



FOUR CHALLENGES OF LONG-TERM SOCIO-ECOLOGICAL RESEARCH IN BRAZIL

José Gilmar Cavalcante de Oliveira Júnior^{1,2}, Norah Costa Gamarra², Felipe Alexandre da Silva Vieira², Inaê Farias Vieira Dantas², Evelynne Letícia dos Santos Farias Cardoso de Barros², Mikaella Roberta dos Santos-Silva², Ana Paula de Oliveira Santos², Johnny Antônio da Silva Lima², Nidia Noemi Fabrê³, Vandick da Silva Batista¹, Ana Claudia Mendes Malhado², Chiara Bragagnolo², Richard James Ladle² & João Vitor Campos-Silva^{2,4}*

¹ Universidade Federal de Alagoas, Instituto de Biologia e Ciências da Saúde, Laboratório de Gestão e Conservação da Pesca, Av. Lourival Melo Mota - Tabuleiro do Martins, CEP: 57072-900, Maceió, AL, Brazil.

² Universidade Federal de Alagoas, Instituto de Biologia e Ciências da Saúde, Laboratório de Conservação do Século 21, Av. Lourival Melo Mota - Tabuleiro do Martins, CEP: 57072-900, Maceió, AL, Brazil.

³ Universidade Federal de Alagoas, Instituto de Biologia e Ciências da Saúde, Laboratório de Ecologia, Peixes e Pesca, Av. Lourival Melo Mota - Tabuleiro do Martins, CEP: 57072-900, Maceió, AL, Brazil.

⁴ Norwegian University of Life Sciences, Faculty of Environmental Sciences and Natural Resource Management, Ås, 1432, Norway.

E-mails: gilmaroliveirajunior@gmail.com (*corresponding author); norahgamarra@gmail.com; felipealexandresv@gmail.com; vieirainae@gmail.com; evelynecdebarros@gmail.com; mikaellaroberta15@hotmail.com; ana.pesca@yahoo.com.br; johnnyasilima@hotmail.com; nidia.fabrê59@gmail.com; vandickbatista@gmail.com; anaclaudiamalhado@gmail.com; chiara.bragagnolo@yahoo.com.br; richardjamesladle@gmail.com; jvpiedade@gmail.com.

Abstract: Long Term Ecological Research (LTER) aims to monitor natural ecological processes that operate over longer time periods than are typically permitted by standard research grants (e.g. species life cycles, natural resource dynamics, and the ecological effects of climate changes). Despite the enormous success of LTER, many of the initial projects largely overlooked the consequences of their study sites being embedded in wider socio-ecological systems. This potential shortcoming led to the development of Long Term Socio-Ecological Research (LTSER), a logical extension of LTER that seeks to fully integrate the human dimension into long term environmental monitoring. LTSER sites have now been successfully established in many countries, although such an approach is still incipient in Brazil's program of LTER (known by the acronym PELD in Portuguese). The PELD APA Costa de Corais is one of Brazil's newest PELD sites, and intentionally incorporated a strong socio-ecological focus into its design and implementation. In this brief perspective we draw on our experiences of creating a LTSER, identifying four key challenges that need to be overcome to ensure successful implementation.

Keywords: LTER, LTSER, PELD, ILTER, Socio-ecological systems, Governance.

INTRODUCTION

The concept of Long Term Ecological Research (LTER) emerged in the early 1980s (National Science Foundation 2019) with the aim of investigating

ecological processes at temporal scales of years to decades. Such an approach was essential for scientists to detect changes in ecological processes such as succession, range shifts, species turnover, long term population dynamics and adaptive

shifts in life history traits in response to changing ecological conditions (including those attributable to the changing climate) (Hobbie *et al.* 2006). LTER was developed at a time when environmental scientists were strongly focused on natural (‘intact’) ecosystems and it is therefore understandable that many of the original LTER sites largely overlooked the direct and indirect impact of human actions on their sites (Haberl *et al.* 2006, Collins *et al.* 2011). With an increasing understanding of the ubiquity of anthropogenic influences on ecosystems, the concept of LTER was expanded to include Long-Term Social Ecological Research (LTSER), used to denote sites that explicitly explored the linkages between social and natural systems at large-scales (Haberl *et al.* 2006).

As one of the most recent PELD sites in Brazil, when we designed the PELD Costa dos Corais Alagoas (established in 2017) we were able to draw upon (and be inspired by) the extensive recent literature on LTSERs (Haberl *et al.* 2006, Haase *et al.* 2018). We used this to create a long term social-ecological study site that attempted to fully integrate the diverse interactions between individuals, communities and institutions and the complex coastal ecosystem where they live, work and visit (details about the PELD Costa dos Corais Alagoas are provided in Miranda *et al.* in this volume). Our overall objective for the PELD Costa dos Corais Alagoas (hereafter PELD-CCAL) was to create a research program that considered human activities as more than simply threats to the natural reef system. Rather, we wanted to understand the complex feedbacks and dynamics of the users of the ecosystems, including those with a role in governance. Such an ambitious project threw up many challenges, some of which we were able to address (and many of which we are still actively engaging with). In this brief perspective we would like to outline four of the most general challenges of implementing LTSER in a Brazilian context, and some of the potential strategies to overcome these.

Challenge 1: Building an interdisciplinary team

Although most scholars are now accustomed to working in collaborative research teams, these are often composed of researchers with similar academic backgrounds and skills. The study of socio-ecological systems, almost by definition, requires

the formation of collaborative teams composed of those from both the natural and social sciences, with different perspectives, epistemologies and methodologies. These differences make it difficult, though not impossible, for academics from these disciplines to work together collaboratively. This is especially the case when researchers can significantly contribute to shared areas of interest. This is particularly apparent in environmental research, where the British Geographer Andrew Goudie (Goudie 2017) has identified seven areas that are particularly apt for interdisciplinary research: seven closely interweaved themes: (1) the study of hazards and disasters and of resilience and vulnerability; (2) global changes and their causes, mitigation, and adaptation; (3) Earth System Science; (4) human impacts; (5) the Anthropocene; (6) environmental history and environmental influences on human history and prehistory, including migration and settlement abandonment; and (7) the study and appreciation of landscape. All seven themes are represented within the PELD APACC, providing a fertile academic context to promote interdisciplinary research.

Identifying common research goals that require multiple methods and perspectives helps build a common purpose, approach, and performance goals but does not, in itself, ensure the creation and maintenance of high-performing collaborative research teams (Cheruvilil *et al.* 2014). To do this it is necessary to pay close attention to team diversity and to facilitate good interpersonal skills (e.g., social sensitivity, emotional engagement) among participants. Several independent studies have noted that diverse teams tend to function better (Stokols *et al.* 2008, Whitfield 2008). In this context, diversity refers not just to different disciplinary backgrounds, but to gender, career stage, ethnicity, collaboration history, degree of specialism, etc.). With such a large, complex research project we were able to divide the PELD research staff, students and collaborators into sub-teams, where each team had a mixture of experienced and early-stage researchers, balanced genders and, where appropriate, researchers from different disciplines. We also actively sought collaboration with researchers from outside of Brazil (US, Argentina and UK), further broadening the cultural profile of the overall team.

In practice, of course, we have encountered many barriers to constructing and maintaining

high-functioning interdisciplinary teams within the PELD. The traditionally rigid separation between disciplines in Brazilian Universities means that it is sometimes bureaucratically difficult to have students from one department doing research projects in a different department – we were fortunate to receive several engineering students who revolutionized our PELD drone monitoring program. Similarly, the rather top-down management style adopted by experienced academics does not always encourage critical dialogue and foster interpersonal skills between team members. Finally, as we all know you cannot force commitment to shared goals, and the current uncertainties engulfing Brazilian research together with day to day work pressures mean that not all of the senior staff have always been able to engage as much as they may have liked. Nevertheless, by following broad recommendations for the formation of high functioning interdisciplinary teams (Cheruvilil *et al.* 2014) and by committing to our deep socio-ecological perspective we have been able to create a research team that was particularly well suited to explore the consequences of the recent oil spill off the northeast coast.

Challenge 2: Going beyond humans as threats

In the last decades, humans have been causing unprecedented alterations in ecosystems (Vitousek *et al.* 1997), with often dramatic knock-on effects on human welfare (MMA 2005). We sought to capture this dynamic, two-way process in the APACC by adopting the “Press-pulse” framework, created to integrate the interplay between human actions and ecosystem dynamics within the same conceptual package (See details in Collins *et al.*, 2011). Under this framework, pulse events are discrete and rapid and can be driven by humans or natural phenomenon such as a management intervention or a change in land use. Press events in turn, represents chronic and slower changes, including nutrients deposition and climate change (Collins *et al.* 2011). To build the human component into the PELD-CCAL framework, we adapted the social template and its linkages with biophysical components, generating four interlinked research areas: (i) Cultural Ecosystem Services, (ii) livelihoods and human behavior, (iii) threats and (iv) governance and policy (Figure 1).

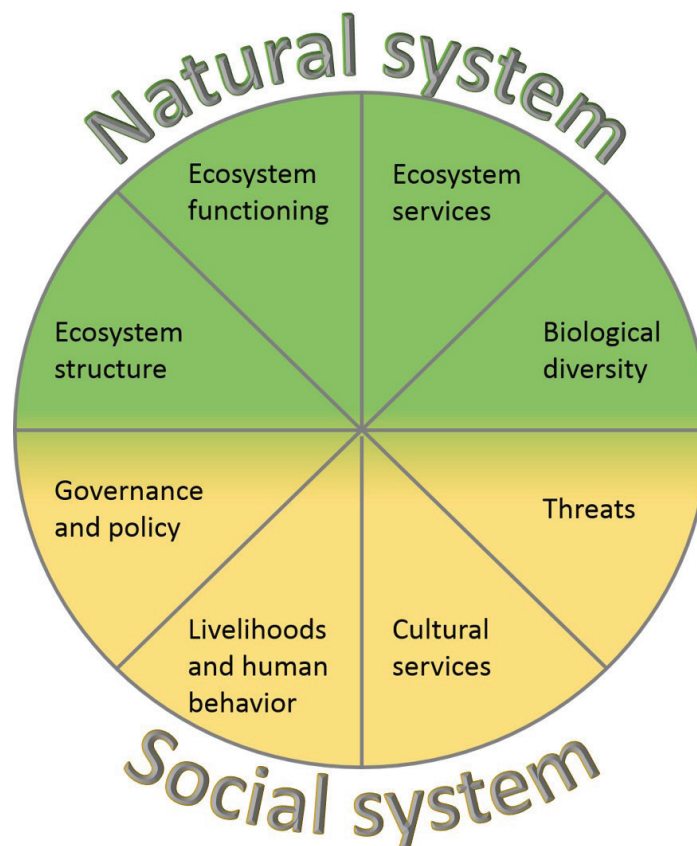


Figure 1. Components used to build the social-ecological component of PELD-CCAL, including threats, Cultural Ecosystem Services, livelihoods and human behavior and governance and policy.

Cultural Ecosystem Services

Traditional populations frequently use the natural resources as part of their biocultural heritage (Toledo & Barrera-Bassols 2009). The cultural aspects of human societies are often rooted on the values they place on environmental components and, therefore, understanding the relationships between ecosystems structure, functions, services and the benefits they generate to people is fundamental for monitoring socio-ecological systems (Groot *et al.* 2002, Costanza *et al.* 2017). Traditionally, only a portion of so-called Ecosystem Services have been integrated in LTER and similar ecological assessment programs. The missing components are frequently the cultural attributes that generate intangible values of ecosystems (known as Cultural Ecosystem Services - CES). Though often lacking a direct economic component, these services are highly valued by people worldwide and have strong links with many constituents of human well-being (e.g. mental and physical health, social cohesion, etc.) (MEA 2005). Supporting and investing in CES is also an effective strategy to increase the cultural sustainability of environmental policies (Vieira *et al.* 2018).

In PELD-CCAL we have been monitoring a range of CES (e.g. aesthetic values, recreation, social relations) by employing a mix of methods (Retka *et al.* 2019) such as the traditionally used questionnaires and innovative big data approaches that identify CES from the content of social media photos (Retka *et al.* 2019). As each method has its strengths and weaknesses, this integrative approach is expected to result in an in-depth assessment of the heterogeneous preferences of users in the APACC. Specifically, our results may provide very useful information on what, where and when CES are delivered to multiple user groups of APACC (e.g., residents, researchers and tourists), helping to avoid conflicts between biodiversity conservation actions and users' preferences (e.g., choosing recreational and no-take zones). We are also monitoring perceptions of local APACC users about aesthetic valuation of natural features, local history, learning spaces common spaces, spiritual places, etc. Preliminary data suggest that natural features are highly valued by local users for their aesthetic qualities, while educational, historical and spiritual services are generally poorly perceived.

Livelihoods and human behavior

Support for social welfare and maintenance of local livelihoods is a key facet of successful biodiversity conservation programs. When successfully implemented, sustainable resource management should be able to contribute to ecological, social and economic objectives (Gutiérrez *et al.* 2011, Borrini-Feyerabend & Hill 2015, Campos-Silva & Peres 2016). Productive activities that take place within processes influenced by the type of resource to be exploited (Diegues 1983), such as the community management of fishery resources, are an alternative to the overexploitation of resources or the imposition of externally mandated and heavily policed resource-use regulations. A prerequisite for developing such systems is an understanding of how local elements influence people's welfare, and how it is affected and affects the ecological dynamics. In the PELD-CCAL we have addressed this challenge by monitoring the socioeconomic context and social organization of local residents, measuring key social components such as livelihood satisfaction and food security. These data can be used to inform trade-offs and to facilitate the social willingness to conserve biodiversity and natural environments. We are also investigating the maintenance of cultural practices in the local fishing communities. Preliminary data suggest that as much as 75 % of fishers do not want their children to continue their profession due to a combination of high risk and low social prestige. Many fishers want their children to focus on education and to actively keep away from fisheries activities. Nevertheless, fisheries still has a strong cultural importance for local communities, not only for commerce, but also as the main source of dietary protein among poor families.

Threats

Due to the rapidly increasing human population, anthropogenic threats are the main drivers of biodiversity loss (Turner *et al.* 1990, Harte 2007) and are frequently a major focus of LTER. According to the Conservation Action Planning developed by The Nature Conservancy (TNC), environmental threats might be monitored according to their qualities such as severity, magnitude, persistency across the time and geographical distribution (Leverington

et al. 2008). The specific threats of each locality vary according to the socio-ecological context in which the conflict occurs. Notwithstanding, the general classes of environmental threats are almost always the same (*i.e.* unmanaged hunting, logging, mining, anthropogenic land use, urban wastes and tourism). Threats may be assessed by the synthetic knowledge of managers or researcher perceptions (WWF-Brasil & ICMBio 2012, Pennino *et al.* 2018) or of community people by assessment on the Local Ecological Knowledge (LEK) (Beyerl *et al.* 2016). However, a possible challenge that might arise from the assessment of threats by LEK is that most of these threats are associated with nature conservation conflicts (Redpath *et al.* 2013). In PELD-CCAL, we have been monitoring the main threats identified by decision makers and local communities, including some types of fisheries, tourism, pollution, human-wildlife conflicts and others. Significantly, most of the factors threatening the health of the environment are the same as those that threaten human wellbeing and sustainable livelihoods.

Governance and policy

Good environmental governance is about conducting processes clearly, sharing power with those who depends on nature, creating fair and equitable regulations, and establishing good communication among stakeholders (Lockwood 2010, Lockwood *et al.* 2010). In the PELD-CCAL we are investigating stakeholder and community attitudes to governance principles, and how these principles can shape their relationships with nature. Moreover, this closes the gaps in communication among different levels of decision-making, promoting better connectivity. We are using the eight good governance principles proposed by Lockwood (2010) to monitor governance, analyzing the perceptions of local APACC users on governance aspects (legitimacy, transparency, accountability, fairness, social inclusion, connectivity, institutional capacity and institutional resilience). Preliminary results suggest that the perception of these principles differs depending upon the type of user. Remarkably, only 30% of the local APACC users are even aware of the existence of the protected area, even when they live next to it and visit it daily to conduct their activities. This highlights the urgent need to strengthen social participation

in the APACC, which has a huge territory and an enormous diversity of users.

Challenges 3 and 4: (Really) including local communities and stakeholders in the PELD, and how to support (and study) management

Community-based participatory research (CBPR) has been successfully used as a collaborative strategy to create meaningful outcomes for local communities (Lucero *et al.* 2018). The Sustainable Development Goals (SDGs) also emphasize that the inclusion of local representatives in multi-stakeholder partnerships can strengthen community cohesion, cultural identities, power sharing and others (target 17.16). In the PELD-CCAL, local leaders and stakeholders were involved since the planning stage of the project, playing a central role in identifying research priorities, threats and sample design. Moreover, local residents with different skills and expertise are also an official part of the PELD team as fellows. This strategy ensures higher legitimacy, challenges researchers with alternative perspectives and ultimately allows a deeper understanding of the social and ecological interactions within our study area. This strategy also facilitates the feedback between scientific outputs and management needs, because the demands of local stakeholders are one of the most important drivers of the PELD-CCAL research targets.

MOVING FORWARD LTER IN BRAZIL

The Brazilian model of LTER is continuously evolving, and many sites (older and more recent) have been actively integrating social components into their predominantly ecological research programs with the aim of generating a more holistic view of the processes surrounding long-term ecological changes. We hope this process will continue and recommend that future and existing projects not only look at socio-ecological interactions from a negative perspective (*e.g.* the impacts of anthropogenic threats on the environment) (Donoso & Zavaleta 2014) Universidad Austral de Chile. All Rights reserved. Currently Chile belongs to the International Long Term Ecological Research network (ILTER, but also seek to incorporate sociocultural indicators such as measures of Cultural Ecosystem Services, governance systems and local perceptions and

attitudes. An important issue, which could be encouraged by the funding agencies, is the incorporation of professionals from different field of knowledge, including psychology, social sciences and economy. The inclusion of ethical and humanistic aspects assessed by social indicators according to political reality at local and broader scales is imperative to increase our understanding of the dynamics of social-ecological systems in the long-term (Anderson *et al.* 2008) addressing problems that encompass decadal or longer time frames, began as a formal term and program in the United States in 1980. While long-term ecological Studies and observation began as early as the 1400s and 1800s in Asia and Europe, respectively the long-term approach was not formalized until the establishment of the U.S. long-term ecological research programs. These programs permitted ecosystem-level experiments and cross-site comparisons that led to insights into the biosphere's structure and function. The holistic ecosystem approach of this initiative also allowed the incorporation of the human-dimension of ecology and recently has given rise to a new concept of long-term socio-ecological research (LTSER). The PELD-CCAL has tried to adopt an innovative approach, seeking to build bridges among stakeholders and managers by generating transdisciplinary knowledge to support effective and socially responsive policy and management of the APA.

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