



Underuse of social-ecological systems: A research agenda for addressing challenges to biocultural diversity



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ABSTRACT

Conservation is often operationalized as a minimization of human intervention in nature. However, many social-ecological systems depend on human interventions to maintain characteristics of biological diversity. Therefore, reduced use or full abandonment of such systems can diminish rather than enhance biological diversity and its related cultural diversity (biocultural diversity). We link the definition of “underuse” with the extinction rate used in the planetary boundaries framework to support a more objective use of the term. We execute a structured cross-continental review of underuse in social-ecological systems of regions that contain more affluent countries to frame a global research agenda on underuse. Our working approach delineates causes, consequences, and strategies concerning underuse. Based on this comparative review, we identify causes of underuse that are similar in different continents, including globalization, and demographic or structural change in Europe, Japan and Oceania. Conservation paradigms emphasizing wilderness ideals in policies are characteristic of underuse in North America, whereas post-socialist transformation processes characterize underuse in Eastern Europe. Land abandonment and de-intensification of use are a common result, particularly in marginal and protected areas. Consequences of the loss of biocultural diversity include the loss of ecosystem services, traditional knowledge, or landscape amenities. We identified a pervasive gap in transcontinental comparative research that stymies the development of effective strategies to reduce underuse of biological diversity and thereby maintain related cultural diversity. We advocate for a global research agenda on governance approaches that address the challenges of underuse. Within this agenda, we emphasize the need for an international cross-case synthesis and a trans-continental mapping of state and civil society-based interventions and co-management approaches to re-establish humans as parts of ecological systems. Such comparative work on best practice cases in a real-world context should enhance adaptive management of biocultural diversity and prevent extinction caused by underuse. Thus, this innovative connection between underuse and the planetary boundary extinction rate, along with our new global research agenda on underuse, should initiate much needed support for policy makers and natural resource managers who must decide on appropriate types and levels of human intervention to implement, both inside and outside of protected areas.

1. Introduction to the problem of underuse

Many ecosystems around the world have been shaped by human land use for centuries. A co-evolution of “human and natural systems” has resulted in distinct agroecosystems and bio-cultural diversity.

Therefore, change or lack of human land use can become a crucial issue for the conservation of bio-cultural diversity. Underuse, i.e. the lack of human intervention when it is needed to maintain biological and associated cultural diversity (in the sense of the diversity of place-based agricultural practices, skills and historical heritage), is the core issue of

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this paper. We review studies from post-agrarian countries in North-America, East Asia, Oceania and Europe to document causes, consequences, and strategies related to underuse and to derive an agenda for future research.

Justifications for biodiversity conservation activities are manifold. Although biodiversity conservation is often conceptualized based on “naturalness”, “humans-out” or wilderness, the extent and magnitude of human impacts throughout all regions of the globe have become so pronounced as to herald a new geological epoch, the Anthropocene (Steffen et al., 2003; Zalasiewicz et al., 2010). Therein, anthropogenically modified ecosystems or anthromes are ubiquitous (Ellis and Ramankutty, 2008; Ellis et al., 2010). In this context, the extent of human intervention is discussed intensively, for example considering indigenous people’s intervention in connection with the wilderness debate (Aplet and Cole, 2010) or human-induced global (climate) change associated with the industrial revolution (Steffen et al., 2015).

Despite these overall effects by humans, many habitat types do not necessarily need any human intervention in the sense of a “consumptive or productive use” (Primack, 2006:86ff), while others are fully dependent on various interventions. Thus, based on use, conservation interests can be broadly differentiated into a number of scenarios:

1. maintenance of untouched natural assets such as a primary forests (Gillson and Willis, 2004; Ross-Bryant, 2005; Barlow et al., 2010; Mauerhofer et al., 2016),
2. sustainable use of natural assets that require some human use for their persistence, such as particular species or habitat types associated with a cultural landscape (Ichinose et al., 2007; Halada et al., 2011), or
3. restoration of any of the above as far as possible (Aronson et al., 2006; Hobbs et al., 2009).

In this regard, overuse is related to any exploitation of a yet untouched natural asset (Boakes et al., 2010), the harvest of natural assets beyond a maximum sustainable yield (e.g. Mueter and Megrey, 2006; Gibson et al., 2011), or other forms of harmful interventions (e.g., intensive tourism or recreation) that significantly threaten a favorable conservation status of wild species or habitat types (Mehtala and Vuorisalo, 2007; O’Brien, 2015). Both the concepts of maximum sustainable yield and favorable conservation status of wild species and habitat types address overuse as well as underuse (see in general e.g. Tisdell, 2011). Under both concepts, no-use can also be considered a threat to natural assets that require at least a modicum of human intervention for survival (similar to underuse).

Approaches that foster no-use or overcome underuse should not be seen as contradictions, but should be appreciated as two complementarily concepts depending on the particular natural assets involved in conservation. Management measures such as those applied by the World Heritage Convention of the UNESCO (2012) take into consideration both cases by focusing on natural as well as cultural heritage sites. The latter sites include numerous habitat types and wild species that are dependent on human consumptive or productive use. The UNESCO biosphere reserves aim to link human use and no-use to achieve conservation and sustainable development goals. Strictly protected core zones follow the “humans out” (no-use) conservation approach, whereas buffer and transition zones explicitly encourage sustainable (traditional) uses of ecosystems (Elbakidze et al., 2013).

To the public, conservation of natural assets focuses mainly on national parks and wilderness, with the terms and approaches for sustainable management of social-ecological systems less well appreciated or understood. A short review of the literature of “social-ecological system”, “social environmental system”, “human-nature system”, “cultural-ecological system”, “biocultural system”, “cultural landscapes”, and “man-made landscapes”, as well as newly coined terms such as “Globally Important Agricultural Heritage Systems” - GIAHS (Harrop,

2009), “Socio-ecological Production Landscapes” - SEPLS (Gu and Subramanian, 2012) and “Satoyama” (Takeuchi, 2010). This plethora of terminology is not that surprising given the many different conceptualizations of the relationships between humans and nature. Nonetheless, the use of multiple terms diffuses public attention and challenges comparative research. This paper retains “social-ecological systems” and “landscapes”. The latter is particularly appropriate when refereeing to cases in Europe and Japan, where cultural landscapes or the very similar concept of *Satoyama* have become dominant paradigms describing coupled social-ecological systems that might be affected by underuse, resulting in unwelcome changes.

In this connection, underuse can roughly be defined as the absence of human intervention when it is needed to maintain biological diversity.¹ and associated cultural diversity (in the sense of the diversity of place-based agricultural practices, skills and historical heritage) in a social-ecological system (cumulatively considered hereafter as “biocultural diversity”²). To precisely define underuse - similar to overuse - is challenging, as what is perceived as underuse in one context or by one stakeholder group, might be seen as overuse by others in other contexts. The terms of underuse as well as overuse suggest that there is some kind of agreement on an optimal level or threshold of use where underuse or overuse initiates problems. The concept of planetary boundaries represents an attempt to identify thresholds of harmful overuse. More specifically, Rockstrom et al. (2009) proposed a planetary boundary for the rate of biodiversity loss of 10 extinctions per million species per year, and found that the current rate is far greater than that boundary. Such an approach also considers resilience (Folke, 2006; Lebel et al., 2006) by applying the precautionary principle³ This method (Rockstrom et al., 2009) includes biodiversity that does not depend on human use (typical for wilderness) as well as that which fully depends on a certain extent of human use (typical for social-ecological systems) - and thus might also be helpful for identifying underuse problems.

The degree of threat, and consequently the likelihood of extinction to species, are regularly conveyed via Red Lists at different geopolitical scales such as at the national scale or by IUCN at the global level (e.g. Cooke, 2008; Rodriguez et al., 2011). For many wild species and habitat types (e.g., birds of farmlands) that are under pressure from underuse and overuse, the extent of threat is much higher than that for other wild species or habitats that are “solely” threatened by one of these two factors (e.g. Donald et al., 2006; Katayama et al., 2015a). Biodiversity loss is quantified by comparing current with past extinction rates of species or habitat types (Rockstrom et al., 2009). A problem definition based on species extinction is intrinsically linked to spatio-temporal scales, as species need long periods to spread, develop and adapt to particular habitats. In socio-ecological systems that have evolved over centuries or even millennia (e.g., traditional vine or rice terraces, anthropogenic heathlands or alpine meadows), underuse will affect species that are well adapted to and sometimes only found in particular

¹ As defined in Article 1 of the Convention on Biological Diversity: “biological diversity” means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems;” (UNEP, 1992) and often abbreviated as “biodiversity”.

² As we focus on underuse and land use in this article, the understanding of biocultural diversity applied here is concentrated to certain land use practices and thus more narrow as other definitions. e.g., “the total variety exhibited by the world’s natural and cultural systems” (Loh and Harmon, 2005. A global index of biocultural diversity. Ecological Indicators 5, 231–). In their work that focused in terms of culture mainly on language and religion, they refer regarding this definition to Maffi, L. ([Ed.], 2001. On Biocultural Diversity: Linking Language, Knowledge, and the Environment. Smithsonian Institution Press, Washington, DC).

³ Article 15 of the Rio Declaration from 1992 (UNEP, 1992) defines this principle in the following way: “In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”

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