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SOCIOCULTURAL INDICATORS IN ECOLOGICAL STUDIES AT THE LANDSCAPE SCALE: A FIELD UNDER CONSTRUCTION

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ABSTRACT

The science of landscape ecology aims to study quantitative variables to modelling relationships between ecological processes in ecosystems and the effect of human disturbances. The landscape, however, is a holistic system in which nature and culture co-evolve. Hence, management interventions designed to support sustainability and the conservation of landscapes are the result of human decision-makers, who have different values and worldviews and who may affect the management decisions. Despite their importance, the social and cultural dimensions of landscapes have not been adequately studied or considered an important theme in landscape ecology or management, mainly because of the difficulty of quantifying them. In this sense, an important step is to establish quantifiable sociocultural indicators that reflect these values in metrics that facilitate their introduction in the landscape ecology models or management. In this sense, the main objective of this study is, through a systematic literature review in Google Scholar, to propose a set of quantitative indicators for measure tangible and intangible values of landscape, highlighting the importance of social participation to obtain them within communities. This study also explore the importance of social and cultural values for landscape analysis, and discusses the opportunities for and limitations to develop quantifiable indicators for these values. Of the 66 articles found, 16 presented 29 sociocultural quantitative indicators to be measured in the landscape (18 tangible and 11 intangible).

Keywords: cultural landscapes, landscape ecology, sense of place, social capital, vernacular language, well-being.

INDICADORES SOCIOCULTURALES EN ESTUDIOS ECOLÓGICOS A ESCALA DE PAISAJE: UN CAMPO EN CONSTRUCCIÓN

RESUMEN

La ciencia de la ecología del paisaje pretende estudiar variables cuantitativas para modelar las relaciones entre los procesos ecológicos de los ecosistemas y el efecto de las perturbaciones humanas. Sin embargo, el paisaje es un sistema holístico en el que coevolucionan la naturaleza y la cultura. De ahí que las intervenciones de manejo diseñadas para apoyar la sostenibilidad y la conservación de los paisajes sean el resultado de seres humanos, que tienen valores y visiones del mundo diferentes y que pueden afectar a las decisiones de manejo. A pesar de

su importancia, las dimensiones sociales y culturales de los paisajes no se han estudiado adecuadamente ni se han considerado un tema importante en la ecología o en el manejo del paisaje, principalmente por la dificultad de cuantificarlas. En este sentido, un paso importante es establecer indicadores socioculturales cuantificables que reflejen estos valores en métricas que faciliten su introducción en los modelos de ecología o manejo del paisaje. En este sentido, el objetivo principal de este estudio fue, a través de una revisión bibliográfica sistemática en Google Scholar, proponer un conjunto de indicadores cuantitativos para estimar los valores tangibles e intangibles del paisaje, destacando la importancia de la participación social para obtenerlos dentro de las comunidades. Este estudio también se explora la importancia de los valores sociales y culturales para el análisis del paisaje, y discute las oportunidades y limitaciones para desarrollar indicadores cuantificables de estos valores. De los 66 artículos encontrados, 16 presentaron 29 indicadores cuantitativos socioculturales para ser estimados en el paisaje (18 tangibles y 11 intangibles).

PALABRAS CLAVE: bienestar, capital social, ecología del paisaje, idioma, paisajes culturales, sentido del lugar.

INTRODUCTION

A landscape comprises abiotic and biotic elements, such as water bodies, the sea, and living elements like native vegetation and humans, that intervene in this geographic space in different ways. Landscape is therefore recognized as a holistic system in which nature and culture co-evolve. However, landscape ecology in the early days, has focused on the effects of human disturbance on pristine landscapes (Naveh, 1982; Risser *et al*., 1984) and, more recently, in the construction of models of relationships between spatial patterns and ecological processes, using mainly quantitative variables (Wiens, 2007).

Almost all ecosystems and landscapes around the world have been influenced by humans, that keep promoting the development of cultures, legacies, and histories (Kareiva *et al*., 2007). This culture and nature link is reflected by the fact that landscapes shaped by this link, have maintained their biodiversity and ecosystems services. Thus, most of landscapes are rich in natural and cultural values, not despite the presence of people but because of it (Brown *et al*., 2005). Therefore, any artificial separation between culture and nature, or between people and place without a holistic framework, can obstruct a realistic understanding of these complex adaptive systems (Wu, 2010). Given this holism, landscape studies also could offer a great opportunity for linking various aspects of social, cultural, and ethical values related to nature and for promoting the sustainability of societies and ecosystems (Leopold, 2004; Ceccon *et al*., 2020a).

At same time, humans depend on landscapes for many services, including health (e.g., medicinal plants), food (e.g., water, the harvest of wild and cultivated species), and shelter (e.g., construction materials or natural dwellings). Other humans' dependencies from landscapes are less visible. For example, the landscape can provide a sense of place and home (belonging), that is very important in the lives of most people, because it provides relevant experiences, such as having roots, an awareness of limits, and a connection with everyday life (Escobar, 2001). The landscape is also a place for recreation, for inspiration, and for improving mental health; all these factors play an important part in our overall well-being. In this sense, interventions designed to support natural resources management, sustainability, and landscape conservation, must be the result of decisions taken together with local inhabitants by considering their wishes, customs, spirituality, knowledges, and laws. However, this cultural dimension of ecosystem services, remains less developed when compared with the ecological dimension (Musacchio, 2013).

Nearly four decades ago, Caldwell (1990) and Naveh (1982, 1995) had already indicated the urgent need for more holistic conservation and management strategies for landscapes, especially in rural areas, due their biological and sociocultural values. Both authors proposed that landscape ecologists and planners from governmental, nongovernmental, and international agencies, needed to have a critical understanding of sociocultural and natural aspects of environment, to promote a public comprehension of the significance of landscapes for quality of life (Naveh, 1995).

In this sense, it is important to understand that culture is complex since includes knowledge, moral, law, customs, and any another capability and habit acquired by human beings as a member of society (Tylor, 1924). This concept has been much discussed, but not fundamentally changed (Bradley, 2018). Therefore, by introducing the notion of culture, it is important to expand landscape ecology or management from the physical, biological, and ecological aspects of the natural sciences to the sociological, anthropological, psychological, philosophical, and historical fields. It is also important to perceive that the mechanistic conceptualization of humans as agents of negative environmental impact obscures the conception of individuals' thoughts, feelings, and potentially, their love for nature (Golley, 1990). The relationship between the individual and the landscape is therefore mediated by a symbolic network between material and the immaterial, between visible and invisible and to attitude that means a value (Cosgrove, 1998).

Cultural landscapes emerge from above complex relationship between human beings and nature. They are created by a particular cultural group from a natural landscape. Culture is the agent, the natural area is the medium, the cultural landscape is the result. Under the influence of a certain culture, which can change over time, the landscape can also change (Sauer, 2006). In short, cultural landscapes are regions that express a long and intimate relationship between people and their natural environments through sustainable land-use techniques (UNESCO, 2010).

In terms of public policies, the importance of cultural landscapes began to be recognized over the past three decades. Category V of the IUCN´s Protected Landscapes (International Union for Conservation of Nature; IUCN 1994) refers to landscapes that have been protected through their exceptional natural and cultural value. This was followed 10 years later (2006) by the Global Protected Area Management Guide (Lockwood *et al*., 2006) covering 26 topics with many case studies including places of outstanding aesthetic quality, rich biodiversity, and cultural value because of the presence of people.

The IUCN has identified many benefits of protected cultural landscapes (UNESCO, 2009), including: i) conserving nature and biodiversity, ii) buffering more strictly controlled areas, iii) preserving human history in structures and land-use patterns, iv) maintaining traditional ways of life, v) offering recreation and inspiration, and vi) providing education and understanding. Simultaneously, the 2001 UNESCO Universal Declaration on Cultural Diversity recognized the fundamental role of protecting the human rights of indigenous people, including respect for traditional knowledge and its contribution to the protection of the environment and the management of natural resources, and the synergy between modern science and local cultural knowledge (Rössler, 2006). Another important political and scientific event that has enhanced our understanding of the importance of cultural aspects around the world, was the symposium "The role of sacred natural sites and cultural landscapes," which was considered the major theme of the UNESCO/IUCN 2005 international "Conserving Cultural and Biological Diversity" meeting (UNESCO/IUCN, 2006).

Once the importance of cultural landscapes was recognized institutionally, it has been considered very important the developing relevant criteria for the elaboration of quantitative sociocultural indicators, that can be introduced in the landscape ecology models and in the sustainable management frameworks. These new criterium could provide a more realistic interpretation of this complex system and connecting these indicators

to broader national and international public policies goals. These are key challenges for policy makers and scientists (McShane *et al*., 2011). In this sense, a wide participation of the local communities is crucial in the process for obtaining sociocultural indicators, promoting a dialogue of knowledge among managers and local people (Ceccon, 2020; Ceccon *et al*., 2020b). These local communities can generate creative and resilient responses to global pressures despite being under their overwhelming impact (Campbell, 2009; Galicia-Gallardo *et al*., 2021, 2023). These participatory approaches have also shown that working within social and cultural contexts have the potential to strengthen the perception of legitimacy in community-level decision- making and to facilitate a project implementation (Muro and Jeffrey, 2008; Hernández-Muciño *et al*., 2018).

An important approach for sociocultural indicators was presented by the Millennium Ecosystem Assessment (MEA, 2005), which identified cultural ecosystem services (CES) that included some components for socioecological systems, such as "heritage values" and "sense of place." Nevertheless, the MEA largely excluded intangible services (Chan *et al*., 2012). The UNU biodiversity cultural indicator toolkit, the Mauri model decision-making framework (Bergamín *et al*., 2013; Sterling *et al*., 2017b) and some published papers, also expanded the breadth of resilience indicators available for decision-making in sociocultural criteria, that include cultural landscape and community asset mapping, multispecies ethnographies, and the development of community well-being indicators for the cultural landscape conservation (Verschuuren *et al*., 2014; McCarter *et al*., 2018).

In accordance with what was mentioned above, it is possible to conclude that the development of sociocultural indicators in landscapes are still a field under construction, mainly when it comes from quantitative frameworks. Therefore, the aim of this study is, through a systematic literature review in google scholar, to develop a table with quantifiable indicators that reflect tangible and intangible sociocultural values, mainly to be used in the developing of more holistic and realistic landscape ecology models, management plans and public policies strategies. The secondary objective is discuss about the opportunities and limitations in the development of sociocultural indicators and the basic criteria used for developing them, highlighting the importance of social participation in obtaining these indicators within the communities.

MATERIAL AND METHODS

I searched in Google Scholar the follow words combinations (no date limitations): "quantitative indicators" and "sociocultural" and "landscape scale". From 66 papers found, 16 articles presented directly 29 quantitative sociocultural indicators in landscapes management (18 tangible and 11 intangible). Also, I evaluated in some articles the opportunities and limitations to develop these indicators.

RESULTS AND DISCUSSION

Opportunities and limitations in developing sociocultural indicators. Social and cultural approaches are interrelated since they explicitly study human practices and rely on local knowledge and cultural identities, which together influence, and shape landscapes inhabited by traditional communities (Gavin *et al*., 2015). This means that all cultural approaches are socioecological in nature, but not all social approaches frame relevant local cultural perspectives.

Sociocultural approaches present opportunities but may generate challenges for creating metrics that facilitate linkages between scales. For example, locally important, culturally grounded values, can be less tangible and harder to measure than global ones, and we need to identify ways to equitably include them (Eoin and King, 2013; Satterfield *et al*., 2013). These may be locally measured and justified through local ontologies, but they are difficult to translate across scales (Sterling *et al*., 2017b; Verschuuren *et al*., 2014).

In the development of effective sociocultural indicators, it is important consider several community characteristics. First, the research must begin establishing a participative

process, trying to understand how community institutions use or managing resources. For this, it is important to have a clear awareness of who people is included in this community, the criteria upon which community membership is based, the diverse opinions within the community, and at what scale and by whom decisions are made (Fraser *et al*., 2006).

The first benefit of participatory methods is that, in many cases, local actors have sufficient knowledge to ensure that locally important indicators are precisely measured (Carruthersand Tinning, 2003). The indicators developed also must be deeply relevant to people´s way of life and cover social and cultural values, just like the worldviews that shape people's understanding of their roles and responsibilities within their landscape (Escobar, 2014) (e.g., the mapping of sacred places; Sterling *et al*., 2017a). In addition, how to measure and monitor the indicators must be coordinated with local people's livelihood strategies or their social activities (Oba and Kotile, 2001). In short, these indicators must be developed and monitored using community-based and participatory methods, that explicitly consider a perspective that emphasizes feedback among ecological, social, and cultural elements (Galicia-Gallardo *et al*., 2021).

At same time, local participation can also help building the community's capacity for addressing future problems. The act of identifying its own problems can play a key educational role in the community, which goes beyond the simple identification of relevant community indicators. The methods used to collect, interpret, and display data must be easily and effectively used by local communities, so that all stakeholders can participate in the process (Fraser *et al*., 2006). Social participation can also favor collective learning, environmental awareness, empowerment, and governance in traditional communities. Long-term participatory monitoring programs in the landscapes are also necessary to evaluate long-term socioecological changes (Ceccon *et al*., 2020b; Mendez-Toribio *et al*., 2021).

On the other hand, sometimes quantifiable parameters of sociocultural indicators could distract from unquantifiable values like aesthetic, ethical or cultural (Piorr, 2003). Simensen et al. (2018), published an international review of different types of landscape characterization, and concluded that no single method can address all aspects of a landscape, but all approaches involve consideration between human and natural interactions factors, and must include multiple sources of knowledge. Methods for analyzing landscapes must be parsimonious, with the exclusion of some characterisics, and prioritization of others.:

Sociocultural indicators in landscapes: A field under construction.

The selection of criteria for develop indicators in landscapes. A criterium is a kind of subjective condition that makes it possible select a relevant indicator. To be useful, an indicator should be based in valid, well-constructed, reliable, and accurate criteria (Frongillo, 1999). A fundamental criterion for develop an indicator is that it can be quantifiable. Quantitative sociocultural indicators may be useful tools for reflecting on an aspect of a given sociocultural characteristic in the landscape (Figure 1). Quantitative sociocultural indicators can provide a more holistic interpretation in landscape ecology models, greatly facilitate the manager's decisions by precisely defining the focus of attention and allowing trade-offs at different levels of value and making these trade-offs visible. They can also facilitate the identification of crucial problems and solutions that are missing in several landscape management frameworks (McShane *et al*., 2011)

Another criterion for developing quantitative sociocultural indicators in the landscape should be based on knowledge and customs of social and cultural norms related to and supported by local practices (Figure 1). The importance of sociocultural values to human well-being is widely recognized. However, quantifying these non-material benefits is challenging (Figure 1). In the same way, recognizing culturally important species are related to landscape domestication concept, which can be defined

as a deliberate human process, which transforms the environment through the manipulation of biodiversity and the abiotic environment, looking for a more productive and suitable place for human beings (Clement and Cassino, 2018), what is intimately associated with the culture of a certain social group, the transmission of knowledge, and distribution of several species (Pérez-Valladares *et al*., 2022; Figure 1).

Identifying the people who have long-established relationships with the area of interest might be an important step in ensuring key values and knowledge are included in the landscape indicators. Place-based peoples are those with strong and deep connections to their environments. These peoples have ways of life that they have shaped, and they have in turn been shaped by the places they inhabit. In addition, they usually have extensive knowledge developed through generations of learning about the ecological limits of the environment in which they live, by observation and trial and error (Berkes and Turner, 2006)

The selection of indicators. Indicators are typically constructed by classifying values of a single measure, or an index or scale calculated from multiple measures, based on degree or specific meaning. Deriving an indicator usually implies that there is an understanding of what value of a measure, index, or scale is considered adequate or not (Fronguillo *et al*., 2004).

Sociocultural indicators can offer a culturally relevant and socially comprehensive approach for establishing management priorities across landscapes to promote social, cultural, economic, and ecological resilience (Gavin *et al*., 2015; Sterling *et al*., 2017a, Galicia -Gallardo *et al*., 2023). The process of defining useful indicators, however, has not been extensively developed (Sterling *et al*., 2017a).

The "sense of place" can be an outstanding indicator to explain how connectedness with the place is important for social–ecological resilience in the landscape (Table1). Also, the connection among people may be related to "social capital" indicator (Table 1), since this indicator involves the effective functioning of social groups through interpersonal relationships, a shared sense of identity, norms and values, mutual trust, cooperation, and reciprocity (Vlami *et al*., 2017). Because it encompasses the concepts above mentioned, the presence of social capital is also a relevant indicator of "sense of place" of community members, and it is essential for ensuring the long-term sustainability of the management projects (Coleman, 1988) (Table 1).

Place-based relationships also may be related to "resources management", since the circulation of natural resources (e.g., food, planting materials, land) within and between generations, families, and communities is traditional practice in the landscapes. Furthermore, not always these connections relate to people who are alive, but It could also refer to ancestors, who may be present in living and non-living components of ecosystems (Dacks *et al*., 2019) (Table 1). Spiritual values have strong cultural importance, because they can promote changes in the well-being of humans. Indicators such as the increase or reduction in the "number of sacred sites", participation and number of rituals, presence of spiritual leaders, and sacred site custodians (Table 1), also have great importance. In addition, the status of "totemic species" may fortify local visions of well-being because people's perceptions are tied to the health of their totems (Sterling et al., 2017a). In fact, totemic species continue to be respected in many communities despite of influence of nontraditional religions and modern education (Hiemstra et al., 2014; Figure 1; Table 1).

Another important cultural indicator associated with the understanding of how human well-being is perceived and experienced by individuals with strong cultural, generational, and genealogical ties to the land (including local species knowledge, ecosystems services perception and values) is the "vernacular language", which is a native dialect or form of speech of specific people or within a region (Figure 1; Table 1). Local names of species reflect a broad spectrum of information, such as local uses, ecology, physiology, pharmacognosy and several other aspects. It is a well-recognized fact that most of the knowledge about plants as well as many native local

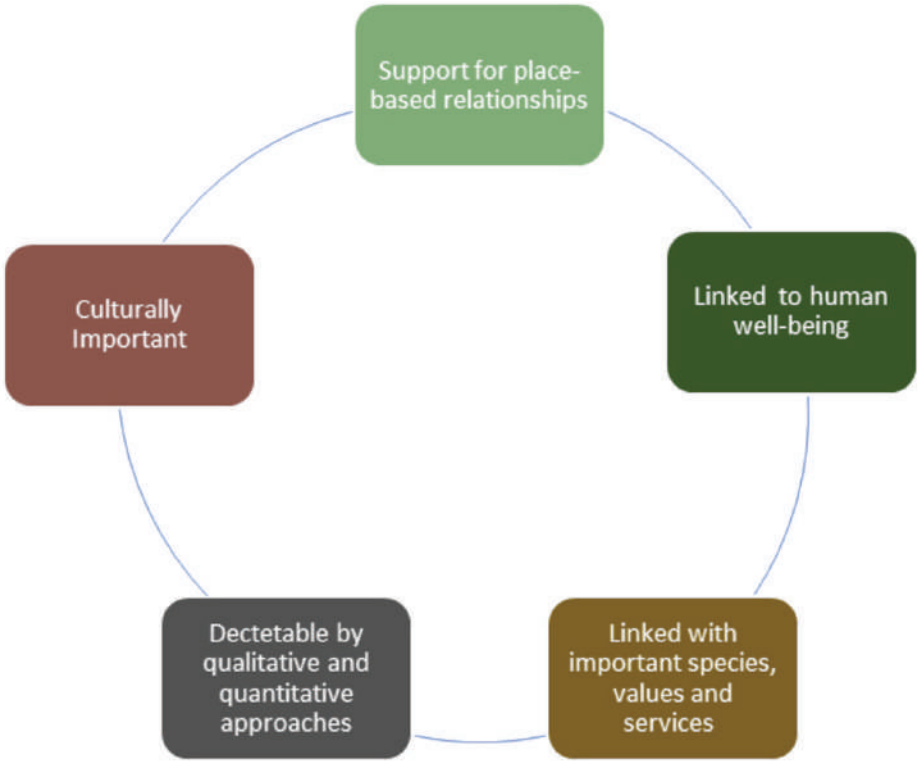

Figure 1. Five emergent criteria proposed to the development of sociocultural indicators, useful in environmental management, and monitoring of landscapes.

languages are disappearing, making critical that this information be documented and preserved. Therefore, the recognition of these species has a positive effect on the cultural and spiritual well-being of the community.

Another relevant indicator associated with human well-being criterion is "food security", defined by FAO (1996) as ''physical, social, and economic access by people, to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" food security is now a priority for many governments. In the global community there is heightened awareness of the need to improve the understanding and measurement of food security. Common concerns among communities are about diet and the shifts in homegardens productivity, including changes in preference toward store-bought and imported foods and associated health issues. In fact, new indicators are proposed to measure food security and cultural acceptability (e.g., whether people can consume foods that they enjoy and are culturally acceptable as often as they like) (Table 1).

"Traditional farming" is an indicator in landscapes that also provides well-being and some greatest opportunities for biodiversity conservation. These farming practices have changed relatively little over long time, often centuries (Table1). Traditional farming has distinctive biophysical characteristics, including substantial amounts of natural or seminatural vegetation and high heterogeneity in land cover. Several cultural traditions and norms evolved to maintain these agroecosystems, including traditional ecological knowledge and a multitude of formal and informal institutions (Berkes *et al*., 2000).

"Governance" indicator is high when the landscape has capable, accountable, and transparent local institutions for the effective management of its resources and local biodiversity. Usually, a high indicator for "social equity" is associated to a high governance and refers to that rights and access to resources and opportunities for education, information and decision-making are fairly and equitably distributed among all community members, including women.

Table 1. Quantitative indicators for measuring sociocultural values in ecological studies at the landscape scale.

SOCIAL AND CULTURAL VALUES	QUANTITATIVE INDICATORS
TANGIBLE	
1. Sacred places (natural and human constructed sites, e.g., temples) and surroundings	Number of sites and people respecting and using them[1]
2. Totemic species (plants and/or animals)	Number of species and number of people respecting them[1]
3. Religious, spiritual, cultural, and archaeological artefacts	Number of artefacts[1]
4. Existence of spiritual leaders and sacred site custodians	Number of spiritual leaders and sacred site custodians performing their roles[1]
5. Food security, nutrition	(a) Percentage of households in the community that report having a stable food supply throughout the year. Food supply can be subsistence-based, purchased, or bartered. (b) Average length of time after a disaster for which households in the community have access to an emergency supply of culturally valued food. Both can be measured by the food insecurity experience scale (FIES). [2, 16]
	% homegardens[3-6]
6. Traditional farming	0 = No or insignificant traditional farming; 1 = Presence of traditional farming within site
	2 = Important areas with traditional farming in site with at least one landscape unit dominated by traditional farming[4,16]
7.Degree of recognition (customary and/or formal) of the community's rights over land/ (seasonal) pastures/ water and natural resources	(5) Very high
	(Rights are fully recognized and not disputed)
	(4) High
	(3) Medium
	(2) Low
	(1) Very low (rights are not recognized and heavily disputed)[3]
8. Culturally important species	Number of culturally important species that are known, planted or harvested[2, 6, 16]
9. Land distribution	Establish three ranges related to the region size scale
	Gini coefficient of inequality:
	$CGT = 1 - \sum_{n}^{n-1} (X_{k+1} - X_k) * (Y_{k+1} - Y_k)$
	X = Cumulative proportion of people who are producers or responsible for the land
	Y = Cumulative proportion of agricultural production units (APU) – area measured in hectares[8]
10. Rural poverty	% of poor people[9]
11. Rural population density	Inhabitants /km^2[,9]
12. Human population variation (migration)	Percentage of change of population over the last three decades
	International or national migration rates[9]
13. Human Development Index (HDI)	Life expectancy + Education Index+ Gross National Income per capita (Municipal level)[9,10]
14. Land use	% of each land use[9]
15. Land ownership	% of land ownership: social, private, governmental3
16. Fuelwood consumption	% of population that use fuelwood for cook and heating[13]
17. School education	Number of primary and secondary schools[14]
	% of students age 14 or younger who attend school[14]

Table 1. Cont.

SOCIAL AND CULTURAL VALUES	QUANTITATIVE INDICATORS
18. Sustainable management of common resources	% of common lands that have sustainable management[15,16]
INTANGIBLE	
1. Traditional festivals and celebrations	Number of festivals and the number of people attending[1]
2. Traditional artisanship	Number of traditional crafts that are being pursued and the number of practitioners and artisans[1]
3. Recognition and respect for religious beliefs	Number of religions and their adherents[1]
4. Ability to practice spiritual beliefs and undertake ceremonies related to beliefs	Number of ceremonies and people practicing them[1]
5. Language and oral traditions	Number of languages and oral traditions and the number of their speakers[1]
6. Local knowledge and cultural traditions related to biodiversity transmitted from elders and parents to young people in the community	(5) Very high (Local knowledge and cultural traditions are transmitted to young people) (4) High (3) Medium (2) Low (1) Very low (Local knowledge and cultural traditions are lost)[4]
7. Connection and coordination among individuals within and among communities through networks that manage resources and exchange materials, skills, and knowledge (social capital)	Sum of five parameters: 1) training, 2) trust, 3) organization, 4) participation, and 5) the capacity to change and to resolve conflicts. Interviewees are asked to rate each parameter in a 0 to 2 scale, which is summed to obtain a composite value in a 0 to 10 scale[4,5,12]
8. Knowledge and practice of social and cultural norms related to place-based practices	Perceptions of the degree to which community members follow locally appropriate cultural norms. (5) Very high (all members follow) (4) High (3) Medium (2) Low (1) Very low (Few members follow)[5] Percentage of community members that have knowledge about places forbidden for certain persons (e.g., gender, matriclans, family) or certain behaviors
9. Knowledge and practice of stories, songs, chants, and dance	Number of community members who perform a locally important cultural activity that involves local ecological knowledge
10. Vernacular language as a key component of local identity	Number of native species known by the vernacular language[7]
11. Governance and social equity	Gender inequalities, social exclusion and marginalization are values that can hinder the ability of women, indigenous groups and others to participate in the landscape management (5) Very high (all members participate) (4) High (3) Medium (2) Low (1) Very low (Few members participate)[16]

[1]Hiemstra *et al*. (2014), [2]Sterling *et al*. (2017a), [3]Aguirre and Ceccon (2020), [4]Vlami et al. (2017), [5]Dacks *et al*. 2019, [6]Fazey *et al*. (2011), [7]Lynch *et al*. (2002), [8]Rodríguez-Castillo (2013), [9]Crouzeilles *et al*. (2020), [10]UNDP (2021), [11,12]Galicia -Gallardo *et al*. (2021, 2023), [13]Salgado-Terrones *et al*. (2017), [14]Fraser *et al*. (2006), [15]Sterling *et al*. (2017b), [16]Bergamin *et al*. (2013).

There are several methods to obtain the previously mentioned indicators, what most have in common is the need to involve the community in the process. Unfortunately, in the literature there is little information to guide how to act in the process of involvement with communities.

The use of new analytical tools such as quantitative sociocultural indicators in landscape research has enormous potential for increase our understanding of cultural landscapes that are changing. Moreover, may made which policies and management initiatives can be most effective in directing change in these landscapes to the desired directions, by both local people and managers.

CONCLUSIONS

To establish an effective sustainability in landscapes, the communities require of transformations including changes also in how they are self-valued. It is also important to establish new relations between societal actors and new governance approaches. In this context, sociocultural indicators are very important for understanding how human well-being is perceived and experienced by individuals with strong cultural, generational, and genealogical ties to the landscape.

The sociocultural paradigm emphasizes the connections between nature and human well-being, shifting the attention in sustainability debate from economic development to sociocultural values, which may lead to non-instrumental relationships with nature. Sociocultural indicators can shed light on the knowledge systems and practices that sustain socioecological systems and contribute through participative and committed research to create the necessary conditions for establishing landscape sustainability.

Sociocultural indicators must be deeply relevant to the way of life of local people and cover their social and cultural values and worldviews. In addition, the ways of measuring and monitoring implemented management decisions must include the effective participation of local communities and must be coordinated with their livelihood strategies and/or their social activities.

The adoption of a sociocultural paradigm by academia, professionals and policy makers can catalyze the joint construction of relevant knowledge, practices, and sustainable policies by different social actors in landscapes. The fruitful collaboration between these different social sectors must be based on the understanding of their different conceptions, knowledge and sociocultural characteristics associated with their respective agendas.

It is very important to take into account quantitative sociocultural indicators in landscape ecology models, as well as in management frameworks and in public policy programs related to the landscapes, in order to obtain a more holistic and realistic analysis of these complex systems.

REFERENCES

Aguirre-Salcedo, C., E., Ceccon. 2020. Socioecological benefits of a community-based restoration of traditional homegardens in Guerrero, Mexico. *Etnobiología* 18(3):72-9.

Bergamín N., W. Dunbar, P. Eyzaguirre, K. Ichikawa, I. Matsumoto, D. Mijatovic. 2013. *Toolkit for the indicators of resilience in socioecological production landscapes and seascapes (SEPLS)*. Bioversity International, Rome, Italy.

Berkes, F., N.J. Turner. 2006. Knowledge, learning and the evolution of conservation practice for social-ecological system resilience. *Human Ecology* 34(4):479-494. DOI: http://dx.doi. org/10.1007/s10745-006-9008-2

Berkes, F., J. Colding, C. Folke. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* 10:1251–1262.

Bradley, N. 2018. Essentialism in the concept of culture: gauging belief. *Journal of*

Intercultural Communication 21:1–21.

Brown, J., N. Mitchell, M. Beresford (Eds). 2005 *The protected landscape approach linking nature, culture and community*. IUCN.

Caldwell, L.K. 1990. Landscape, law and public policy: conditions for an ecological perspective. *Landscape Ecology* 5:3-8.

Campbell, J. 2009. Islandness: vulnerability and resilience in Oceania. *Shima* 3:85–97

Carruthers, G., G.Tinning. 2003. Where, and how, do monitoring and sustainability indicators fit into environmental management systems? *Australian Journal of Experimental Agriculture* (43):307-323.

Ceccon, E. 2020. Productive restoration as a tool for socioecological landscape conservation: The case of "La Montaña" in Guerrero, Mexico. In: Baldauf, C. (ed). *Participatory Biodiversity Conservation – Concepts, Experiences and Perspectives*. Springer, 113-128.

Ceccon, E., C.H. Rodríguez León, D.R. Pérez. 2020a. Could 2021-2030 be the decade to couple new human values with ecological restoration? Valuable insights and actions are emerging from the Colombian Amazonia. *Restoration Ecology* 28(5):1036-1041, DOI: https://doi.org/10.1111/rec.13233.

Ceccon, E., M. Méndez-Toribio, C. Martínez-Garza. 2020b. Social participation in forest restoration projects: insights from a national assessment in Mexico. *Human Ecology*, 48:609–617. DOI: https://doi.org/10.1111/rec.13233.

Chan, K.M.A., T. Satterfield, J. Goldstein. 2012. Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics* 74:8-18. DOI: https://doi.org/10.1016/j.ecolecon.2011.11.011

Celik, F. 2013. Ecological landscape design. In: Ozyavuz, M. (Eds). *Advances in Landscape Architecture*. RU: Open. 325-350.

Coleman, J.S. 1988. Social capital in the creation of human capital. *American Journal of Sociology* 94 (Supplement): S95-S120.

Cosgrove, D.E. 1998. *Social formation and symbolic landscape*. Univ of Wisconsin Press.

Crouzeilles, R., D. Maurenza, P.V. Prieto, F.S. Barros, C. Jakovac, M.S. Ferreira, M.R. Guariguata. 2021. Associations between socio-environmental factors and landscape-scale biodiversity recovery in naturally regenerating tropical and subtropical forests. *Conservation Letters* 14(2):e12768. DOI: https://doi.org/10.1111/conl.12768

Dacks, R., T. Ticktin, A. Mawyer, S. Caillon, J. Claudet, P. Fabre, S. Wongbusarakum. 2019. Developing biocultural indicators for resource management. *Conservation Science and Practice* 1(6):e38. DOI: https://doi.org/10.1111/csp2.38

Eoin, N.L., R. King. 2013. How to develop intangible heritage: the case of Metolong Dam, Lesotho. *World Archaeology* 45:653–669. DOI: http://dx.doi.org/10.1080/00438243.2013.823885

Escobar, A. 2001. Culture sits in places: reflections on globalism and subaltern strategies of localization. *Political Geography* 20(2):139–174.

Escobar, C. 2014. Community well-being in Bolivia: an indigenous perspective. In: Verschuuren, B., S.M., Subramanian, W. Hiemstra (Eds). *Community well-being in cultural landscapes*. Practical Action Publishing, Rugby, 42–57.

FAO-Food and Agriculture Organization. 1996. *Rome Declaration on World Food Security and World Food Summit Plan of Action*. Rome: FAO

Fazey, I., N. Pettorelli, J. Kenter, D. Wagatora, D. Schuett. 2011. Maladaptive trajectories of change in Makira, Solomon Islands. *Global Environmental Change* 21(4):1275-1289. DOI: http://dx. doi.org/10.1016/j.gloenvcha.2011.07.006

Fraser, E.D.G., A.J. Dougill, W. Mabee, M.S. Reed, P. McAlpine. 2006. Bottom up and top down: analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *J. Environmental Management* 78:114-127.

Frongillo, E.A. 1999. Validation of measures of food insecurity and hunger. *J Nutr* 129(2 S suppl): 506S-9S.

Frongillo, E., S. Nanama, W. Wolfe. 2004. *Technical guide to developing a direct, experience based measurement tool for household food insecurity*. Food and Nutrition Technical Assistance, Academy for Educational Development. Washington, D.C.

Galicia Gallardo, A.P., E. Ceccon, A. Castillo, C.E. González-Esquivel. 2021. Resisting socio-ecological vulnerability: agroecology and indigenous cooperativism in La Montaña, Guerrero, Mexico.

Agroecology and Sustainable Food Systems 45(1): 65-85. DOI:10.1080/21683565.2020.1793871

Galicia-Gallardo, A.P., E. Ceccon, A. Castillo, C.E. González-Esquivel. 2023. An integrated assessment of socioecological resilience in Me´Phaa indigenous communities in southern Mexico. *Human Ecology*. DOI: https://doi.org/10.1007/s10745-022-00382-w

Garnett, S.T., N.D. Burgess, J.E. Fa, Á. Fernández-Llamazares, Z. Molnár, C.J. Robinson, I. Leiper. 2018. A spatial overview of the global importance of Indigenous lands for conservation. *Nature Sustainability* 1(7):369-374. DOI: https://doi.org/10.1038/s41893-018-0100-6

Gavin, M.C., J. McCarter, A. Mead, F. Berkes, J.R. Stepp, D. Peterson, R. Tang. 2015. Defining biocultural approaches to conservation. *Trends in Ecology & Evolution*, 30(3):140-145. DOI: https://doi.org/10.1016/j.tree.2014.12.005

Golley, F.B. 1990. Love of the land. Editors comments. *Landscape Ecology* 4:8 I-82.

Hernández-Muciño, D., M. Borda-Niño, B. Santiago, R. Rodríguez, A. Rodríguez, M. Muciño, E. Ceccon. 2018. La comunidad Me ´Phaa construye su futuro: agroecología y restauración como herramienta del desarrollo sustentable. In: Merçon J., B. Ayala-Orozco, J.A. Rosell (Coords). Construyendo lo común desde las diferencias. Experiencias de colaboración transdisciplinaria para la sustentabilidad. CopIt-arXives Press.

Hiemstra, W., M. Suneetha, S. Verschuuren, B. Verschuuren. 2014. Exploring a new approach to well-being assessment. In: B. Verschuuren, M. Suneetha, S. Verschuuren (Eds). *Community Well-being in Biocultural Landscapes: Are we living well?* Practical Action Publishing. Warwickshire, UK.

IUCN. 1994. *Guidelines for protected area management categories*. IUCN.

Kareiva, P., S. Watts, R. McDonald, T. Boucher. 2007. Domesticated nature: shaping landscapes and ecosystems for human welfare. *Science* 316:1866–1869. DOI: http://www.jstor.com/stable/20036578

Leopold, C. 2004. Living with the land ethic. *BioScience* 54:149-154.

Lynch, J., M. Ross, T. Crowley. 2002. *The Oceanic languages*. Curzon Press, Richmond, UK.

Lockwood, M., W. Ashish, L. Kothari. 2006. *Managing protected areas: a global guide.* Earthscan/IUCN.

McCarter, J., E.J. Sterling, S.D. Jupiter, G.D. Cullman, S. Albert, M. Basi, E. Betley, D. Boseto, E.S. Bulehite, R. Harron, P.S. Holland, N. Horning, A. Hughes, N. Jino, C. Malone, S. Mauli, B. Pae, R. Papae, F. Rence, C.E. Filardi. 2018. Cultural approaches to developing well-being indicators in Solomon Islands. *Ecol. Soc.* 23(1):32. DOI: http://dx.doi.org/10.5751/ES-09867-230132

McShane, T.O., P.D. Hirsch, T.C. Trung, A.N. Songorwa, A. Kinzig, B. Monteferri, D. Mutekanga, H.V. Thang, J.L. Dammert, M. Pulgar-Vidal, M. Welch-Devine, J. Peter Brosius, P. Coppolillo, S. O´Connor. 2011. Hard choices: making trade-offs between biodiversity conservation and human well-being. *Biological Conservation* 144:966–972.

Méndez-Toribio, M., C. Martínez-Garza, E. Ceccon. 2021. Challenges during the execution, results, and monitoring phases of ecological restoration: Learning from a country-wide assessment. *PLOS ONE*. DOI: https://doi.org/10.1371/journal.pone.0249573

MEA-Millennium Ecosystem Assessment. 2005. *Ecosystems and human well-being*. Island Press, Washington, DC.

Muro, M., P. Jeffrey. 2008. A critical review of the theory and application of social learning in participatory natural resource management. *Journal Environmental Planning and Management* 51:325-344. DOI:https://doi.org/10.1080/09640560801977190

Musacchio, L.R. 2013. Cultivating deep care: integrating landscape ecological research into the cultural dimension of ecosystem services. *Landscape Ecology* 28:1025–1038. DOI: https://doi.org/10.1007/s10980-013-9907-8

Naveh, Z. 1990. Landscape ecology as a bridge between bioecology and human ecology. In: Svobodová, H. (Ed). *Cultural aspects of landscape*. Pudoc. Waseningen.

Naveh, Z. 1995. Interactions of landscapes and cultures. *Landscape and Urban Planning*, 32:43-54.

Oba, G., D.G. Kotile. 2001. Assessments of landscape level degradation in southern Ethiopia: pastoralists versus ecologists. *Land Degradation and Development* 12:461–475.

Pérez-Valladares, C.X., A.I. Moreno-Calles, J.F. Mas, A. Velázquez. 2022. Species distribution modeling as an approach to studying the processes of landscape domestication in central southern Mexico. *Landscape Ecology* 37: 461–476. DOI: https://doi.org/10.1007/s10980-021-01365-w

Piorr, H.P. 2003. Environmental policy, agri-environmental indicators and landscape indicators. *Agriculture, Ecosystems and Environment* 98(1–3):17-33.

Risser, P.G., J.R. Karr, R.T.T. Forman. 1984. *Landscape ecology: directions and approaches.* Illinois Natural History Survey Special Publ. 2. University of Illinois, Urbana.

Rodríguez-Castillo, D. 2013. *Modelar la concentración de la tierra en Colombia mediante modelos econométricos espaciales*. Subsecretaría de Información – SENPLADES. Bogotá.

Rössler, M. 2006. World heritage: linking nature and culture. In: UNESCO/IUCN. *Conserving cultural and biological diversity: the role of sacred natural sites and cultural landscapes*. Proceedings UNESCO/ IUCN International Symposium, United Nations University, Tokyo.

Salgado-Terrones, O, M. Borda-Niño, E. Ceccon. 2017. Fuelwood use and availability in "La Montaña" region in the state of Guerrero and their implications in the environmental unity. *Madera y Bosques* 23:121–35.

Satterfield, T., R. Gregory, S. Klain, M. Roberts, K.M. Chan. 2013. Culture, intangibles and metrics in environmental management. *Journal of Environmental Management* 117:103-114. DOI: http://dx.doi.org/10.1016/j.jenvman.2012.11.033

Sauer C.O. 2006. La morfología del paisaje. *Polis Revista de la Universidad Bolivariana* 5(15) [en línea]. Disponible en: https://journals.openedition.org/polis/5015 (verificado 20 de septiembre 2023).

Simensen, T., R. Halvorsen, L. Erikstad. 2018. Methods for landscape characterization and mapping: A systematic review. *Land Use Policy* 75:557–569. DOI:10.1016/j.landusepol.2018.04.022.

STATISTA. 2020. *Porcentaje de población indígena en países seleccionados de América Latina en 2020*. Disponible en: https://es.statista.com/estadisticas/1268541/latinoamerica-porcentaje-de-poblacion-de-origen-indigena/ (verificado 23 septiembre 2023).

Sterling, E.J., C. Filardi, A. Toomey, A. Sigouin, E. Betley, N. Gazit, S.D. Jupiter. 2017a. Biocultural approaches to well-being and sustainability indicators across scales. *Nature Ecology & Evolution* 1(12):1798-1806. DOI: https://doi.org/10.1038/s41559-017-0349-6

Sterling, E., T. Ticktin, T.K.K. Morgan, G. Cullman, D. Alvira, P. Andrade, A. Wali. 2017b. Culturally grounded indicators of resilience in social-ecological systems. *Environment and Society* 8(1):63-95. DOI: https://doi.org/10.3167/ares.2017.080104

Tylor, E.B. 1924. *Primitive culture: Researches into the development of mythology, philosophy, religion, language, art, and custom* (7th ed.). Brentano's. DOI: https://doi.org/10.1037/13484-000

UNDP. 2021. *Human Development Index (HDI)*. Disponible en: http://hdr.undp.org/en/content/human-development-index-hdi (verificado 22 de septiembre 2023)

UNESCO. 2001. *Indigenous people and parks. The Surin Islands project*. UNESCO Office of the Regional Advisor for Culture in Asia and the Pacific in collaboration with Chulalongkorn University Social Research Institute. Bangkok.

UNESCO. 2005. *Operational guidelines for the implementation of the World Heritage Convention.* UNESCO World Heritage Centre. Paris, France.

UNESCO. 2009. World Heritage Cultural Landscapes: a handbook for conservation and management. World Heritage Papers 26. UNESCO World Heritage Centre. Paris, France.

Vlami, V., I. Kokkoris, S. Zogaris, C. Cartalis, G. Kehayias, P. Dimopoulos. 2017. Cultural landscapes and attributes of "culturalness" in protected areas: an exploratory assessment in Greece. *Science of Total Environment* 1:229-243.

Verschuurenn B, S.M. Subramanian, W. Hiemstra (Eds). 2014. *Community well-being in cultural landscapes: Are we living well?* Practical Action Publishing,

Amazon Digital Services LLC. DOI: http://dx.doi.org/10.3362/9781780448374

Wiens, J.A., M.R. Moss, M.G. Turner, D.J. Mladenoff (Eds). 2007. *Foundation papers in landscape ecology*. Columbia University Press, New York.

Wu, J. 2010. Landscape of culture and culture of landscape: does landscape ecology need culture? *Landscape Ecology* 25:1147–1150. DOI: https://doi.org/10.1007/s10980-010-9524-8