Chapter 7
Indigenous and Local Knowledge Contributions to Social-Ecological Systems' Management

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7.1 Introduction

Social-ecological systems (SES) are complex and adaptive, for which their governance requires holistic understanding of the different components of the system and their relations, capacity to respond to change and uncertainty, and well-functioning institutional frameworks (Janssen & Ostrom, 2006). Indigenous and local knowledge (ILK) systems, or the sophisticated sets of ecological knowledge, management practices, and customary institutions generated by different Indigenous peoples and local communities (IPLC) with long histories of place-based living and time-honored traditions, often entail these characteristics (Berkes, 2017). ILK systems have traditionally guided many social-ecological interactions, resulting in the maintenance of the integrity of many aquatic and terrestrial ecosystems (Cámara-Leret et al., 2019; Kimmerer, 2000). Given that many of the lands and waters that IPLC own or manage are critical for biodiversity conservation and climate change mitigation (Ens et al., 2016; Fa et al., 2020; Porter-Bolland et al., 2012), analyzing how ILK contributes to the governance of complex SES could help in achieving planetary sustainability.

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Indigenous and local knowledge systems use a variety of languages to express multiple and complex values of nature, providing a good example of the need for multi-criteria evaluation proposed by the Barcelona School of Ecological Economics and Political Ecology (Munda, 2008). Many ILK systems capture and reflex human dependence on the interconnected web of life (e.g., Lyver et al., 2017; Reo, 2019). In many of such conceptualizations, humans are viewed as an integral component of nature (Coscieme et al., 2020), and nature is imbued with social, cultural, and spiritual values (Berkes, 2017). Moreover, IPLC conceptualizations of nature often draw on stewardship ethics based on mutual reciprocity between humans and nature, temporary custody for future generations, and health of and attachment to land (Pascual et al., 2017; Reo, 2019). These conceptualizations, which are dynamic and adapt to changes (McMillen et al., 2017), form the basis for land and seascape management (e.g., Joa et al., 2018). Indeed, the defense of the value systems that underpin such conceptualizations has resulted in a myriad of environmental conflicts, particularly when activities based in other valuation systems (e.g., extractive activities with a purely monetary valuation) are imposed on areas managed by IPLC (Scheidel et al., 2020).

In this chapter, I draw on published research to summarize how ILK (1) draws on conceptualizations of nature that contribute to the long-term maintenance of functioning SES, (2) enhances our understanding of complex SES, and (3) articulates resistance to SES degradation and promotes SES restoration. The chapter concludes elaborating on why, although IPLC contributions to complex SES management are growingly recognized, such contributions will not be fully realized unless IPLC are fully acknowledged as equal partners at different levels of environmental governance, as proposed by the post-normal science approach adopted by the Barcelona School of Ecological Economics and Political Ecology.

7.2 Conceptualizations of Nature Embedded in ILK Systems Contribute to Long-Term Maintenance of Complex SES

While acknowledging diversity, many examples show that IPLC conceptualizations of social-ecological relations often build on concepts such as attachment to land, interests in restoration, a powerful stewardship ethics, reciprocity between humans and nature, relational webs – including kinship – with natural elements, and continuity between nature and culture (Díaz et al., 2015; Sterling et al., 2017). These conceptualizations are embedded in customary management practices, such as the protection of sacred forests and fresh or seawater areas or species or taboo enforcement, but also on selective cutting and burning or other biodiversity-enriching small-scale disturbances (Forest Peoples Programm et al., 2016; Guadilla-Sáez et al., 2019; Joa et al., 2018). Such customary management practices extend to the management of coastal ecosystems, including wetlands, mangroves, and seaweed and seagrass beds (Cinner & Aswani, 2007), and of areas particularly sensible to climate change, such as the Arctic (Johnson et al., 2015).

Many examples show that ILK-based SES management arrangements (e.g., traditional agriculture, aquaculture, fishery, and community forestry) contribute to biodiversity maintenance in production landscapes (Chaudhary et al., 2016), ecosystem restoration (Reyes-García et al., 2019a, b), pollution buffering (Fernández-Llamazares et al., 2020), and nutrient cycling (Malley et al., 2016). Examples of these practices include purposive burning to create diversity (Shaffer, 2010; Trauernicht et al., 2015), waste deposition practices resulting in soil carbon enrichment (Solomon et al., 2016), swidden cultivation systems able to maintain forest cover and plant diversity (Takasaki et al., 2022; Wangpakapattanawong et al., 2010), or weeding meadows to maintain grassland productivity and resilience (Babai & Molnár, 2014). Indeed, as a result of the application of these management systems, much of today's world's wild and domesticated biodiversity lies in areas traditionally owned, managed, used, and/or occupied by IPLC (Brondizio & Le Tourneau, 2016; Garnett et al., 2018). Moreover, despite increasing pressures from the expansion of commodity frontiers and resource extraction, biodiversity is declining less rapidly in land and seascapes owned or managed by IPLC than in other ecosystems (IPBES, 2019).

Despite IPLC contributions to the maintenance of global biodiversity, IPLC are often excluded for environmental governance and customary management practices are disappearing (Forest Peoples Programm et al., 2016; Witter et al., 2015). For instance, while more than 40% of government-protected areas overlap with IPLC lands, less than 1% of protected areas are formally governed by IPLC (Garnett et al., 2018). Moreover, in many areas, agricultural expansion, logging, or conservation activities limit or replace customary management practices (Hayes, 2010), with recent proposals to safeguard 30% (Dinerstein et al., 2019) or 50% (Wilson, 2016) of the planet from human use. Researchers have documented that the loss of traditional management systems affects the functionality and stability of the SES previously managed under such rules through landscape homogenization, the increase of invasive species presence, pollution, urbanization, or soil erosion (Fletcher et al., 2020; Fernández-Llamazares et al., 2020; Guadilla-Sáez et al., 2019). This, in turn, has cascading effects on other elements of the SES including reduced abundance and access to culturally valued resources (e.g., food) (Garibaldi, 2009; Kuhnlein, 2014) and deterioration of traditional governance systems and institutions (Oldekop et al., 2012; Sirén, 2017). The erosion of traditional management practices also weakens local conceptualizations of nature (Stocker et al., 2016; Turner et al., 2008), impacting relations with and responsibilities to other-than-human-beings and forces (e.g., Fernández-Llamazares & Virtanen, 2020).

7.3 ILK Enhances Our Understanding of Complex SES

Beyond the actual management of SES, ILK systems encode key information essential for our understanding of complex SES. Thus, ILK systems have been crucial to further scientific understanding of species ecological distribution ranges

(Wilder et al., 2016) and historical population baselines and trends (Bender et al., 2013; Ziembicki et al., 2013), particularly in biologically diverse but little studied regions of the world. For example, ILK has contributed to fisheries science through mapping spawning grounds, understanding seascapes' use and ecology, and documenting fisheries' long-term trends (Lavides et al., 2016; Tesfamichael et al., 2014). In a way, the contributions of ILK systems to the generation of actionable knowledge for sustainability exemplifies the potential of the post-normal science approach for the management of complex issues (Funtowicz & Ravetz, 1993). According to the post-normal science framework which has guided much of the research of the Barcelona School of Ecological Economics and Political Ecology, when facts are uncertain, values in dispute, stakes high, and decisions urgent – as is the case of environmental management – the normal scientific approach is insufficient and new norms of evidence and discourse need to be developed.

In that sense, over the years, ILK systems have contributed not only to provide an enriched picture of biodiversity functioning, but ILK systems have also aid in efforts to sustain nature (Tengö et al., 2014; Wilder et al., 2016). For example, around the world, different place-based, historical land-use practices have been used along with biological data to create more effective national plans to protect biodiversity while supporting local livelihood activities (Diamond & Ansharyani, 2018). Similarly, new knowledge co-produced by scientists and IPLC referring to carbon stocks assessment (Butt et al., 2015), wildlife monitoring (Luzar et al., 2011; Takasaki et al., 2022), or participatory mapping (Herlihy, 2003) has resulted in the development of adaptation strategies to highly variable social-ecological conditions. Moreover, ILK has also contributed to map, monitor, and report changes in SES, including the dynamics of agricultural systems (Coomes et al., 2015), resource over-exploitation (Forest Peoples Programm et al., 2016), invasive species expansion (Bart & Simon, 2013), climate change impacts (Reyes-García et al., 2019a, b), and pollution (Fernández-Llamazares et al., 2020; Orta-Martínez et al., 2007). For example, through a community-based monitoring program which started in 2006 and which builds on their detailed knowledge of the environment, Achuar and Quechua Indigenous Peoples of the Peruvian Amazon have been able to monitor, map and report oil spills impacts on soils, water, wildlife, and their own health (Cartró-Sabaté, 2018; Rosell-Melé et al., 2018; Yusta-García et al., 2017). Their knowledge has uncovered impacts that oil companies had never reported (e.g., concealed oil spills, illegal operations; Orta-Martínez & Finer, 2010), as well as animal geophagia of polluted soils, a behavior unknown to scientists (Cartró-Sabaté, 2018).

7.4 ILK Articulates Resistance to SES Degradation and SES Restoration

IPLC's understandings of the interconnections in nature and of human dependence of the interconnected web of life are at the bases of many environmental conflicts through which Indigenous peoples aim to protect their territories from extractive

and industrial development pressures (Scheidel et al., in press; Benyei et al., 2022). Drawing on their understanding of SES functioning and the changes such systems can endure, IPLC have been proactive in implementing innovative strategies to prevent, limit, or stop activities that potentially led to SES degradation (Fernández-Llamazares et al., 2020; Martinez-Alier et al., 2016), sometimes even facing violence for defending the land and resources (Scheidel et al., 2020). Thus, IPLC, through the world, have resisted mining operations, hydrocarbon exploration, infrastructure development, and toxic waste dumping (Martinez-Alier et al., 2016; Orta-Martínez & Finer, 2010; Reyes-García et al., 2020). Some of these actions have been preventive, such as the fight of the Dongria Kondh against bauxite mining in their sacred homelands in India, in which IPLC used their understanding of SES functioning to raise opposition before the activity started to operate (Temper & Martinez-Alier, 2013).

ILK is also at the basis of IPLC activities to restore lands and waters after these areas have been overexploited or degraded by extractive activities (Reyes-García et al., 2019a, b). For instance, some restoration efforts have used insights from local knowledge systems to identify what species to use and which sites to focus on in restoration efforts. ILK can provide baseline ecosystem information on cultural keystone species, i.e., culturally salient species that shape people's identity (Garibaldi & Turner, 2004; Reyes-García et al., 2023), or cultural keystone places, i.e., particular places that are critically important for the flow of ecosystem service and to people's lifeways (Cuerrier et al., 2015). For example, traditional fire management practices have been used to restore overgrown broad-crowned black oak tree stands in California (Long et al., 2003), and in Nepal many local communities contribute to safeguard and restore communal forests and watersheds, thus slowing deforestation, after the Nepali state devolved forests into community control in the 1970s (Paudyal et al., 2015). In some cases, restoration efforts have resulted in a change in the local political context, creating a space for Indigenous spiritual and cultural values to be further reflected in their participation in restoration efforts (Fox et al., 2017).

7.5 Conclusion

Around the world, a myriad of Indigenous and local knowledge systems have achieved the long-term management of functioning ecosystems, informed scientific efforts to maintain ecosystems, and prevented further SES degradation. And, nevertheless, the critical role of IPLC in SES management is not fully recognized in most conservation research, policy, and practice. This is so to the extent that IPLC continue to face challenges of representation in international climate and biodiversity conservation policy processes (Forest Peoples Programm et al., 2016; Witter et al., 2015) and, in some regions of the world, pressures and violence against them are growing (Scheidel et al., 2020). Moreover, ILK systems are globally eroding due to the negative impact of globalization, colonialism, and environmental change (Aswani et al., 2018; Fernández-Llamazares et al., 2021), which endangers not only the very foundations of IPLC' ways of life but also planetary sustainability.

The post-normal science approach proposed by the Barcelona School of Ecological Economics offers principles to bring IPLC to environmental governance. The approach proposes that different groups of interests (beyond scientists) can provide legitimate inputs to the co-production of knowledge for issues affecting them, for which it is first necessary to create the conditions to identify, involve, and engage the relevant communities (Funtowicz & Ravetz, 1993). Drawing in these insights, conservation institutions and governance systems could better reflect ILK contributions and IPLCs crucial roles and rights in planetary sustainability in two complementary ways. On the one side, strengthening frameworks that bridge scientific and Indigenous and local knowledge systems, ensuring collaborative and equitable relations between scientists and IPLC. Such frameworks are vital to the effective co-production of knowledge that enhances conservation strategies, sustainable resource policy and management, and the well-functioning of SES (Tengö et al., 2017; Orlove et al., Accepted). On the other side, these institutions should involve IPLC as partners in governance by promoting inclusive measures that substantially increase the sustainability of land-use practices and the effectiveness of protection (Brooks et al., 2012; Ens et al., 2016). Such measures include safeguarding IPLC knowledge ownership, supporting territorial rights, protecting threatened land defenders, respecting Indigenous laws and principles, and promoting customary management practices.

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