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Protected area tourism and management as a social-ecological complex adaptive system

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This article presents a mini review of systems and resilience approaches to tourism analysis and to protected area management, and of how the Social-Ecological Complex Adaptive Systems (SECAS) framework can help link them together. SECAS is a unique framework that integrates social theories (structuration) and ecological theories (hierarchical patch dynamics) and examines inputs, outputs, and feedback across a variety of hierarchically nested social and ecological systems. After an introduction to the need for continued theoretical development, this article continues with a review of the origins and previous applications of the SECAS framework. I subsequently highlight how complex adaptive systems and resilience have been presented in the literature as a way to separately study (1) protected area management, (2) protected area tourism/ecotourism, and (3) land-use change in adjacent forest and agricultural landscapes. The purpose of this article is to build on the frameworks described in this literature and link them through the SECAS framework. I populate the SECAS framework with components identified in the literature on protected area management, ecotourism, and land-use change to present an example of a full systems perspective. Each component also represents a hierarchically nested system, such as a governance system, health system, or transportation system. I conclude with a three-step (5-part) multi-scale and temporal method for SECAS research derived from hierarchy and structuration theories.

KEYWORDS

system, protected areas, tourism, complex, adaptive

Introduction

In their review of the connections between ecotourism and conservation, Stronza et al. (2019) identify a number of research elements that are frequently missing; sometimes these are conducted independently, but it is necessary to conduct them together for rigorous evaluation. These elements include: (1) gathering longitudinal data (Zambrano et al., 2010; Hunt et al., 2015), (2) addressing issues of scale (Hunt and Stronza, 2009), (3) studying community outcomes beyond economic impacts (Lupoli et al., 2015), (4) participatory evaluation (Castro-Arce et al., 2019), and (5) addressing the larger social context driving land-use change and deforestation (Geist and Lambin, 2002). Special issues on systems and resilience approaches to protected area management (Cumming et al., 2015; Cumming and Allen, 2017) and nature-based tourism (Morse et al., 2022a) and the articles therein (i.e., Maciejewski and Cumming, 2016; Arlinghaus et al., 2022) have advocated for the further development of social-ecological systems (SESs) and resilience frameworks, and for research that explicitly considers hierarchical dynamics and feedback loops and incorporates

analysis that considers protected areas and surrounding landscapes where tourism and conservation occur. This article builds on these frameworks and links the bodies of literature on tourism, protected areas, and landscape change through a Social-Ecological Complex Adaptive Systems (SECAS) framework.

The SECAS framework was originally developed to enable an interdisciplinary team to assess the social and ecological impacts of Costa Rica's Payments for Ecosystem Services (PES) program (Morse, 2007; Morse et al., 2009, 2013). Ecosystem services are the benefits that people receive from ecosystems, including production (e.g., food, fiber, and timber), regulation (e.g., carbon sequestration and water purification), and cultural services (e.g., aesthetics, tourism, and spiritual services; MEA, 2005). In 1996, Costa Rica passed a Forestry Law (no. 7575) that prohibited converting natural forests to other land uses and established one of the first programs that paid landowners directly for providing several environmental services, including watershed protection, biodiversity conservation, carbon sequestration, and aesthetic values (Morse et al., 2009). Costa Rica targeted the PES program toward a system of biological corridors that linked national parks and other conservation areas. These corridors generally consisted of areas with high forest cover and agricultural land use that were privately owned but located in poorly developed areas of the country. The PES program was designed to enhance conservation and improve local household and community livelihoods in the regions outside of protected areas. Our team research was conducted in the San Juan–La Selva Biological Corridor in northern Costa Rica, where some of the highest concentrations of private forests mixed with agricultural lands connect the highlands of the central volcanic range, including Braulio Carrillo National Park, Volcan Poas National Park, Juan Castro Blanco National Park, and several forest reserves through lowland areas to the Indio Maiz Biological Reserve in Nicaragua along the San Juan River (Morse et al., 2009). A framework was needed to organize our project, which examined how a social conservation policy (PES) could influence landowners' decisions on land use (to reforest pasture or maintain natural forest on their farm), which would then change the land cover (farm by farm) across the landscape over time to have an impact on the desired ecosystem services (Morse et al., 2013). The framework was clearly required to incorporate social and ecological system factors and hierarchical multi-scale considerations (policy-to-household and farm-to-landscape) that changed over time. We needed a SECAS framework.

The initial development of the complex adaptive system (CAS) concept came from ecology (Holling, 1973; Hartvigsen et al., 1998; Levin, 1999; Gunderson and Holling, 2002). CASs are characterized as dynamic, unpredictable, non-linear, multi-scale systems with multiple interacting components, and a lack of central control (Berkes et al., 2003; Norberg and Cumming, 2008). A CAS is defined by the presence of a network of interactions and relationships among the multiple components (Meadows, 2008; Preiser et al., 2018). CASs adapt over time through recursive interactions and feedback between components, and between components and their environment, leading to emergent or novel patterns (Levin, 1998; Walker et al., 2004). CASs are open systems, and dynamic interactions occur across multiple scales, allowing them to self-organize, often into nested hierarchies (Folke et al., 2005). CASs are considered to be non-linear, meaning that cause and effect are not always proportional, and small changes can lead to bigger impacts (or vice versa) on other components or on the whole system (Levin et al., 2013). Interactions can take the form of slow or fast variables and can occur across spatial scales (Gunderson and Holling, 2002). Non-linearity leads to complexity, unpredictability, and uncertainty within and about the system (Walker et al., 2006). The term *adaptive* indicates that a CAS can change, evolve, and self-organize over time in response to feedback (Preiser et al., 2018). Similar to ecological systems, social systems have multiple interacting components across multiple scales, are dynamic, and change over time (Berkes et al., 2003). SESs are considered to be inextricably linked, and together, these systems are considered to be CASs (Gunderson and Holling, 2002; Berkes et al., 2003; Folke, 2006; Norberg and Cumming, 2008; Preiser et al., 2018). The concept of resilience is a way to frame SECAS that explicitly recognizes uncertainty, complexity, and change (Walker et al., 2006). *Resilience* has been defined as the capacity of a system to absorb disturbance and maintain the same identity or the same function, structure, and feedbacks (Walker et al., 2006). Resilience also describes the degree to which a system can self-organize and its ability to build its capacity to adapt or learn (Carpenter et al., 2001). Resilience has become a goal in managing CASs (Lew et al., 2016).

Managing protected areas and tourism as complex adaptive systems

Social-ecological systems, complex adaptive systems, and resilience have been promoted as frameworks for research on and management of protected areas and for tourism based in protected areas (McKercher, 1999; Farrell and Twining-Ward, 2004; McCool et al., 2013; Cumming et al., 2015; McCool and Bosak, 2016; Bosak, 2019). To address biodiversity conservation and protected area management, Cumming et al. (2015) proposed a framework to capture the multi-scale SESs that extend beyond the boundaries of protected areas into the "functional landscapes" (nearby forests, farms, and communities) necessary for conservation and support of the protected area. The authors build on Ostrom (2009) SES framework and address some of the concerns for application by adding five hierarchical levels (patch, protected area, protected area network, national, and international/global) and highlighting temporal dynamics and cross-scale interactions (Cumming et al., 2015). Research from an ecosystem conservation perspective expands the interests in protected area management beyond the administrative boundaries of the area into human-dominated landscapes, as linked SESs focus on cross-scale feedback (Maciejewski and Cumming, 2016), ecological solidarity (Mathevet et al., 2016), and resilience (Cumming and Allen, 2017).

In a seminal article reconceptualizing theoretical frameworks in tourism, Farrell and Twining-Ward (2004) specifically identify the need to fully consider SESs and frame research around the process, transition, or journey of dynamic complex adaptive systems. The authors draw parallels from CASs in ecology with tourism systems, introduce the concept of resilience, and develop their own Complex Adaptive Tourism Systems (CATS) model to address tourism systems more comprehensively (Farrell and Twining-Ward, 2004).

Strickland-Munro et al. (2010) also assesses protected area tourism and local community interactions as multi-scale embedded CASs with two case studies in national parks in South Africa and Australia. Following others, the author emphasizes the importance of resilience thinking (Walker et al., 2006) in understanding continually adapting tourism systems (Plummer and Fennell, 2009). Strickland-Munro et al. (2010) develops a four-step model for research that includes (1) system definition, (2) past system change, (3) current system state, and (4) monitoring of change. Lew (2014) and Lew et al. (2016) emphasize the importance of spatial scale and of an understanding of fast and slow variables; they also emphasize how a resilience perspective will help in placing focus on adaptive management within ever-changing tourism CASs. McCool et al. (2013, 2015) and McCool and Bosak (2016) argue that framing protected area management and tourism research from a systems perspective (employing the frameworks of SES, CAS, and resilience) is essential in order to counter past reductionist perspectives and provide managers with meaningful leverage points to target resilience-building in these systems. These articles also discuss the difficulties involved and the need to work with the public and use systems frameworks to make sense of dynamic and complex contexts (McCool et al., 2013), address the challenges of systems work (McCool, 2022), and identify bridges and barriers to conducting interdisciplinary research (Morse et al., 2007). McCool et al. (2015) provide a set of six "complexity practices" to help frame CASs and manage them toward resilience, namely, (1) building situational awareness, (2) investing in personal relationships, (3) appreciating the power of networks, (4) identifying and using leverage points, (5) employing different forms of knowledge, and (6) learning continuously.

The social-ecological complex adaptive systems framework

The Social-Ecological Complex Adaptive Systems (SECAS) framework was designed based on the fundamental principles of the CAS framework (Gunderson and Holling, 2002; Berkes et al., 2003; Levin, 2005). It was designed to be multi-scale and to integrate across dynamic and non-linear social and ecological systems, with inputs and outcomes across scales and systems (Morse et al., 2013). Visually and conceptually, the framework was based on research by Grimm et al. (2000) on change in land use and land cover, and on research by Ostrom (2007) on linked SESs.

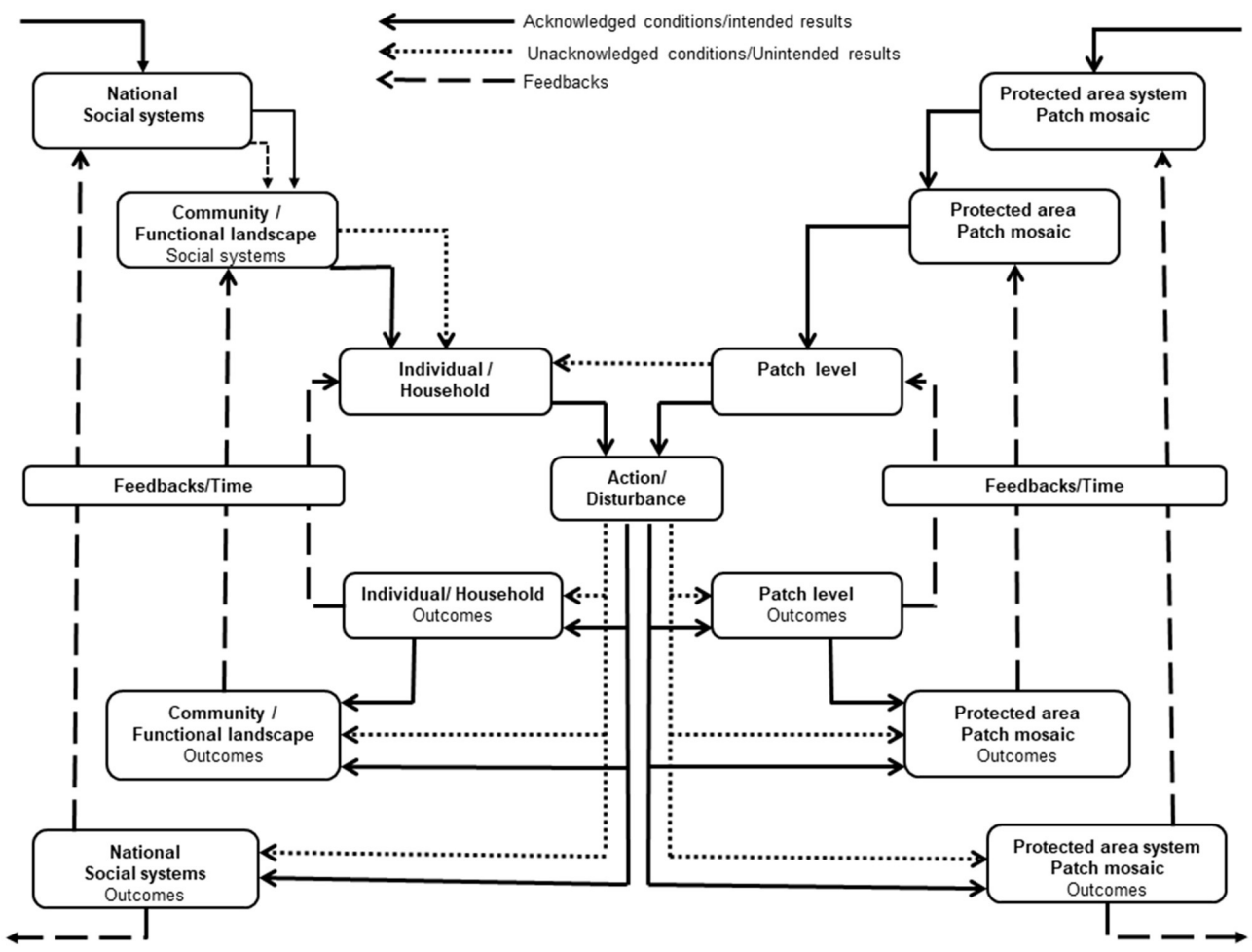

FIGURE 1
Base SECAS model.

Theoretically, our research group used structuration theory from the social sciences to explain social CASs (Giddens, 1984; Stones, 2005), because humans can and do act with foresight and intent, meaning that social and ecological systems are fundamentally different in terms of the drivers of self-organization (Walker et al., 2006). Structuration theory had been identified by others as suitable for linking social and ecological systems (Bebbington, 1999; Scoones, 1999; Scheffer et al., 2002; Westley et al., 2002), and we elaborated on and updated their contributions to include revisions to structuration theory made by Stones (2005). "A defining characteristic of structuration theory is that through recursive social practice or action, social systems (structures) influence the activity of individuals, who in turn, produce, transform, or otherwise reaffirm those same structures constantly producing and reproducing society" (Morse et al., 2013. p. 58). We retain the descriptors "social" and "ecological" (SE) in front of "CAS" in order to highlight the differences in terms of drivers of self-organization. On the ecological side of the SECAS framework, we applied the theory of hierarchical patch dynamics (HPD), where each patch (farm) is nested in a dynamic patch mosaic (landscape), which is again nested in a higher-level patch mosaic (at the national level; Pickett and White, 1985; Wu and Loucks, 1995; Morse et al., 2013).

A base SECAS model that demonstrates the linking of social and ecological systems across scales is presented in Figure 1. The left-hand side of the model represents hierarchically nested social systems, and the right-hand side represents ecological systems in terms of nested patch mosaics. The top of the model illustrates the inputs to an action, and the bottom half represents the outcomes of that action. Actions are modeled as having outcomes that impact both systems and all levels simultaneously, as each is a nested part of the other. In the CAS framework, our knowledge of external social and ecological systems is seen as incomplete, and the outcomes of our actions may be intended or unintended (Morse et al., 2013).

Since the inception of the SECAS framework (Morse, 2007), I have collaborated with others to place existing recreation models into a systems perspective and to integrate them with a cultural recreation ecosystem services perspective (Morse et al., 2022b). McCool et al. (2013) recognize that many of the tools used to manage outdoor recreation are linear and reductionist and do not take a systems approach. The SECAS model has been applied to outline how a number of these recreation tools and constructs, such as the recreation experience model, beneficial outcomes, the recreation opportunity spectrum, limits of acceptable change, and constraints theory, could all be framed together into a unified systems perspective (Morse, 2020). A second application of the SECAS model to recreation is in examining how the field of outdoor recreation research and the concept of recreation ecosystem services could be better integrated (Morse et al., 2022b). This work has further integrated components of recreation management into the SECAS framework, extended the framework to consider outdoor recreation and the corresponding tools and theory as they apply to nature tourism, and added protected area and protected

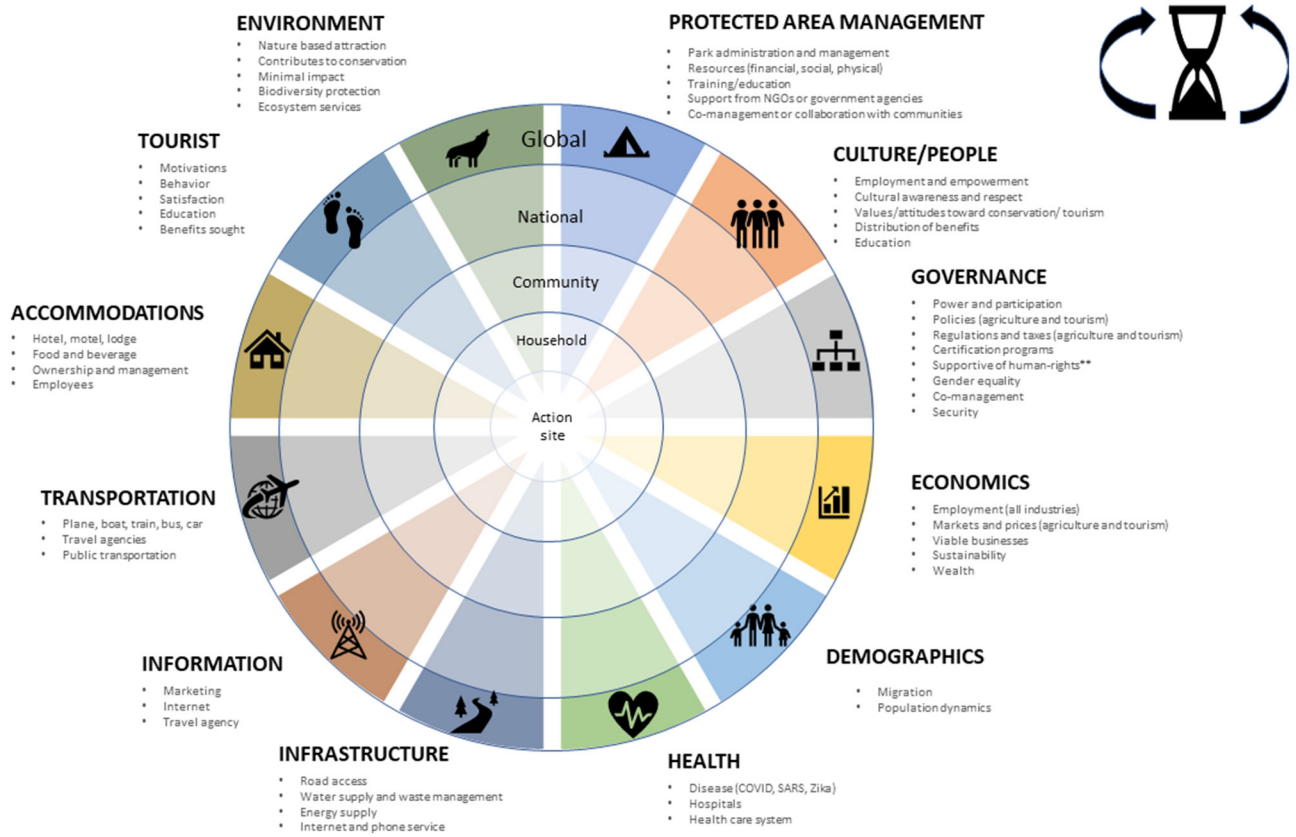

FIGURE 2
Major tourism and protected area component categories.

area management as a third dimension. Furthermore, the article presents the idea of transformation at the center of the recreation experience to highlight the experiential and dynamic nature (as a process or journey) of outdoor recreation and nature tourism (Morse et al., 2022b). While this last application of the SECAS framework does address protected areas and their management, it still considers the entirety of the tourism system in individual boxes on the social side of the model. The current article conceptualizes the tourism system in accordance with the literature on tourism systems and protected area systems, and integrates this with a meta analysis of the drivers of land-use and land-cover change to further frame the ways in which the landscape changes around a protected area with tourism.

SECAS for protected area management and nature tourism

Once the general model is understood, it must be populated with variables that are important to the relevant research questions across scales and systems. If i want to understand the interactions between tourism, conservation, protected area management, and the environment as a SECAS, i need to understand the drivers of agriculture and forest management in the functional landscapes outside of protected areas, how the tourism system impacts local communities and protected areas, and even how the tourist navigates the system through components of the traditional tourism industry. I began by identifying and consolidating the major subsystems identified in the literature on land use and land cover outside protected areas (Geist and Lambin, 2002), items mentioned as critical for ecotourism as a form of tourism closely associated with protected areas (Honey, 2008; Fennell, 2020), and items mentioned in the protected area and tourism CAS literature that was reviewed. The major change to the SECAS model is to move beyond generic two-dimensional representations of social and ecological systems and identify the many other social systems that are important for conservation and tourism around a protected area. I identified 12 major component categories of social systems from the literature (others could be included); these are presented in Figure 2.

Each social subsystem could be modeled as a nested hierarchy with inputs and outcomes, as in the current SECAS framework (all subsystems could make up their own hierarchically nested "side" of the original framework). With all the subsystems included together, the model would be visualized as a sphere with a funnel or hourglass through the middle. For example, park management is its own hierarchically nested social system, from the management of an individual setting (patch), to an individual park, to the park system across a country, to its implications at the global level (Morse et al., 2022b). Governance systems are frequently hierarchically nested. Similarly, tourism accommodations are a hierarchically nested social system with different types and amounts offered at different scales. Ecological systems could similarly be expanded to address watersheds, habitats, and biodiversity as hierarchically nested systems. The side-by-side stepped framework captures the dynamic system with inputs, outcomes, and feedback pathways in two dimensions, while the 12-piece pie chart shows all the different subsystems and how they come together across scales. This view from the top (Figure 2) can be imagined as an open hourglass, seen from above: the center is where all the different variables come together to form a tourism experience and where the sand flows down to the next level to produce outcomes for all the different systems. Feedback loops refill the top half with sand, enabling the process to continue recursively, as tourism, park management, and conservation are part of a continually updated SECAS (input, action, outcome, and feedback).

How to study the SECAS

Where in the system, or what scale, you want to focus your analysis is dependent on the research question at issue. HPD (Wu and Loucks, 1995) has a multi-scale analysis protocol of "enveloping," while structuration theory (Giddens, 1984; Stones, 2005) has "methodological bracketing." Both approaches indicate that multiple levels of analysis are needed to understand a CAS, including the external environment, which provides the conditions for any action/disturbance, and the mechanism that describes how and why things happen at a lower level. Stones (2005) developed methods for analysis of actors' conduct and for context analysis from Giddens's (1984) methodological brackets, and these approaches help in representing the steps for analysis that we outline below. These steps address items from the four-step model of Strickland-Munro et al. (2010) and the six "complexity practices" proposed by McCool et al. (2015). These steps extend these previous models by adding temporal analysis (historical and future), a purposefully scaled analysis, and multiple viewpoints. The steps also address each of the five components that were identified as lacking in rigorous studies on tourism and conservation systems by Stronza et al. (2019). The steps can be used for both social and ecological systems analysis.

Step 1. Context analysis

The context analysis is designed to examine enabling and constraining conditions of the external context for actions (Stones, 2005). This step helps to define the system. Context analysis should be derived from both the researchers' perspectives (from the outside looking in) and the actors' perspectives (from the inside looking out; Stones, 2005).

Past system change: the researcher's historical perspective

To understand how systems change (a slower process) and the influence of feedback over time, a more historical perspective is needed. Examination of the "intermediate temporality" would allow reflection on how social systems enabled or constrained or reacted to different actors' actions (Stones, 2005). This can be done through literature reviews, policy analysis, and other external

analyses. Similar historical analysis can be done for land use change, biodiversity trends, and other ecological assessments.

Building situational awareness

It is also important to obtain multiple perspectives of the current situation at the systems level. For example, interviews, focus groups, and group mapping exercises with government agricultural agencies, non-governmental conservation organizations, and protected area managers can provide new insight as to the specific social systems variables (i.e., policies, markets, and land tenure) that are influencing the system (Morse et al., 2013). This level of analysis helps to build personal relationships and understand power relations and social networks (McCool et al., 2015). Parallel analyses with many of these same groups can explore environmental issues in that local context identifying underlying and proximate drivers, feedback, and change.

The actors' perspective

It is critical to conduct interviews, surveys, and discussions with individual actors or local groups (e.g., landowners, tourism lodge operators, tourism employees, and community committees) about what they believe are the external enabling and constraining conditions (e.g., policies, markets, and land tenure) that are influencing their decisions (Morse et al., 2013). This is the perspective of the actor looking out at the system. For example, Lupoli et al. (2015) developed a rapid assessment tool to capture local community desires regarding volunteer tourism in their community. This process will also help to build personnel relationships, assess the network of actors, provide an understanding of the relevant power relationships and social norms, and begin to identify leverage points (McCool et al., 2015). An understanding of local or traditional ecological knowledge for both farm and landscape management and conservation can be obtained in this phase.

Step 2. Conduct analysis: the actors' perspectives on why they take action

A conduct analysis is an assessment of the knowledgeability, motivations, capabilities, and desires of the actors themselves (landowners, park managers, ecolodge operators, etc.) and how these are translated into action (Stones, 2005). The environmental parallel here is the ecological beliefs and perceptions of ecological outcomes that lead to actors' actions. A protected area manager will be able to explain why they took particular land management actions, and a landowner will likely be able to present the environmental benefits (food production, timber harvest, and so on) and costs (erosion, loss of biodiversity in habitats) that their actions might cause. This is a critical step in identifying leverage points, or those places in a system where intervention might have the greatest impact toward the development of more resilient systems (Berkes et al., 2003).

Step 3. Monitoring change and learning continuously

Understanding the system, developing networks, and identifying leverage points will help with identifying and understanding the relationships among the variables in the system, but understanding the system is only the beginning. A SECAS is characterized by feedback, non-linearity, and uncertainty, indicating that any single assessment at any given time will only provide part of the picture. Adaptive management is a form of continuous learning that can inform management toward the building of more resilience in the target systems, and the steps described above will inform managers of the networks involved and develop the linkages and networks that can facilitate communication and interventions (Plummer and Fennell, 2009). In the same way that one must look back to understand context, long-term monitoring and an adaptive management approach are needed.

Conclusion

Case studies often "[treat] tourism as a separate enclave from its larger social and environmental system, which is anathema to the complex systems approach of resilience" (Lew, 2014, p. 14). To examine protected area management, landscape conservation, and tourism, we need a framework that can capture the entirety of these dynamic and evolving systems, including inputs, actions, outcomes, and feedback. This article has presented the SECAS framework as an organizational concept that can help in framing the multiple systems and subsystems that can drive change and resilience. The major components of the systems of protected area tourism and conservation have been highlighted, along with steps that can help in identification of the specific elements in the systems that can be used to leverage resilience. I hope that the SECAS framework and this article can be used as a springboard for applied analysis and a baseline for further theoretical development.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

WM declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

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