or stall feeding are common practices but are used to facilitate rather than replace extensive grazing on natural or naturalized vegetation.

And of the trees? They seldom produce high value timber, as this tends to be managed with forestry as the main economic activity. Instead, they may produce firewood, charcoal, fruit, fodder, game, or mushrooms for the market. In Iberia, they may produce cork, a high-profit use, but harvested in cycles of many years (Croitoru, 2007). In the United States, the trees in pinyon-juniper woodlands produce valuable pinyon nuts and juniper berries used used for gin. For all, the canopy layer influences the quality and quantity of herbaceous understory, and the dynamics of the understory influence water dynamics for the trees and the potential for tree regeneration and recruitment. Layered onto these natural processes are the impacts of people, livestock, and wildlife. In California's oak woodland rangelands, ranchers believe that forage production and quality are enhanced by the right tree canopy for the location, generally around 50% cover, and they do not tend to thin oaks when cover is sparser (Huntsinger et al., 2010). In most of these systems, people are active managers and even creators of the ecosystem (Huntsinger and Oviedo, 2014). Even California's hardwood rangelands, often believed to be "natural," are increasingly understood to have been shaped by the management of indigenous Californians, settlers, and ranchers (Alagona et al., 2013). Silvopastoral systems can offer an opportunity to study the impacts of long-term management, because the results are reflected in the ages and distribution of the trees. This issue includes a variety of such systems, from the dehesa and montado of Spain and Portugal, to the hardwood rangelands of California, and to the ancient oak pastures of Romania (Fig. 2).

Management

The geographical location of a silvopastoral system, together with management traditions and capacities, shape the configuration and the market and nonmarket goods that can be produced, including wildlife habitat, wood and livestock products, carbon sequestration, game, viewshed, and watershed. This form of "diversified farming" (Sayre et al., 2012) can make an agricultural operation more economically resilient, with some product flows prospering when others decline due to climatic or market factors. Due to their complex structure and traditional low intensity management, wood pastures are often recognized as a high nature value (HNV) farming systems in Europe (Plieninger and Bieling, 2013). This acknowledges that diverse traditional silvopastoral management practices create and maintain a landscape that provides a broad spectrum of ecosystem services important to owners, cultures, and society (Torralba et al., 2016; Torralba et al., 2018).

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