Governance, Values, and Conservation Processes in Multifunctional Landscapes

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Landscape-scale conservation provides a suitable spatial extent for identifying impactful ecological and social processes while providing the necessary granularity to understand local context [1]. Conceptual landscape models evolved from a narrow focus on the viability of isolated patches or protected areas, through understanding ecological and social processes as a function of patches, corridors, and matrices [2], and more recently, as heterogeneous mixed-use mosaics [3]. These processes are also being considered as hierarchical across spatial scales so as to identify suitable intervention points. Given the demonstrated benefits associated with landscape mosaics across scales, research and practice need to consider the diverse values associated with landscape patterns and processes to effectively leverage the opportunities presented by these multifunctional spaces.

There are inherent challenges associated with addressing social and ecological system (SES) objectives across landscape mosaics and at different scales. For example, early biodiversity and natural resource conservation efforts focused primarily on actions and impacts within defined protected areas [4]. The narrow spatial extent of protected areas and their fixed status in the face of global change [5,6] limited the impact they have on threatened species [7]. This resulted in a shift in conservation focus to broader landscapes and regions. Outside of protected areas, however, variation in culture, knowledge, and jurisdictional boundaries [8,9] can result in a patchwork of interventions that fail to address the larger conservation needs [10].

While conservation successes have occurred in SES on small scales, their broader impact is limited given the shortage of policy tools for effective landscape conservation across scales to decrease persistent declines in species abundance, diversity, and reproductive success [11]. Networks of protected areas, providing valuable connectivity between patches and across landscapes, require extensive government input and regulation and may be impeded by private land ownership [12]. Local successes may not scale up to regional or global patterns or persist as sustainable change. For example, while some agricultural environmental schemes in Europe benefit local populations [13], these efforts have not scaled up to reduce the decline of biodiversity [14]. Market-based incentives, such as Payments for Ecosystem Services (PES), typically do not outcompete alternative land uses and frequently fail to provide additional conservation benefits beyond offering compensation for existing environmental practices [15].

We believe that multifunctional landscapes provide a needed framework to link landscape mosaics and diverse values as SESs (Figure 1). Consideration of landscapes as multifunctional acknowledges complexity and diversity in land uses including: private recreation, residential development, energy development, and production of food, fiber, and fuel. Recent research on multifunctional landscapes has shown they support SESs via the conservation of biodiversity and supply of ecosystem services [16]. For example, Walston et al. [6] showed that spatial planning for both native vegetation and solar energy facilities enhanced multiple supporting and regulating ecosystem services including pollination and sediment retention. Likewise, in lake ecosystems, management resulted in...
improved water quality and greater demand for recreation [17]. Forestry, ranching, and agriculture all have been shown to provide provisioning services as well as protecting biodiversity [18–20]. In these latter examples, spatial heterogeneity and consideration of scale were fundamental to measuring the benefits of multifunctional landscapes.

Figure 1. Conceptional landscape models of increasing multifunctionality (Left to Right) with associated aerial imagery from Brazil, Costa Rica, and Germany. Images 1 and 3 from NASA Earth Observatory, Image 2 from Google Earth.

Landscape-scale conservation in multifunctional landscapes may also be best supported by reinforcing plural value structures [21], as opposed to promoting value optimization across alternative land uses [22]. Substantial literature has documented the detrimental impact of economic efficiency on the environment. Value optimization on a small scale commonly leads to overexploitation of local resources in an attempt to gain a competitive edge (or even just entrance into) the global market [23]. As the culture of value optimization seeps into the far extents of the Earth through globalization, conservation could lose out to competitive land uses and market fluctuations [24–26]. This understanding of globalization and capitalism is at the heart of much of the literature critiquing market-based incentives for conservation and similar economic solutions to the conservation problem [27,28].

In contrast, the understanding and promotion of a spectrum of relational values may provide additional policy alternatives that result in an increased ability to meet conservation goals locally, regionally, and globally [29]. Plural value systems are embedded in human-environment relationships [30–32], and thus, the “value” of landscape mosaics shifts in accordance with economic factors and cultural meaning. By supporting complex value systems, conservation initiatives can engage with diverse communities and un-economic reasons for protecting ecosystems and biodiversity. Furthermore, redundant ecosystems, institutions, and value structures may reinforce and support resilient communities [33,34], contributing to the adaptive capacity of social-ecological systems across scales.

Because of these convergent lines of scholarship from different fields (e.g., anthropology, conservation, ecology, economics), there is a need to integrate traditional ways of measuring landscape values and move towards a more pluralistic framework. Progress
has been made, including recent work looking at spatial patterns in the supply and demand of ecosystem services [35]. However, these assessments miss the complexity of diverse value systems. When striving for efficiency, we lose the plurality of values associated with intermediate ecosystem states. For example, in the well-known study by Polasky et al. [22] regarding efficiency frontiers in Oregon, the authors point out that regional planning had failed to optimize land-use values, in terms of trade-offs between biodiversity conservation and economic development, across space. However, critiques of this approach have pointed out that ecosystem services may be in competition with each other across space, and that it may be impossible to truly reconcile all trade-offs across space in an optimal efficiency frontier [36]. The attention to multifunctional landscapes offers a way to explore and measure the diverse values associated with social-ecological systems, including livelihood and wildlife habitat, along with the various policy mechanisms that might promote multifunctional use.

To organize scholarship at this interface, manuscripts in this special issue link landscape-scale conservation with relevant governance structures, approaches, and strategies to address the challenge of reconciling context-dependent relational values with global conservation goals. This special issue presents alternative approaches that embrace the multifunctionality of social-ecological systems as critical for conservation imperatives and system resilience. The research highlighted in the issue considers how governance, policy, and values interact and promote multifunctional landscapes that foster social-ecological integrity, thus contributing to biodiversity conservation.

In the special issue, we see the application of a number of tools for regional planning. Song et al. [37], in their review of multifunctional agricultural landscapes, highlight the challenges of providing comparable metrics of land-use values that can inform policy across scales. This insight applies to social-ecological systems more broadly, as multifunctional landscapes offer various benefits to human and non-human communities that must be weighed into land-use decisions. Gallo et al. [38] describe a multi-criteria decision-making (MCDM) tool with direct application to biodiversity conservation across landscapes. The research provides evidence of the success of MCDM and lessons learned in five iterative case studies, and the authors suggest that it is generally flexible for application in other landscapes. Ureta et al. [39] use InVEST models to show, at a regional scale, how changes in land cover and the related impacts on desired ecosystem services are critical for helping decision-makers design policy. This paper complements similar modeling efforts to show how spatial models can highlight conservation priorities across multifunctional landscapes. Semeraro et al. [40] employ spatial analysis to demonstrate the role that photovoltaic systems can play as part of multifunctional landscapes that contribute to critical ecosystem services including biodiversity protection, water filtration, and climate regulation. Through a case study of solar farms in Southern Italy, the authors offer a design framework for these systems that can contribute to more effective integration of this critical infrastructure into the landscape. Finally, Molina-Holgado et al. [41] provide a case study of two municipalities in Spain. Local inventory efforts in one, Torrelodenes, allowed regional planners to develop urban spaces while maintaining biodiversity in the landscape. This success contrasted with Madrid, where the lack of local information resulted in a steeper loss of biodiversity. This paper highlights that local-level data collected at a fine grain is critical for informing successful conservation policy that balances development needs with biodiversity in multifunctional landscapes. In a similar vein, it is increasingly important to measure the contributions of multifunctional landscapes to human well-being. The paper by Yao et al. [42] explores the use of an alternative indicator, Ecological Wellbeing Performance (EWP), to evaluate the tradeoffs inherent in development between natural resource degradation and increased prosperity. They combined this index with a spatial Markov Chain to assess the EWP across China, highlighting that recent growth has deteriorated EWP in certain sectors, while the environment plays a critical role in various aspects of social health.
Just as multifunctional landscapes demand an understanding of the value of landscapes across space, policy must unite stakeholders and institutions across scales. A subset of articles in this special issue engage with the challenges of understanding cultural ecosystem services and relational values across stakeholders and the tensions between local and regional governance structures. Dale et al. [43] explore the challenges of Community Based Natural Resource Management (CBNRM) and scale through a literature review and accompanying analysis of Australia’s governance system. Their results highlight the potential disconnect across sectors and stakeholders, resulting in fragmented networks that can fail to meet biological and social objectives. They emphasize the need to coordinate long-term goals and monitoring with local-level autonomy and input. Garcia-Llorente et al. [44] highlight the importance of understanding local perceptions of ecosystem services for informing governance approaches. Their case study in Spain demonstrates the particularly high value of cultural ecosystem services to local stakeholders and the ways that institutions mediate public understanding of ecosystems and their values. Further, they highlight the importance of relational values as cultivated through human interactions with multifunctional landscapes as integral to promoting biodiversity conservation while supporting human well-being.

These collected papers reflect the richness of processes, values, and metrics in the literature. The special issue offers insight associated with landscape conservation planning, as manuscripts provide case studies that demonstrate how we might move forward to strengthen policy and governance for multifunctional social-ecological systems. The rapidly emerging discussions around pathway diversity [45,46] suggest a framing that moves away from efficiency, is inclusive of multiple values in a landscape, and works across spatial scales. Governance of multifunctional landscapes offers the possibility of integrating conservation values across regions to overcome these challenges.

Conflicts of Interest: The authors declare no conflict of interest.
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