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Managing Social-Ecological Systems for People and Nature: Insights from the World Network of Biosphere Reserves

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ABSTRACT

Biodiversity loss is a current major environmental problem at a global level. However, given the complexity and interdependency between social-ecological systems, integrated strategies, that combine biodiversity conservation with other environmental and socio-economic goals, are necessary. Biosphere reserves are multifunctional landscapes, designated by UNESCO, that are ideally managed in a participatory way to promote biodiversity conservation and sustainable development. However, despite there are biosphere reserves designated all over the world, their realization has been limited. Research about biosphere reserves' management effectiveness has been mainly focused in investigating specific processes or only include the perspectives of experts. This work uses a more holistic approach to investigate the factors that are important for the success of biosphere reserves.

Building on a systematic literature review of the scientific literature, I found that factors related with biosphere reserves' management effectiveness can be grouped in 53 subcategories and four main categories – context, inputs, processes and outcomes – that interact at different scales. Relationships between subcategories were analysed using multivariate statistics, and three groups of papers identified, which are associated with the goals of biosphere reserves: biodiversity conservation, sustainable development and capacity building. There were also identified gaps in the literature, which limit a more comprehensive understanding. In order to determine what lessons for the success of biosphere reserves can be drawn from the implementation of grassroot approaches, a multiple case-study research with 35 semi-structured interviews was conducted in the Paul do Boquilobo Biosphere Reserve, the Janas Ecovillage and Minga Multisector Cooperative. The analysis of how the initiatives started, their governance, management and outcomes allowed to conclude that the initiatives represent different sustainability pathways and to draw recommendations to increase the success of the biosphere reserve.

This research provides important contributions for the management of social-ecological systems, including the conservation of biodiversity, and for the success of biosphere reserves: (1) at a conceptual level, the multi-dimensional framework developed allows to identify the trade-offs, synergies and conflicts associated with the management of social-ecological systems; (2) recommendations were developed for the implementation of the MAB Programme, the Paul do Boquilobo Biosphere Reserve, Janas Ecovillage and Minga Multisector Cooperative; and (3) a research agenda is proposed, to contribute to advance inquiry about biosphere reserves' management effectiveness.

Keywords

Biodiversity Conservation; Biosphere Reserve; Grassroot Approaches; Management Effectiveness; Mixed Methods; Multifunctional Landscapes; Social-Ecological Systems; Sustainability Pathways; Sustainable Development; Systematic Literature Review.

RESUMO

A perda de biodiversidade é um dos principais problemas ambientais a nível global. Contudo, devido à complexidade e interdependência entre sistemas socio-ecológicos, são necessárias estratégias integradas que combinam conservação da biodiversidade com outros objetivos ambientais e socioeconómicos. As reservas da biosfera são paisagens multifuncionais, designadas pela UNESCO, geridas de uma forma participada para promover a conservação da biodiversidade e desenvolvimento sustentável. Contudo, e apesar de distribuídas por todo o mundo, a sua implementação tem sido limitada. Investigação sobre a eficácia da gestão de reservas da biosfera tem-se focado maioritariamente em determinados processos, ou nas perspetivas de especialistas. Neste trabalho, uma abordagem mais holística é utilizada para investigar que fatores são importantes para o sucesso das reservas da biosfera.

Através de uma revisão sistemática da literatura, foram identificados os fatores importantes para a gestão eficaz das reservas da biosfera, e agrupados em 53 subcategorias e quatro categorias principais – contexto, investimentos, processos e resultados – que interagem a diferentes escalas. As relações entre subcategorias foram analisadas com estatística multivariada, e três grupos de artigos identificados, que estão associados aos objetivos das reservas da biosfera: conservação da biodiversidade, desenvolvimento sustentável e capacitação. Foram também identificadas lacunas na literatura, que limitam uma compreensão mais abrangente. De forma a determinar que lições podem ser retiradas de iniciativas da sociedade civil para o sucesso das reservas da biosfera, foram investigados três casos de estudo com recurso a 35 entrevistas semiestruturadas: a Reserva da Biosfera do Paul do Boquilobo, a Ecoaldeia de Janas e a Cooperativa Multissectorial Minga. A análise de como começaram as iniciativas, a sua governança, gestão e resultados permitiu concluir que estas representam diferentes transições para a sustentabilidade, e desenvolver recomendações para o sucesso da reserva da biosfera.

Esta investigação contribui para uma melhor compreensão de como gerir sistemas socio-ecológicos, incluindo a conservação da biodiversidade, e para o sucesso das reservas da biosfera: (1) a um nível conceptual, a estrutura de análise multidimensional desenvolvida permite identificar sinergias e conflitos da gestão de sistemas socio-ecológicos; (2) foram desenvolvidas recomendações para a implementação do Programa MAB, para a Reserva da Biosfera do Paul do Boquilobo, a Ecoaldeia de Janas e a Cooperativa Multissectorial Minga; e (3) é proposta uma agenda de investigação que contribua para o avanço do conhecimento sobre gestão eficaz de reservas da biosfera.

Palavras-chave

Conservação da Biodiversidade; Desenvolvimento Sustentável; Gestão Eficaz; Iniciativas da Sociedade Civil; Métodos Mistos; Paisagens Multifuncionais; Reservas da Biosfera; Revisão Sistemática da Literatura; Sistemas Socio-Ecológicos; Transições para a Sustentabilidade.

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ACRONYMS

AGROMAIS – Entreposto Comercial Agrícola, C.R.L. (member of the advisory board of the Paul do Boquilobo Biosphere Reserve)

ALDEA - Cooperativa Integral de Sintra (a project of the Janas Ecovillage)

BR – Biosphere reserve

CEDAR – Centre for the Study and Development of Regenerative Agriculture (a project of the Janas Ecovillage)

CESA – Centre for Education for Sustainability (a project of the Janas Ecovillage)

ICDP – Integrated Conservation and Development Projects

ICNF – Instituto da Conservação da Natureza e das Florestas

MAB – Man and the Biosphere Programme

MAB-ICC – International Co-ordinating Council of the Man and the Biosphere Programme

MDS – Multidimensional scaling

NA – Not applicable

NGO – Non-governmental organization

ONGATEJO – regional environmental non-governmental organization (member of the executive body of the Paul do Boquilobo Biosphere Reserve)

PBBR – Paul do Boquilobo Biosphere Reserve

PBNR – Paul do Boquilobo Nature Reserve

SDG – Sustainable Development Goal(s)

SES – Social-ecological system

UNESCO – United Nations Educational, Scientific and Cultural Organization

WNBR – World Network of Biosphere Reserve

"The pressing question, then, is why these insiders have now concluded that mainstream conservation is no longer sufficient and needs to be radically challenged. While we cannot be certain, there is one key element that we believe goes a long way to explaining this: the current empirical realities that conservationists confront on a daily basis. Both new conservationists and neoprotectionists believe that science tells them that certain core ideas and ideals of mainstream conservation need to be challenged, particularly due to the fact that the alarm indicators for biodiversity and ecosystems do not seem to be improving despite tremendous, longstanding and increasing mainstream efforts. And, clearly, it can only take so long before certain actors can no longer deal with the increasing gap between vision and execution and start questioning not just the latter but also the former."

Bram Büscher and Robert Fletcher (2020)

The Conservation Revolution – Radical Ideas for Saving Nature Beyond the Anthropocene, Verso, London & New York

1 Introduction

1.1 Relevance of the study

According to the most recent report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Díaz *et al.*, 2019) there are currently 1 million species facing extinction at a global level. These species and ecosystems are likely to be lost forever because of human actions (Díaz *et al.*, 2019, p. 3). Although negative consequences of human activities on nature are well-known for decades (Carson, 1962; Soulé, 1985), severity of biodiversity loss increased over the last 50 years (Díaz *et al.*, 2019). Several planetary boundaries, including biodiversity loss, climate change and phosphorous and nitrogen pollution, have already been transgressed, and it may as well be impossible to predict or avoid catastrophic consequences of these losses (Rockström & Klum, 2015). Amidst the current climate and ecological crisis, socio-economic problems persist: global wealth is unevenly distributed, the rate of poverty reduction had decreased globally, and extreme poverty have even increased in the sub-Saharan Africa (Lawson *et al.*, 2019). The current social-ecological crises requires no less than new paradigms and visions about models of development that are better for people and nature (Rockström & Klum, 2015; Raworth, 2018).

Biosphere reserves are multifunctional landscapes designated by the United Nations Educational, Scientific and Cultural Organization Man and Biosphere Programme that are managed to achieve a diversity of social and ecological goals, including biodiversity conservation and sustainable development. The concept has a broad importance all over the world: there are 701 biosphere reserves designated in 124 countries, encompassing an area that is almost the size of Australia and in which inhabit about 260 million people (UNESCO, 2019a). There is, however, a gap between the concept and the reality in biosphere reserves (Price, 2002; Ishwaran *et al.*, 2008; Price *et al.*, 2010; UNESCO, 2013). Since they were first designated, biosphere reserves have had difficulties in complying with the criteria required for their designation, such as the implementation of a zoning scheme and a participatory management body (Price, 2002; Ishwaran *et al.*, 2008; Price *et al.*, 2010; UNESCO, 2013). However, little is known about how biosphere reserves are being ideally managed, which are the outcomes of diverse management options and which factors determine their success. This information is of major importance to contribute to biosphere reserves' management effectiveness, i.e., the achievement of the goals for which they are designated. The scientific literature related to biosphere reserves' management effectiveness have focused in a specific process (Schultz *et al.*, 2011) or in the perceptions of experts (Stoll-Kleemann & Welp, 2008; Schultz *et al.*, 2011; Cuong *et al.*, 2017a,b). A more holistic understanding of biosphere reserves' management effectiveness is necessary to include diverse

perspectives about the management of complex systems and to see the relationships, conflicts and synergies between different goals and processes, which are not possible to identify by analysing a single dimension.

This work aims to contribute to the development of a more holistic understanding of biosphere reserves' management effectiveness using the lens of social-ecological systems, and to provide practical recommendations to contribute to its success. As the distinguished 20th century inventor and visionary Buckminster Fuller once said, "You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete". Successful biosphere reserves can provide a new model of development in which people and nature thrive together. In addition, the global scope of the World Network of Biosphere Reserves provides a unique opportunity to leverage change at a large scale. This research adds a contribution in that direction, increasing our understanding about how social-ecological systems can be managed to achieve multiple social and environmental goals, including the conservation of biodiversity.

1.2 Research background

1.2.1 Biodiversity conservation and human well-being

Biodiversity comprises all variety of life at all organizational levels, including genetic, species and ecosystems diversity (Chapin III *et al.*, 2000; Gaston & Spicer, 2004). Species diversity plays important roles in the functioning of ecosystems and influences its resilience and resistance to changes (Chapin III *et al.*, 2000). These functions are fundamental to assure that nature continues to provide a diversity of positive contributions (or services) to people, such as food provision, the purification of water, medicines, inspiration and learning (Chapin III *et al.*, 2000; Díaz *et al.*, 2018, 2019, p. 2). Moreover, biodiversity is important per se, i.e., has a value that is independent of people (Pope Francis, 2015, p. 105; Chan *et al.*, 2016). Regardless what the motivations are – instrumental, relational or intrinsic (Chan *et al.*, 2016) – there is a general agreement about the importance of nature and biodiversity, and the need to conserve and use it sustainably (Díaz *et al.*, 2019, p. 5).

Human activities are changing the global environment and are responsible for unprecedent rates of species extinction (Chapin III *et al.*, 2000; Rockström & Klum, 2015; Díaz *et al.*, 2019, p. 3). Over-exploitation of natural resources, habitat loss and degradation, pollution, invasive alien species and climate change are the main direct anthropogenic drivers of biodiversity change (Secretariat of the Convention on Biological Diversity, 2010a). These drivers are a result of indirect factors, including demographic changes, the economic activity, levels of international trade, consumption patterns, culture and religion, and scientific and technological changes (Secretariat of the Convention on Biological Diversity, 2010a) (Figure 1.1). Moreover, in a world that is increasingly interconnected, the causes of

biodiversity change in one place maybe located in remote parts of the planet (Lenzen *et al.*, 2012; Rockström & Klum, 2015, pp. 46–54).

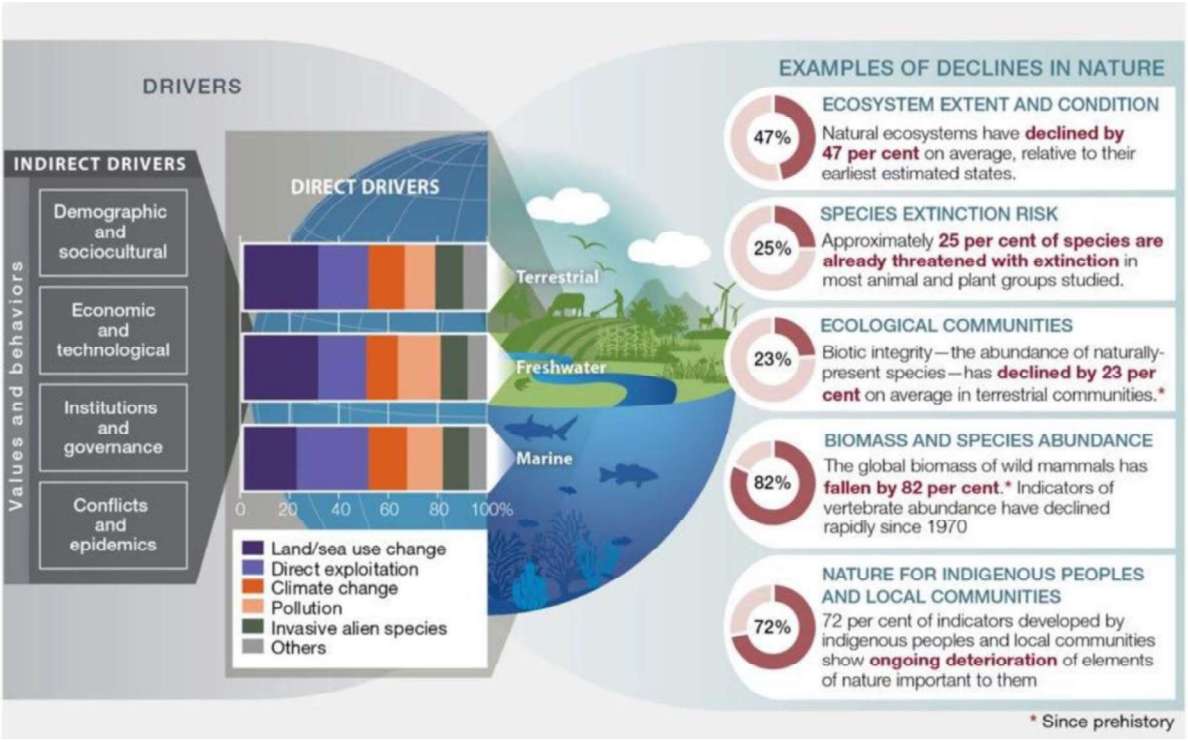

Figure 1.1 Drivers of biodiversity loss. Retrieved from Díaz *et al.* (2019).

Despite it is recognized that halting biodiversity loss requires multiple actions, as identified in the Aichi Biodiversity Targets (Secretariat of the Convention on Biological Diversity, 2010b, p. 7; Marques *et al.*, 2014), the designation of protected areas is still a cornerstone of conservation policies: 15% of the global lands and 7% of the oceans are currently protected (UNEP-WCMC and IUCN, 2018). Therefore, contrary to most of the other Aichi Biodiversity Targets, good progress is being made towards the achievement of the target 11, that establishes the need to increase global coverage of terrestrial and marine areas protected, respectively, to 17% and 10% (Díaz *et al.*, 2019, p. 22). However, without proper management and governance, the effectiveness of protected areas, i.e. the delivery of the outcomes for which they are designated, is limited (IUCN-WCPA, 2003, pp. 21–35; Hockings *et al.*, 2006). Moreover, even with effective management systems in place, protected areas may be unable to deal with external pressures that comes from their immediate vicinity (e.g. Craigie *et al.*, 2010) or originated further away (Hockings *et al.*, 2006). It is, therefore, increasingly recognized that protected areas cannot succeed if managed as if they are islands independent of ecological and socio-economic processes at different scales, and that a more adaptive and integrated approach is necessary (Palomo *et al.*, 2014; Cumming *et al.*, 2015; Cumming, 2016).

The need for integrated approaches in biodiversity conservation is even more relevant considering that, at a global level, priority areas for biodiversity conservation are highly overlapped with areas of severe

poverty (Fisher & Christopher, 2007). It is widely recognized that the implementation of protected areas often result in significant negative impacts on the well-being of the communities where they are implemented, including displacement and the loss of access to means of livelihoods or culturally important sites (Brechin *et al.*, 2002; Adams *et al.*, 2004; Oldekop *et al.*, 2016; Kaplan-Hallam & Bennett, 2017). Human well-being can be conceptualized in five main domains: social (education, infrastructures, security), health (food security, emotional and mental health), economic (employment, equity, wealth), governance (transparency, accountability, rights, participation) and cultural (identity, traditional knowledge, practices) (Kaplan-Hallam & Bennett, 2017). Therefore, besides generating conflicts with local populations, that may ultimately undermine conservation efforts, the implementation of protected areas is also morally questionable: "should biodiversity protection be granted moral superiority relative to the ideals of human welfare and dignity?" and "does the preservation of basic human rights supersede the goals of biodiversity preservation?" (Brechin *et al.*, 2002).

As a result of the recognition of the limitations and human costs of strict protection approaches, more integrated initiatives, that combine socio-economic development with biodiversity conservation (win-win approaches) started to be implemented, including Biosphere Reserves, first designated in 1976 (Batisse, 1985), and Integrated Conservation and Development Projects (ICDP), launched from mid-1980s (Hughes & Flintan, 2001). A cornerstone of these initiatives is the participation of local communities in the management of natural resources, for which they are frequently referred as "community conservation" (Hutton *et al.*, 2005). However, the lack of effectiveness of ICDP (Hughes & Flintan, 2001) and other people-oriented conservation approaches have motivated a return to strict protection (Brechin *et al.*, 2002; Hutton *et al.*, 2005). Today, different approaches to biodiversity conservation co-exist, which conceptualize a diversity of relationships between people and nature (Mace, 2014). The most recent conservation approach - people and nature - goes beyond competing perspectives that emphasize humans or the biosphere, to recognize its interdependency (Mace, 2014). Key concepts of the people and nature conservation approach are social-ecological systems, culture and institutions (Mace, 2014). This approach, in which this research is conceptually framed, is underpinned by interdisciplinary social and ecological sciences (Mace, 2014).

1.2.2 Social-ecological systems

Social-ecological systems are complex systems in which the interdependencies between people and nature are highlighted (Figure 1.2):

"*people are part of ecosystems and shape them, from local to global scales, and are at the same time fundamentally dependent on the capacity of these systems to provide services for human wellbeing and societal development.*" (Fischer *et al.*, 2015)

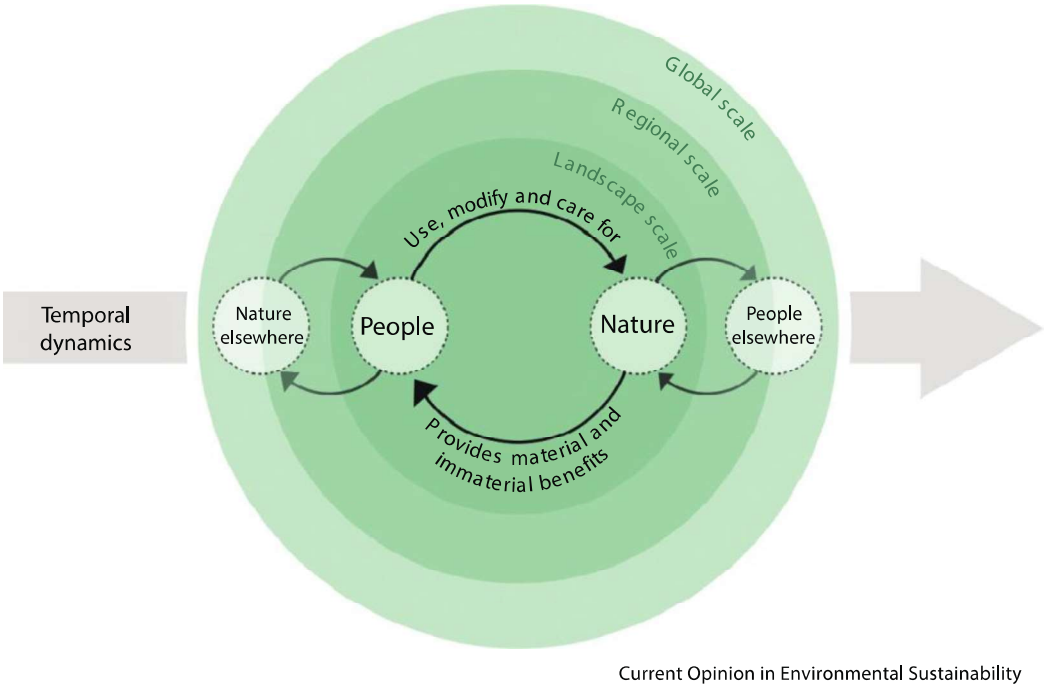

Figure 1.2 A schematic representation of social-ecological systems, retrieved from Fischer *et al.* (2015). The figure stresses the importance of the interactions and the interdependences between social and ecological systems, which are nested across scales and along temporal dynamics. Other terms used to refer to this interdependent relationship between humans and nature include the concept of human-environment systems (Scholz, 2011) or coupled human and natural systems (Liu *et al.*, 2007).

Complex systems are constituted by a large number of interacting parts characterized by a non-linear behaviour, feedbacks, spontaneous order, lack of central control and hierarchical organization (Ladyman *et al.*, 2013). Because of this, management of complex systems requires fundamentally different approaches from conventional polices based in linear models, that, through the definition of yields and centralized, command-and-control management, optimize the use of the resources as if they are "*discrete boxes*" (Holling & Meffe, 1996; Berkes & Folke, 1998; Berkes *et al.*, 2003). Despite command-and-control policies have produced economically efficient ecosystems, because they are predictable and controllable, they have also resulted in the loss of ecosystems resilience and resource mismanagement and depletion, leading to social and ecological problems (Holling & Meffe, 1996; Berkes & Folke, 1998; Berkes *et al.*, 2003). Therefore, alternative approaches that emphasize the feedbacks between the state of the resources and the policies, and the inclusion of a diversity of perspectives and centres of decision across scales, namely adaptive co-management and polycentric governance, have been promoted (Berkes *et al.*, 2003; Nagendra & Ostrom, 2012). In the management and governance of complex social-ecological systems there are not, however, panaceas, i.e. simple

solutions that can be universally applied (Ostrom, 2007), and a diversity of institutions have to be considered (Agrawal & Gibson, 1999; Ostrom *et al.*, 1999; Gatzweiler, 2006; Martín-López & Montes, 2015). According to Ostrom (2005) institutions are "(…) the prescriptions that humans use to organize all forms of repetitive and structured interactions including those within families, neighbourhoods, markets, firms, sports leagues, churches, private associations, and governments at all scales".

In order to advance the understanding of social-ecological systems and determine the main variables for its sustainable management, a diversity of frameworks have been developed (Binder *et al.*, 2013). Frameworks are useful to diagnose the source of the poor outcomes of social-ecological systems' management (Ostrom & Cox, 2010), displaying important concepts and their relationships (Pickett *et al.*, 1994). Comparing to other frameworks, the Ostrom Social-Ecological Systems Framework (Ostrom, 2007, 2009) is more comprehensive, because it considers the social and ecological systems in a similar extent and its interdependencies (Binder *et al.*, 2013). However, Ostrom's framework is of limited use to guide conservation policies because it was developed through the analysis of small-scale common-pool resources, such as inland fisheries, grazing areas or forests, that are collectively managed by communities which are economically dependent from these resources (Ostrom, 1990, p. 26). It has, therefore, an anthropocentric perspective over ecological systems (Binder *et al.*, 2013) but widely ignores other uses of biodiversity, including its protection (non-use). Besides that, it does not consider the interactions between social-ecological systems across scales, and the focus in institutional theory fails to integrate other perspectives of social-ecological systems (Cumming *et al.*, 2015). Therefore, there is a need to develop a more holistic comprehension of the factors that are important to achieve multiple social and ecological goals, including biodiversity conservation, in social-ecological systems management.

1.2.3 Biosphere reserves and grassroot approaches

Biosphere reserves are designated by the United Nations Educational, Scientific and Cultural Organization Man and Biosphere (UNESCO - MAB) Programme (UNESCO, 2015). They comprise multifunctional landscapes in which a diversity of actors collaborate to conciliate natural and cultural values with economic development at a regional scale (UNESCO, 1996, 2015). There are currently 701 biosphere reserves designated in 124 countries (UNESCO, 2019a). Biosphere reserves have three main functions: biodiversity conservation, sustainable development and logistic support (research, education, monitoring) (UNESCO, 1996). The designation of a biosphere reserve requires an appropriate zoning scheme (Figure 1.3): a core zone, that is legally constituted to ensure the long-term protection of natural resources; contiguous buffer area(s), where only activities compatible with the conservation of natural values take place; and a transition zone in which sustainable use of natural resources is promoted (UNESCO, 1996). Moreover, biosphere reserves should promote wide participation, learning,

experimentation and adaptive management (UNESCO, 1996, 2015). Biosphere reserves are linked to national committees, and further integrated in regional and thematic groups (UNESCO, 2015), connecting local to global scales. They incorporate, therefore, many concepts of social-ecological systems management, including adaptive co-management (Schultz *et al.*, 2011; Palomo *et al.*, 2014), integrated landscape management (Palomo *et al.*, 2014; Cumming *et al.*, 2015; Cumming, 2016), cross-scale management (Cumming *et al.*, 2015), a diversity of values of biodiversity and multiple types of knowledge (Palomo *et al.*, 2014). Consequently, they represent privileged places to better understand the key factors influencing the sustainable management of social-ecological systems, including biodiversity conservation and human-well-being.

Figure 1.3 Zoning of biosphere reserves. Retrieved from UNESCO (2019a).

There is, however, a gap between the concept and the practical realization in biosphere reserves (Price, 2002; Ishwaran *et al.*, 2008; Price *et al.*, 2010; UNESCO, 2013). Until recently, only six in a total of 621 biosphere reserves were considered models of the concept (UNESCO, 2013). Since they were first designated, biosphere reserves have had difficulties in complying with the criteria required for their designation, such as the implementation of a zoning scheme and a participatory management body (Price, 2002; Ishwaran *et al.*, 2008; Price *et al.*, 2010; UNESCO, 2013). However, the evaluation of biosphere reserves' management effectiveness is limited, because the existing reporting system – the periodic review process – is more focused in evaluating the compliance with the designation criteria than with the achievement of the goals (Matar & Anthony, 2017). Moreover, the reports are not widely available, and there is a high rate of non-response and delay (Matar & Anthony, 2017). A number of studies have been developed to better understand key factors influencing the effectiveness of biosphere reserves (Stoll-Kleemann & Welp, 2008; Schultz *et al.*, 2011; Cuong *et al.*, 2017b). However, these

studies are mainly focused in the perceptions of biosphere reserves' experts (Stoll-Kleemann & Welp, 2008; Schultz *et al.*, 2011; Cuong *et al.*, 2017b) or in specific process (e.g. participation, Schultz et al., 2011). There is, therefore, a need to better understand which factors influence the success of biosphere reserves in a more holistic way, i.e. including a diversity of perspectives and processes.

The analysis of practices and concepts from other sustainability institutions can provide insights about how to increase the effectiveness of biosphere reserves (George & Reed, 2016, 2017). In this regard, grassroot initiatives can be particularly interesting, because they have been responsible for innovate ideas and processes for sustainable development, such as repair-cafés, complementary currencies, energy cooperatives and garden-sharing (Smith & Stirling, 2018). Grassroot innovations are bottom-up approaches, developed by local communities, to provide solutions at a local level for sustainable development, according to their interests and values (Seyfang & Smith, 2007). Despite some studies have analysed how practices from other sustainability organizations can promote to the success of biosphere reserves (George & Reed, 2016, 2017), the potential contribution of grassroots approaches remains unexplored.

1.3 Research questions

The general purpose of this research is to contribute for a better understanding of how social-ecological systems can be managed to achieve multiple social and environmental goals, including the conservation of biodiversity. To this end I analysed biosphere reserves from all over the world through a systematic literature review and developed a more profound investigation of one biosphere reserve and two grassroot approaches – an ecovillage and a multisector cooperative – that are located in the Portuguese Mediterranean Biome. This work provides contributions to answer to the following research questions (RQ):

RQ#1: Which factors influence biosphere reserves' management effectiveness?

RQ#2: How are factors of the context, inputs, processes and outcomes of biosphere reserves' management related, and which variables influence this relationship?

RQ#3: What are the main differences in the management of biosphere reserves and grassroot approaches?

RQ#4: How can experiences of grassroot approaches contribute to the success of biosphere reserves?

1.4 Research design and structure of the dissertation

In order to answer to the research questions identified in Section 1.3, three main studies were developed. The research questions that are addressed in each chapter, and the main methodologies used, are displayed in Table 1.1.

Table 1.1 Research design, including the general goal of this thesis, the research questions that are addressed in each chapter, and the main methodological approaches

General goal	Contribute for a better understanding of how social-ecological systems can be managed to achieve multiple social and environmental goals, including the conservation of biodiversity		
Chapter	**Title**	**Research questions**	**Methods**
Chapter # 2	A social-ecological systems framework as a tool for understanding the effectiveness of biosphere reserve management	RQ#1: Which factors influence biosphere reserves' management effectiveness?	Systematic literature review of scientific literature; Qualitative content analysis (mixed deductive and inductive)
Chapter # 3	Biosphere reserves' management effectiveness – a systematic literature review and a research agenda	RQ#2: How are factors of the context, inputs, processes and outcomes of biosphere reserves' management related? What variables influence this relationship?	Systematic literature review of scientific literature; Quantitative content analysis (deductive); Descriptive and multivariate statistics
Chapter # 4	Management of social-ecological systems in the Portuguese Mediterranean Biome – what can biosphere reserves learn from grassroot approaches?	RQ#3: What are the main differences in the management of biosphere reserves and grassroot approaches? RQ#4: How can experiences of grassroot approaches contribute to the success of biosphere reserves?	Multiple case-study analysis of the Paul do Boquilobo Biosphere Reserve, Janas Ecovillage and Minga Multisector Cooperative; Semi-structured interviews; Qualitative content analysis (mixed deductive and inductive)

In **Chapter 2,** the framework that will guide the rest of the work is developed. This framework builds on the systematic analysis of peer-reviewed literature about biosphere reserves' management effectiveness. The framework aggregates in 53 subcategories and four main categories – context, inputs, processes and outcomes – factors that influence biosphere reserves' management effectiveness referred in the literature. It is argued that this framework provides a more holistic structure of analysis, comparing to other frameworks of social-ecological systems management.

In **Chapter 3**, the literature selected in Chapter 1 is re-analysed to investigate the relationships between the subcategories identified in the framework previously developed. Moreover, a comprehensive analysis of the papers is performed in order to determine which variables influence this relationship. This study reveals gaps and bias in the literature that were aggregated in a research agenda for the field.

In **Chapter 4**, the framework developed in Chapter 1 is used to analyse three different initiatives managing social-ecological systems in the Portuguese Mediterranean Biome: the Paul do Boquilobo Biosphere Reserve and two grassroots approaches – the Janas Ecovillage and the Minga Multisector Cooperative. Building on a holistic analysis, the main differences between the initiatives are identified, and recommendations about which processes from grassroot approaches can provide opportunities to the success of the Paul do Boquilobo Biosphere Reserve discussed.

The final part of this thesis - **Chapter 5** - contains a general discussion that summarizes the main contributions of this thesis for the theory, practice and research about the management of socio-ecological systems and the success of biosphere reserves and grassroot approaches. This chapter also includes the main conclusions, future research needs, and the outputs that resulted from this work.

This thesis follows a structure in which the main body of work (Chapters 2, 3 and 4) is organized in independent manuscripts. Chapter 2 *"A social-ecological systems framework as a tool for understanding the effectiveness of biosphere reserve management"* contains a paper that is published in the journal Sustainability. Chapter 3 "*Biosphere reserves' management effectiveness - a systematic literature review and a research agenda"* contains a study that has been previously submitted and, after incorporating the suggestions received, which contributed to improve the manuscript, it has been resubmitted to a peer-reviewed journal. Chapter 4 *"Management of social-ecological systems in the Portuguese Mediterranean Biome – what can biosphere reserves learn from grassroot approaches?"* contains a paper that is being prepared to be submitted to a peer-review journal in June 2020.

2 A social-ecological systems framework as a tool for understanding the effectiveness of biosphere reserve management

This study is published in the journal Sustainability:

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Author Contributions:

The first author has conceptualized and designed the study, carried out the review procedure and wrote the manuscript. Heike Zimmermann, Rui Santos and Henrik von Wehrden have supported the first author in the design of the research, discussion of the results and revision of the manuscript.

Abstract

Biosphere reserves aim to reconciliate social and economic development with biodiversity conservation through complex spatial and governance arrangements. However, there is a generalized lack of information about how biosphere reserves are being managed and governed, and at what point their goals are being achieved, which limits a better understanding of the factors influencing biosphere reserve management effectiveness. This study builds on a systematic review of existing empirical studies, to develop a framework that identifies the main features related to biosphere reserve management effectiveness. Four main categories were identified - context, inputs, process and outcomes - and 53 subcategories, which interact at different scales and shape biosphere reserve effectiveness. The results demonstrate that the capacity of biosphere reserves to achieve their goals is not only related to the way they are managed/governed, or to the inputs invested, but to many social and ecological contextual factors. Benefits and impacts that were associated to biosphere reserves around the world were also identified. Comparing to other social-ecological system frameworks, the proposed framework provides a more inclusive approach, since it integrates the findings of studies with different research perspectives, considers a plurality of values attributed to natural resources, and the social-ecological system's scales dynamics.

Keywords

Biodiversity; Biosphere Reserve; Conservation; Framework; Governance; Management Effectiveness; Protected Area; Social–Ecological System; Sustainable Development; Systematic Review

2.1 Introduction

2.1.1 Biosphere reserves and social-ecological systems management and governance

Biosphere reserves are unique places to understand how to sustainably manage and govern social-ecological systems, given their integrated approach to conserve biodiversity and promote sustainable development, and their global scope. Along this manuscript, the term "management" is used to refer to procedures and activities that are pursued in order to achieve given goals (Borrini-Feyerabend *et al.*, 2013), and "governance" is used to address how and who make the decisions (Lausche, 2011). The designation of biosphere reserves is the main instrument for the implementation of the United Nations Educational, Scientific and Cultural Organization Man and Biosphere Programme (UNESCO-MAB) (UNESCO, 2015), which, in June 2017 when this work was developed, contained 669 designated places, distributed over 120 countries (UNESCO, 2017). As in April 2020 there are 701 biosphere reserves designated in 124 countries (UNESCO, 2019a). The first biosphere reserves were designated in 1976 to conserve natural areas and their genetic material (Batisse, 1985); however, in 1996, their goal and functions were altered in order to accommodate sustainable development along with biodiversity conservation goals (UNESCO, 1996). Biosphere reserves are now "sites of excellence to explore and demonstrate conservation and sustainable development on a regional scale" (UNESCO, 1996). Each biosphere reserve is expected to fulfil three functions: biodiversity conservation, sustainable development, and a logistic support function that is related to research, training and education (UNESCO, 1996). In order to achieve these functions, biosphere reserves have to meet the designation criteria, which includes the implementation of a zoning scheme: a legally constituted core area of adequate size to meet the long-term conservation objectives, surrounded or contiguous to a buffer zone, where activities consistent with the conservation goals can be performed, and a transition zone, where sustainable resource management should take place (UNESCO, 1996). Besides the zonation and dimension requirements, biosphere reserves have to be relevant for the conservation of biodiversity within its biogeographic region, and provide arrangements to promote the participation of a range of stakeholders in its governance, inter alia, public authorities, local communities and private interests (UNESCO, 1996).

The UNESCO Man and Biosphere Programme integrates key concepts from the social-ecological systems management and governance literature (Berkes *et al.*, 2003; Schultz & Lundholm, 2010; Palomo *et al.*, 2014; Cumming *et al.*, 2015). The goals of biosphere reserves are not only related to the

conservation of biological diversity, but also cultural diversity, ecosystem services, and sustainable development (UNESCO, 2015). Their logistic function places emphasis on the importance of learning, a key property of adaptive management (Berkes *et al.*, 2003). Governance of biosphere reserves requires the inclusion of a diversity of actors, a property of co-management and polycentric governance. They can provide the arena where a diversity of organizations and stakeholders, at different scales or within the same level, interact. The role of bridging organizations is particularly important in this regard; to foster collaboration, build trust and resolve conflicts between the different stakeholders (Hahn *et al.*, 2006).

A big gap between the biosphere reserves concept and practice has been reported (Price *et al.*, 2010; UNESCO, 2013). According to a report of the International Co-ordinating Council of the MAB Programme (UNESCO, 2013), the big majority of the designated biosphere reserves were not fulfilling the designation criteria, and only six (out of a total of 621) were considered to fully meet the criteria. However, a comprehensive understanding of biosphere reserve management effectiveness, i.e., if biosphere reserves achieve the goals for which they are designated, as defined in protected areas' management effectiveness literature (Hockings *et al.*, 2006), is not available (the terms "biosphere reserves' management effectiveness" and "biosphere reserves' effectiveness" are used interchangeably along this manuscript). The mechanism that evaluates biosphere reserves - the periodic review process - is considered inadequate to monitor management effectiveness, because it mainly focuses on evaluating the compliance with the designation criteria, and not its management and governance performances (Reed & Egunyu, 2013). Besides that, the information available is scarce, not only because most biosphere reserves have not established any reporting until very recently (UNESCO, 2013), but also because the periodic reviews are not accessible. Assessment of biosphere reserve effectiveness (and of protected areas in general) is also hampered by the general lack of available data for biodiversity and social monitoring (Bertzky & Stoll-Kleemann, 2009). This situation limits the understanding of which factors may be related to success or failure of biosphere reserves and also their contribution for a better understanding of pathways towards more sustainable social-ecological systems.

Some large-scale studies have evaluated biosphere reserve management effectiveness and the factors that can be associated with its success or failure. However, these studies are not comprehensive because they analyse specific management/governance practices (e.g. Schultz *et al.* 2011 analysed how stakeholder participation and adaptive co-management influence the goals of biosphere reserves), or their evaluations were only based on the perceptions of managers and researchers (Stoll-Kleemann & Welp, 2008; Schultz *et al.*, 2011; Cuong *et al.*, 2017b). There is, therefore, a need to integrate the available studies, in order to have a more holistic understanding of the factors that influence biosphere reserve management effectiveness.

2.1.2 Social-ecological systems frameworks and biodiversity conservation

Calls for an increasing integration of social-ecological systems concepts in biodiversity conservation have occurred in recent years (Ban *et al.*, 2013; Palomo *et al.*, 2014; Cumming *et al.*, 2015; Martín-López & Montes, 2015). Social–ecological systems (SES) are complex systems, in which the interdependence and interactions between both social and ecological systems across scales and time are recognized (Berkes & Folke, 1998; Fischer *et al.*, 2015). The study of SES has relied on the development of frameworks, theories and models which help to make sense out of these complex systems (Cumming, 2014). A framework is the structure of a theory, in which concepts and their relationships are displayed in a logical way (Pickett *et al.*, 1994). Using a diagnostic perspective, frameworks are useful to understand the source of the poor outcomes of social-ecological systems (Ostrom & Cox, 2010). Because frameworks are not as general as theories, or as precise as models, they are adequate to address the panacea problem in policy design (Ostrom & Cox, 2010). Social-ecological systems frameworks differ, e.g. in the weight given to the ecological and social systems, and in the conceptualization of the relationships between both systems (Binder *et al.*, 2013). Despite a diversity of frameworks having been developed to better understand SES (Binder *et al.*, 2013), there is not a single framework that can be considered fully comprehensive, and different frameworks highlight different components of the same problem (Cumming, 2011).

Ostrom's social-ecological systems framework (Ostrom, 2009) is particularly relevant in the context of natural resource management and governance. The framework integrates the findings of a number of case studies around the world where communities self-organize to manage natural resources of which excludability is not possible, e.g. forests, fisheries and groundwater systems (Ostrom, 2009). Ostrom's framework has, however, some limitations that make its adaptation to conservation policies limited (Cumming *et al.*, 2015). The main focus of Ostrom's framework in common-pool resources has raised questions about at what point the framework can also be used with public goods and services, such as many ecosystem services (McGinnis & Ostrom, 2014). Besides that, biodiversity conservation frequently imposes restrictions on natural resource use, and therefore, there is no process of extraction, which is a cornerstone in Ostrom's framework (McGinnis & Ostrom, 2014). Its emphasis on single focal situations, that develop mainly at one scale, fails to account for the linkages and dynamics of SES across scales (Cumming *et al.*, 2015). Although some of Ostrom's rules may be useful at larger scales (Dietz *et al.*, 2003; Stern, 2011), its application faces many challenges (Stern, 2011) due to the increased level of complexity associated with such large-scale systems (Ostrom *et al.*, 1999). Ostrom's framework has also been criticized for its focus on institutional theory, failing to account for other perspectives on SES (Cumming *et al.*, 2015). In order to overcome the limitations regarding biodiversity conservation issues, the work of Ostrom has been combined with other frameworks, such as resilience theory and systematic conservation planning (Ban *et al.*, 2013; Cumming *et al.*, 2015). These frameworks are, however, not fully comprehensive, and build mainly on conceptual instead of empirical analysis.

Therefore, a social-ecological systems framework that considers the existing empirical knowledge about integrated strategies for biodiversity conservation and sustainable development remains to be developed. Biosphere reserves represent unique opportunities to develop such a framework.

2.1.3 Study goals

In this study, the existing empirical literature about management and governance of biosphere reserves is reviewed in order to develop a holistic framework which represents its main features. The specific goals of this study are:

(i) Provide a more comprehensive understanding of factors related to biosphere reserve management effectiveness and;

(ii) Contribute to a better understanding of factors, which are important for the integrated management of social-ecological systems and the conservation of biodiversity.

2.2 Methods

The literature used to identify the main factors associated with biosphere reserve management effectiveness was selected using existing approaches for systematic reviews (Luederitz *et al.*, 2015, 2016). The review process followed other systematic literature reviews (Srnka & Koeszegi, 2007; Newig & Fritsch, 2009; Luederitz *et al.*, 2016), and included a systematic procedure for paper selection (steps 1 to 5), and the development of a category scheme (step 6) through a stepwise deductive–inductive coding procedure (Table 2.1; Figure A1).

Table 2.1 Review procedure, adapted from other systematic literature reviews (Srnka & Koeszegi, 2007; Luederitz *et al.*, 2015, 2016)

Review Step	Procedure	Results
1. Data gathering	Database search on Scopus using the defined search string.	Bibliographical information of 2499 potentially relevant papers
2. Data screening	Screening of the data to define the inclusion criteria. Papers published before 1996 were excluded.	Data set reduced to 2286 potentially relevant papers
3. Data cleaning	Screening the title, abstracts and keywords guided by the questions: (i) Is the study engaged with the biosphere reserve concept? (ii) Is the study about management or governance of biosphere reserves? Is the study useful to understand the factors influencing management and governance of biosphere reserves? (iii) Is it an empirical study? 10% of the papers were evaluated by two reviewers and the different decisions discussed.	Data set reduced to 186 potentially relevant papers
4. Data scoping	Download of the potentially relevant papers.	Download of 177 papers (9 papers with no full-text access)
5. Paper classification	Definition of the scale of analysis resulted in the exclusion of those studies with more than one case study. Further papers were excluded because they were not developed in UNESCO biosphere reserves or they didn't comply with the criteria defined in step 3.	66 case studies
6. Categorization	"Thought units" were selected as the units of coding. The category scheme was developed through a backward and forward inductive-deductive approach, based on preliminary and recursive coding.	Category scheme with 4 categories and 53 subcategories

2.2.1 Paper selection

Existing literature was screened in the Scopus database on 10 March 2017. Different combinations of keywords along with "biosphere reserve", such as "management" or "governance", were initially used. However, the inclusion of these terms in the search string was excluding potentially relevant papers, and therefore, only "biosphere reserve" was used. The search was limited to peer-reviewed papers published in English (search string is in the Appendix A). Papers published before 1996 were also excluded because their empirical work was developed before the Statutory Framework (UNESCO, 1996), when the goals of biosphere reserves were mostly focused on the conservation of biodiversity than on a more integrated social-ecological approach. The resulting subset of papers (n = 2286) was screened for the definition of the inclusion criteria (Table 2.2).

Table 2.2 Description of the criteria used to decide the inclusion/exclusion of a paper

Criteria	Description
Engagement of the study with the biosphere reserve concept	Studies performed in biosphere reserves, or that engage with them in some way, e.g. studies realized in adjacent areas, but which report implications for the biosphere reserve.
Link with management or governance of biosphere reserves	A paper was considered to be about management or governance of biosphere reserves if it reports specific actions that were associated with the decision-making body of the biosphere reserve. Defining effectiveness against some pre-determined goals was not possible because the goals of the program are very broad (e.g. sustainable development) and different biosphere reserves have different, more tangible goals. Papers about why management or governance is performed in a specific way were also included. Besides that, only papers about biosphere reserve management or governance, and not its designation, were selected, in order to exclude "paper biosphere reserves", i.e., those where active management is not in place.
Empirical study	An empirical study includes primary or secondary data but not "analysis of analysis", i.e., reviews or research synthesis (Newig & Fritsch, 2009). A critical appraisal of the methods and results of the papers resulted in the elimination of those that do not present enough information for meaningful interpretation (Petticrew & Roberts, 2006) and opinion papers. Studies using very different strategies (e.g. experiments, surveys, ethnographies) were included, in order to cover a diversity of inquiry belief systems or worldviews (Saunders *et al.*, 2009). This selection is, however, influenced by the research philosophies of the reviewers, which determined not only the strategies and methods adopted, but also the perceptions about what is important or useful to consider (Saunders *et al.*, 2009).

The conformity of the papers with the inclusion criteria was made by screening the title, abstract and keywords of each paper. The full-texts were screened by the author, and a precautionary approach was taken - if a paper was perceived to potentially present relevant information, it was included. A portion (10%) of the papers was randomly selected to be evaluated by a second reviewer, and disagreements were discussed and resolved. This helped with building a common understanding and minimizing bias during the process of paper selection (Luederitz *et al.*, 2016). The application of this criteria resulted in the selection of 186 potentially relevant papers. This subset was downloaded, and when the full text was not available, emails were sent to the authors. The analysis of the 177 available full-texts resulted in the further exclusion of those papers that: (i) were developed in biosphere reserves that are not included in UNESCO available databases (UNESCO n.d., 2017); or (ii) included more than one biosphere reserve, or biosphere reserves and other instruments, in multiple case-studies. By including papers that developed studies in only one biosphere reserve, potentially relevant literature of the field may be excluded from this analysis (e.g. Cuong et al., 2017; Reed & Egunyu, 2013; Schultz et al., 2011; Stoll-Kleemann et al., 2010). Many of these papers were, however, included in the discussion of the

framework that resulted from this analysis, in Section 2.4.1. Further papers were iteratively eliminated because they did not comply with the inclusion criteria previously defined. The final number of papers which were used in the next step of the review was 66.

2.2.2 Development of the categories

The categorization procedure followed the one proposed by Srnka & Koeszegi (2007), which is broadly represented in Figure A1. Only the results section of each paper was coded, using NVivo version 11.4.1.1064 (QSR International, 2017). In order to identify general themes, the results sections of the papers were analysed, looking for repetitions, similarities and differences, and causal relations in the text (Ryan & Bernard, 2003). Three main subjects emerged: factors influencing management/governance, management/governance processes, and outcomes. The coding started with an inductive analysis, where codes were assigned to thought units, i.e., text chunks without a pre-defined length but in which a main idea is expressed (Srnka & Koeszegi, 2007). The codes were organized in the general topics previously identified; however, along the coding procedure, the main categories changed to reflect the topics that were emerging from the data. The codes were developed in hierarchies in order to obtain a detailed and precise category scheme (Srnka & Koeszegi, 2007). The coding was performed in a stepwise procedure, in which the data of an increasing number of random papers was assigned to codes. At each step, the coding scheme was reviewed in order to incorporate the new data from the group of papers just coded, but at the same time keeping it at a manageable size. In parallel, existing literature was used to help make sense of the data (deductive approach). When about half of the papers was coded, the scheme had four categories and 113 subcategories. The scheme continued to be interactively changed and simplified, a process that was supported by the discussion of the coding process with other researchers, including comparing different coding solutions, and by checking with existing literature. A second round of coding was performed in which the first papers coded were coded again. The coding scheme continued to be interactively changed in a similar way as in the previous steps, until it was perceived to capture most of the information in the papers. About 20% of the papers were coded a second time (recursive step). The final scheme, with four categories and 53 subcategories, was found to be the most relevant and plausible solution; however, other criteria could have been conceptualized out of the available data. Clear definitions were provided to categories and subcategories.

2.3 Results

The systematic selection of the papers resulted in the inclusion of 66 case-studies for further analysis, i.e., less than 3% of the peer-reviewed English literature with the term “biosphere reserve” present in

the title, abstract or keywords. Reviewed papers are listed in Table A1. As a result of the categorization procedure, four categories and 53 subcategories, which represent factors related to biosphere reserve management effectiveness, were defined. The interactions between these factors across scales result in a dynamic system, which is generally depicted in Figure 2.1.

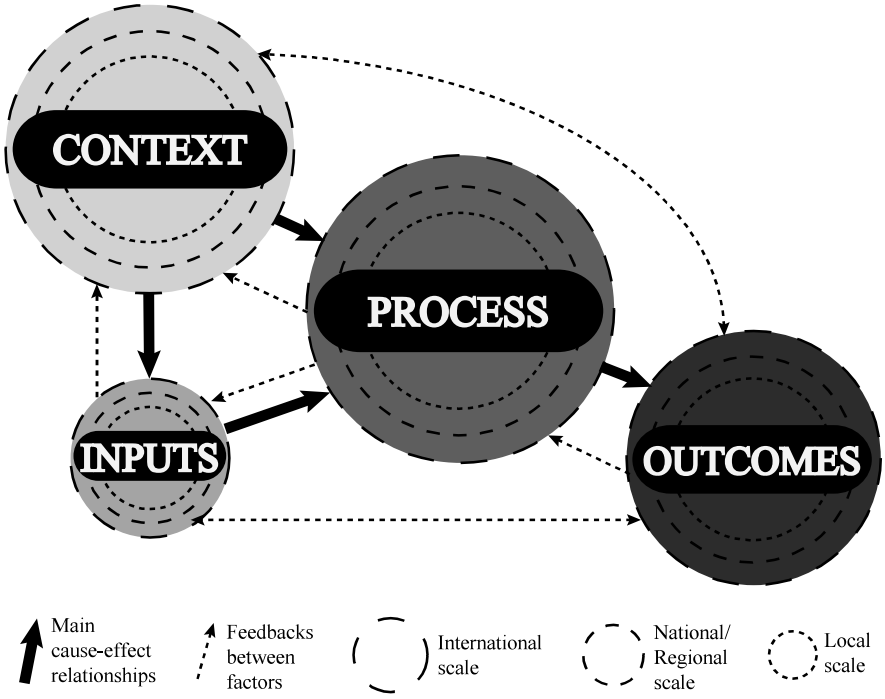

Figure 2.1 A framework to understand biosphere reserve management effectiveness. The figure represents the four core categories that emerged from the empirical literature about the management and governance of biosphere reserves. It also highlights the interactive nature of factors influencing management effectiveness across different scales. The size of core categories is representative of the number of subcategories included: 18 in the process, 17 in the context, 13 in the outcomes and five in the inputs. Different factors are represented by the different intensity of colour of each category and distributed across different scales. The lack of clear boundaries between factors in different categories and scales is represented by the dashed circles. The area of the circles is only illustrative, since information about the number of factors that are important at each scale have not been systematically accessed.

Four core categories were developed: context, inputs, process and outcomes. In the context category it was included place-based and multiscale features, which their presence or absence shape the settings where biosphere reserves are implemented. The inputs category embraces material and immaterial investments in the process. The process category includes factors related to management and governance per se, i.e., those actions and mechanisms which are associated with biosphere reserve decision-making. Finally, in the outcomes category, it was included the impacts and benefits in social and ecological systems that followed the implementation of the process. These factors were associated with subcategories, as depicted in Table 2.3 and are defined in the Tables A2-A6.

Table 2.3 Categories (context (C), process (P), inputs (I), outcomes (O)) and subcategories (C1, C2, etc.) that emerged from the literature about the management and governance of biosphere reserves. Subcategories are organized in thematic groups (in italic) for better understanding

Context (C)	**Process (P)**
Institutions and organizations	*Process and spatial dimension*
C1 Regulations - formal rules	P1 Process scale
C2 Informal institutions and culture	P2 Spatial design
C3 Power issues	*Decision-making*
C4 Organizations	P3 Process initiation
Time related	P4 Public participation
C5 Historical factors	P5 Participatory processes
C6 Time	P6 Management body
Socio-economic attributes	P7 Coordination and leadership
C7 Economy and politics	P8 Institutions for management
C8 Socio-economic attributes	*Instruments*
C9 Information related	P9 Material investments and infrastructure
Purpose of natural resources use	P10 Human resources related
C10 Use of natural resources livelihoods	P11 Conservation and habitat management
C11 Use of natural resources cultural purposes	P12 Restrictions
Human-nature relationship	P13 Enforcement and control
C12 Impacts on natural resources	P14 Incentives
C13 Human-wildlife conflicts	P15 Economic development
C14 Cultural landscape	P16 Research and monitoring
C15 Conservationist value	P17 Information and capacity building
Ecological context	P18 Planning
C16 Bio-physical attributes	
C17 Resource mobility	

Inputs (I)	**Outcomes (O)**	
Attitudes and beliefs	*Benefits*	*Impacts*
I1 Attitudes	O1 Economic	O8 Economic
I2 Beliefs	O2 Social	O9 Social
Investments	O3 Empowerment	O10 Inequality
I3 Funding and material support/opposition	O4 Health	O11 Health
I4 Non-material support/opposition	O5 Learning	O12 Cultural
I5 Type of knowledge	O6 Cultural	O13 Environmental
	O7 Environmental	

A total of 53 subcategories were identified: 17 in the context category, 5 in the inputs category, 18 in the process category and 13 in the outcomes category. “Context” includes features related with social systems, such as the organizations and institutions in place; human-nature interactions, such as human-wildlife conflicts; and ecological features, such as the presence of species with high mobility (e.g. migratory species). “Inputs” includes the attitudes and beliefs actors express in relation to the process; material and immaterial support/opposition; and the type of knowledge (scientific and/or experiential knowledge) that was used as an input for the management/governance. “Process” relates mainly with

decision-making procedures and the instruments used for management, but also with its scale (project vs biosphere reserve management/governance), and process spatial design (features related with, for example, spatial zoning, area and location). "Outcomes" reports economic benefits and impacts, such as the increase/decrease of jobs; positive or negative changes linked with social and cultural features, such as empowerment and creation/deepening of inequalities; and environmental benefits and impacts, such as the increase/decrease of endangered species populations. The factors that influence biosphere reserve management effectiveness occur at different scales. At an international scale, a financial crisis, included in the subcategory economy and politics (C7), was reported in the study of Trillo-Santamaría & Paül (2016). National government material and non-material support (included in the subcategories I3 and I4) was important in the study of Devine (2014). The same study reported on the local degradation of natural assets inside the reserve (subcategory C12 - impacts on natural resources). Factors also occur at different temporal scales - impacts of colonialism (subcategory historical factors; C5) were identified to still be important today in the study of Lyon et al. (2017). A diversity of actors was also covered, of which relevance varies between different factors. Examples of relevant actors in different subcategories include: beliefs of managers of biosphere reserves (subcategory I2, Sundberg, 1998); material support of the national government (subcategory I3, Trillo-Santamaría & Paül, 2016); and economic impacts in local communities (subcategory O8, Maikhuri et al., 2000). In Figure A2, a scheme demonstrating how the different components of the framework can interact is given.

2.4 Discussion

2.4.1 Factors influencing biosphere reserve management effectiveness

In the proposed framework, there were identified 53 subcategories which represent different factors that influenced biosphere reserve management effectiveness around the world. Outcomes were also included as influencing factors, because of the feedback between them and the other subcategories. The high number of factors in the proposed framework combines elements of different global and regional studies, which highlight the importance of factors related to the management/governance process (Stoll-Kleemann & Welp, 2008; Cuong *et al.*, 2017b), the inputs, and the socio-economic and institutional context (Ravindra, 2004; Hirschnitz-Garbers & Stoll-Kleemann, 2011). In addition, the proposed framework considers the importance of contextual variables related to the existing ecological characteristics, and to the interaction and interdependence between the ecological and social systems. The reviewed literature reports conflicts that emerged because of restrictions to natural resource use were applied in contexts where communities are highly dependent on them for their livelihoods (e.g. Azcárate, 2010). In other studies analysed, existing conflicts between humans and wildlife (for instance, the depredation of livestock by predators, Maikhuri *et al.*, 2000) required some interference by managers, such as compensation for the economic losses. In both situations, managers face challenges

that may not exist in other biosphere reserves and therefore have to correspondingly adapt the management/governance process. Many factors related to the way that biosphere reserves are managed and governed were identified in the reviewed literature. The implementation of biosphere reserves is taking place by using a variety of instruments related to the MAB Programme goals (UNESCO, 1996, 2015). Biodiversity conservation and the sustainable use of natural resources is promoted through conservation and habitat management initiatives (P11), restrictions (P12), enforcement and control (P13) and incentives (P14). Incentives (P14) and economic development (P15) are related to the biosphere reserve's sustainable development goals. The logistic function of biosphere reserves is being implemented through research and monitoring (P16) and information and capacity building (P17). Although it was not accessed if all biosphere reserves are working towards the three goals, the identification of factors related to instruments to achieve the goals of sustainable development and logistic support is indicative that there are already biosphere reserves moving from their previous conservation focus.

According to the MAB Programme (UNESCO, 2015), community participation should take place at many stages of biosphere reserve implementation. This study concurs with existing research that highlights the importance of public participation for the success of biosphere reserves (Stoll-Kleemann & Welp, 2008; Schultz *et al.*, 2011; Cuong *et al.*, 2017b). However, the way participatory processes are developed (P5), including who participates, in which moments and the available information, was also found to be important (e.g. Durand *et al.*, 2014). Other relevant factors related to the decision-making include the way the process was initiated (top-down, bottom-up or mixed; P3), the degree of centralization of the management body (P6), coordination and leadership (P7), and which institutions (P8) - formal or informal - are mainly used for management.

In the Section 2.1.1, it was discussed how the assessment of biosphere reserve management effectiveness is hampered by the lack of an adequate evaluation mechanism and indicators. In this study this limitation was overcame by inductively identifying the changes resulting from the implementation of the processes, instead of evaluating effectiveness against some predetermined goals. Remarkable achievements, following biosphere reserve implementation, were identified, such as empowerment (O3) and learning (O5). Following existing definitions of empowerment (Oldekop *et al.*, 2016), this subcategory includes situations in which local communities are given the responsibility and decision-making of managing their own resources. This was reported in the Sian Ka'an Biosphere Reserve in Mexico, where fishermen participated in the definition of new no-take marine zones (Velez *et al.*, 2014). Evidence of social and transformative learning, as defined by Armitage *et al.* (2008), was reported in the Kristianstads Vattenrike Biosphere Reserve in Sweden. In this biosphere reserve, politicians have changed their perceptions about the importance of informal gatherings, and developed new processes accordingly, such as the "environmental breakfasts", to discuss the environment with farmers (Hahn, 2011).

The implementation of biosphere reserves is also associated with negative social and environmental changes. In the Waterberg Biosphere Reserve (South Africa), up-scale tourism, based on the creation of luxury spaces where "ordinary man" can't afford to visit, is being developed (Lyon *et al.*, 2017). The unequal access to the cultural benefits arising from ecotourism development was included in the inequality subcategory (O10). The same study reports environmental impacts (O13) deriving from the development of this kind of tourism; in particular, the unsustainable use of water. This example is demonstrative of the need for more clear guidelines regarding what "sustainable development" means in a biosphere reserve: at what environmental expense can development take place? Is equality a less important goal than providing environmental and economic benefits?

During the framework development, the importance of three main scales emerged: local, regional-national and international. There were identified factors related to natural and social processes, which are relevant at regional or global scales, e.g. the life cycle of migratory species and factors related to globalization. The importance of scale and cross-scale dynamics are increasingly recognized in environmental management, in particular the mismatch between biophysical systems and their management and governance structures (Cash & Moser, 2000; Cumming *et al.*, 2006). Biosphere reserves are in a privileged position to address scale mismatches, given their global network and their role as arenas where a diversity of stakeholders at different scales interact. Studies on collaboration networks may provide useful insights in this regard by analysing cooperation and communication strategies between the different actors (Nita *et al.*, 2016, 2018).

A social-ecological system understanding of biosphere reserve management effectiveness, as displayed in the proposed framework, revealed many factors that were overlooked in previous studies. The author acknowledges that the framework is not fully comprehensive, and that different criteria could have been conceptualized out of the available data. The integration of more studies, including from grey literature or potentially sub-represented regions, would be important. A better conceptualization of some subcategories e.g. attitudes (I1) and beliefs (I2), is also needed to avoid confusion between them. Despite that, the framework brought a higher tangibility to some factors, in particular those related to how biosphere reserves are being managed and governed, and which contextual factors could be important, which are frequently referred to at a high abstract level (Hirschnitz-Garbers & Stoll-Kleemann, 2011). Furthermore, this framework shows that social and ecological benefits and impacts have been associated with the management and governance of biosphere reserves, which, to my knowledge, has never been systematized. A better understanding of the factors that consistently led to benefits or impacts of biosphere reserve management and governance is necessary; however, at this point, these cause-effect relationships were not possible to systematize. Future work is needed in order to better understand the system dynamics. Also, the spatial distribution of the subcategories identified would lead to a better understanding of the main patterns related to the context, inputs, process and outcomes of biosphere reserve management and governance. The framework is, therefore, a first step

towards a more holistic systems analysis of biosphere reserve management effectiveness. It can further inspire management and governance of biosphere reserves at different scales, e.g. through the definition of specific third-level variables, the framework may provide a structure for the development of criteria for the establishment and evaluation of biosphere reserves, as developed for biosphere reserves in South Africa (Pool-Stanvliet *et al.*, 2018). It may also be useful to systematically report experiences with management and governance, as already proposed in relation to adaptive co-management processes (Plummer *et al.*, 2017). Such systematization can provide a better understanding of factors associated with positive and less positive outcomes and, eventually, the identification of the factors in the system that may leverage biosphere reserves success. The framework also provides a structure to comprehensively analyse literature about management and governance of biosphere reserves, and identify major trends and research gaps. Considering its operationalization, the framework should be regarded as a flexible tool in which subcategories may be added or eliminated, or some may even change between the four main categories, in order to better address the challenge at hand.

2.4.2 Biosphere reserve framework and social-ecological system frameworks

The proposed framework connects different fields of knowledge and provides a comprehensive understanding of the factors related to sustainable management and governance of social-ecological systems. It is a social-ecological framework in which dynamics of social, ecological or social-ecological elements are linked across different scales and time. It has empirical support since the categories emerged from the results section of previously selected peer-reviewed empirical papers. The mixed inductive-deductive coding process allowed the incorporation of previously developed ideas from social-ecological systems literature (the Ostrom social–ecological systems framework, Ostrom, 2009), social-ecological systems and protected areas (Cumming *et al.*, 2015; Martín-López & Montes, 2015), biosphere reserve effectiveness (Hirschnitz-Garbers & Stoll-Kleemann, 2011) and environmental management (TEEB, 2009). Other references used are identified in the description of the subcategories (Tables A2-A6). Because the proposed framework included studies from a diversity of researchers, it embraces their different worldviews, research strategies and methods, making it more comprehensive than a single-study analysis. This diversity is required in the study of complex systems because it allows the incorporation of different perspectives in the management and governance of systems that are highly uncertain and poorly understood (Berkes *et al.*, 2003). It is not claimed, however, that the proposed framework is value-free, and this is particularly relevant considering that the categorization process was primarily developed in an inductive way. In order to increase the reliability of the review procedure without compromising its validity, multiple reviewers were included in both the selection of the papers and categorization processes and the coding procedure was carefully disclosed, as recommended by Srnka & Koeszegi (2007). The proposed framework follows, therefore, the major criteria Cumming

(2014) has proposed for the development of theory-driven social-ecological system frameworks. Despite being accomplished through the analysis of biosphere reserve management and governance, it may also contribute to the advancement of theory in social-ecological systems.

Compared to other SES frameworks, the proposed framework includes the same number of subcategories as Ostrom's second-level variables (Ostrom, 2009). Many variables are in common with Ostrom's framework, e.g. the mobility of resources, monitoring and sanctioning processes, socio-economic attributes of users, norms/social capital and the importance of the resource. Ostrom's framework places more emphasis on the ecological variables and variables related to the process of extraction (e.g. harvesting levels and the number of users). The framework proposed in this study highlights that existing conservationist values are also important, because they trigger the interest and actions of actors at different scales, which will change the local social settings. Many variables related to existing power relations were also identified, which are absent in Ostrom's framework (e.g. historical factors, power issues and inequality). These differences can be related to the broader scientific perspectives that have been included in this study, comparing to Ostrom's roots in an institutional analysis. In Table 2.4 a comparison between some aspects that may explain the differences between both frameworks is provided.

Table 2.4 Elements of the Ostrom's (Ostrom, 1990, 2009) and biosphere reserve frameworks which may explain the differences between them. The comparation is performed with Ostrom's initial work and excludes more recent updates to the framework, e.g. McGinnis & Ostrom (2014)

Element/ Framework	Ostrom	Biosphere reserves
Goal	Understand factors that affect the likelihood of self-organization for natural resource management	Understand factors that affect biosphere reserves management effectiveness
Scale	Small-scale, usually a common-pool resource (e.g. forest, fisheries, groundwater)	Local to international scales – some case studies focused in the management of a specific task, while others in the management of a transboundary biosphere reserve
Public/private nature of the resources	Mainly common-pool resources; public goods and socio-technical systems to a smaller extent	Diverse: private, common or public goods and services
Biodiversity values included	Economic values	Economic and non-economic values, e.g. fundamental and eudemonistic values (Jax *et al.*, 2013) associated with the core and buffer zones
Governance actors	Local communities	Diverse: governments, communities, non-governmental organizations, and/or multiple ways of collaboration between them

Table 2.4 (continuation)

Element/ Framework	Ostrom	Biosphere reserves
Roots	Institutional theory, collective action theory, rational choice theory and institutional change	The framework was developed to reflect the theoretical perspectives of the authors of the included studies (e.g. political ecology). The influence of the reviewer's disciplinary background (ecology) cannot, of course, be discarded
Based in blueprint solutions?	No	Yes, to some extent (e.g. strict protected core area)

The proposed framework is also consistent with other social-ecological frameworks. It concurs with Cumming et al. (2015), by emphasizing the relevance of scales for the effectiveness of conservation strategies. It is also consistent with the framework developed by Plummer *et al.*, (2017), concerning adaptive co-management initiatives. Using a similar structure, based in settings, antecedents, process and outcomes, the authors developed a set of subcategories, which are particularly important regarding the processes of learning and collaboration. Both frameworks differ in respect to many of the subcategories identified and how are they arranged in the four main categories. The framework proposed in this study also provides a more exhaustive identification of most of the subcategories, and a clear recognition of the importance of the context, feedbacks and scales across all categories. Therefore, besides being consistent with the frameworks discussed (Ostrom, 2009; Cumming *et al.*, 2015; Plummer *et al.*, 2017), this framework adds new information, and provides a more holistic perspective on social-ecological systems management and governance.

2.5 Conclusions

Current and predicted high rates of biodiversity loss (Butchart *et al.*, 2010; Pereira *et al.*, 2010), along with high variability, uncertainties and ignorance about the ecological systems (Daly & Farley, 2011) constitute a large challenge for the sustainable management and governance of social-ecological systems. Biodiversity conservation strategies are required because of the role biodiversity plays in the provision of ecosystem functions and structure, from which human well-being ultimately depends (Daly & Farley, 2011), but also because of the value that biotic resources have on their own. The proposed framework reveals that the cross-scale interlinkages between those social and ecological systems where conservation strategies are implemented cannot be overlooked, contributing a better understanding of management and governance of social-ecological systems along with the conservation of biodiversity. Through the integration of a diversity of empirical studies about biosphere reserve management and governance, the framework integrates multiple worldviews, research strategies and methods, providing

a more holistic perspective of social-ecological systems. The proposed framework reveals that a big diversity of factors potentially influences the capacity of biosphere reserves to achieve their goals. Biosphere reserves are not islands - they are influenced by the interlinkages of social and ecological contextual factors at different spatial and temporal scales. They are dependent on a set of inputs to be managed and governed, which are also associated with a diversity of scales and actors. The varied strategies used to manage and govern social-ecological systems in biosphere reserves are also important, because they trigger social and ecological changes, and not only in a positive way. The framework proposed may provide a structure to further analyse such complex system dynamics, and potentially reveal the sources of poor and successful outcomes in biosphere reserves and social-ecological system management and governance. Biosphere reserves may offer a unique opportunity to understand pathways for more sustainable social-ecological systems. Their ambitious goals match the huge challenges humanity currently face, including halting biodiversity loss and ending poverty. It is expected that the proposed framework may contribute to a more holistic, systems understanding of biosphere reserve management and governance, and to its effectiveness, i.e., “a world where people are conscious of their common future and interaction with our planet, and act collectively and responsibly to build thriving societies in harmony within the biosphere” (UNESCO, 2015).

3 Biosphere reserves' management effectiveness – a systematic literature review and a research agenda

This study was submitted to a peer-reviewed journal:

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Author Contributions:

The first author has conceptualized and designed the study, carried out the review procedure and wrote the manuscript. Heike Zimmermann, Rui Santos and Henrik von Wehrden have supported the first author in the design of the research, analysis of the data, discussion of the results and revision of the manuscripts.

Abstract

Research about biosphere reserves' management effectiveness can contribute to better understanding of the existing gap between the concept and its implementation. However, there is a limited understanding about where and how research about biosphere reserves' management effectiveness has been conducted, what topics are investigated, and which are the main findings. This study addresses these gaps in the literature building on a systematic literature review of the scientific literature. There were investigated: characteristics of publications, scope, status and location of biosphere reserves, research methods and management effectiveness. The results indicate that the research is conceptually and methodologically diverse, but unevenly distributed. Three groups of papers associated with different goals of biosphere reserves were identified: capacity building, biodiversity conservation and sustainable development. In general, each group is associated with different methodological approaches and different regions of the world. The results indicate the importance of scale dynamics and trade-offs between goals, which are advanced as important leverage points for the success of biosphere reserves. Building on the gaps identified in the literature, a research agenda is proposed, focusing on the need to investigate mechanisms for holistic research, outcomes and trade-offs, transformations for social-ecological fit and institutions for integrated management across scales.

Keywords

Biodiversity Conservation; Biosphere Reserve; Leverage Points; Management Effectiveness; Research Agenda; Social-Ecological Systems; Sustainability Science; Sustainable Development; Systematic Literature Review; Trade-Offs

3.1 Introduction

Biosphere reserves are privileged places to understand how to sustainable manage and govern social-ecological systems (Ferreira *et al.*, 2018) and to advance sustainability science (UNESCO, 2015; Reed, 2019). The World Network of Biosphere Reserves (WNBR) currently contains 701 designated sites, distributed over 124 countries (UNESCO, 2019a). The relevance and broad interest in the biosphere reserve enterprise does not translate, however, into a successful implementation, as there is a considerable gap between the concept and its practical realization (Ishwaran *et al.*, 2008; Price *et al.*, 2010; UNESCO, 2013). Research about biosphere reserves' management effectiveness can provide a better understanding of why there is this gap (Cuong *et al.*, 2017a,b; Ferreira *et al.*, 2018), what is its extension (Reed & Egunyu, 2013) and how can it be closed (George & Reed, 2016, 2017; Stoll-Kleemann & O'Riordan, 2017). However, there is a limited understanding about where and how the research about biosphere reserves' management effectiveness has been conducted, what topics have been investigated and which are the main findings. This study addresses these gaps in the literature.

Biosphere reserves are the means of implementation of the United Nations Educational, Scientific and Cultural Organization Man and Biosphere (MAB) Programme (UNESCO, 2015). The first biosphere reserves were designated in 1976 in eight countries (Vernhes, 1987) and were focused in the protection of natural and genetic diversity and in supporting ecological and environmental research and education (UNESCO, 1974). Most of them were superimposed in already existing protected areas (Price *et al.*, 2010). However, with the adoption of the Seville Strategy and the Statutory Framework (UNESCO, 1996) a more integrated approach, that remains as a cornerstone of the Programme, was implemented. According to the Statutory Framework (UNESCO, 1996) and the most recent MAB Strategy (UNESCO, 2015), biosphere reserves have four main goals: (1) the conservation of biodiversity, sustainable use of natural resources and restoration of ecosystem services; (2) sustainable human and economic development, and promotion of healthy and equitable societies; (3) logistic support to research and environmental education and the facilitation of sustainability science and education for sustainable development; and (4) contribution to the mitigation and adaptation to climate change. The Statutory Framework (UNESCO, 1996) also determined the criteria required for the designation of a biosphere reserve, which includes an appropriate zoning scheme with three areas, associated with different degrees of use of natural resources, and a participatory governance body that includes a diversity of actors. The periodic review process, which evaluates the conformity of biosphere reserves

with the designation criteria every 10 years, was also adopted with the Statutory Framework. This is the only existing mechanism that evaluates the implementation of biosphere reserves, however, it provides limited information because it is more focused in the compliance with the designation criteria, than with effectiveness in achieving the goals (Matar & Anthony, 2017). Besides that, there is high rate of non-response and delay, and periodic review reports are not widely available (Matar & Anthony, 2017).

Following the definition adopted in the literature of protected areas (Hockings *et al.*, 2006, p. 1), biosphere reserves' management effectiveness is how well biosphere reserves are being managed, i.e. the extent to which they achieve the goals for which they are designated. Management effectiveness integrates three dimensions: design, adequacy of processes and delivery of goals (Hockings *et al.*, 2006, p. 1). Existing scientific literature related with biosphere reserves' management effectiveness have mainly focused in identifying general factors that influence the success of biosphere reserves (Stoll-Kleemann & Welp, 2008; Cuong *et al.*, 2017b) or in determining compliance with the designation criteria, through the analysis of periodic reviews (Price *et al.*, 2010; Reed & Egunyu, 2013). Only one large-scale study investigated the relationships between processes - participation in implementation and decision-making - and the achievement of the goals of biosphere reserves (Schultz *et al.*, 2011). Therefore, most of the large-scale studies have focused more on the design and process dimensions of management effectiveness than on a more holistic analysis that also includes the delivery of goals. Moreover, the studies frequently rely in the analysis of the opinions of experts of biosphere reserves, such as managers and scientists (Stoll-Kleemann & Welp, 2008; Schultz *et al.*, 2011; Cuong *et al.*, 2017b), excluding other forms of determining and perceiving the effectiveness of biosphere reserves' management.

The conceptual framework developed by Ferreira *et al.* (2018), summarises the most important factors to be considered in biosphere reserves' management effectiveness, according to a more holistic approach. This framework highlights four main categories – context, inputs, processes and outcomes – and 53 subcategories that interact at different scales. However, it is still poorly understood how the relationship among these subcategories may reflect the success of biosphere reserves. To contribute to a better understanding, this study access how the current scientific literature is related according to these subcategories. The scientific literature analysed in this study was retrieved from Ferreira *et al.* (2018), and re-coded according to the presence/absence of each subcategory from the same framework. Further data was collected to provide a comprehensive overview of the scientific literature related with biosphere reserves' management effectiveness: information about the publications (e.g. publication year and affiliation of the author), scope, status and location of the biosphere reserves studied, and the methods used in the research. The results demonstrate the existence of bias and gaps in the field that were used to develop a research agenda about biosphere reserves' management effectiveness, in order to inspire and advance inquiry about this important topic.

3.2 Methods

3.2.1 Data collection

Selection of the papers

The selection of the papers used in this study results from the systematic literature review conducted by Ferreira *et al.* (2018), to develop a conceptual framework that summarises which factors are important to biosphere reserves' management effectiveness. An overview of how the papers were selected is given here, however, a more profound description can be found in Ferreira *et al.* (2018). A literature search was conducted in the Scopus database on the 10th of March 2017 (search string available in the Appendix A). Only peer-reviewed papers published in English were included. Papers published before 1996 were excluded in order to focus the analysis in the more integrative approach biosphere reserves have adopted after the Statutory Framework (UNESCO, 1996). The abstract, title and keywords of 2286 potentially relevant papers were screened against the following inclusion criteria: i) engagement with the biosphere reserve concept; ii) useful to understand management and governance of biosphere reserves; and iii) is an empirical study. Another reviewer evaluated 10% of the papers to identify disagreements in the paper selection process. From the 177 papers downloaded (9 papers were not accessible), those that performed comparative analysis (e.g. Reed & Egunyu, 2013; Reed, 2016) were excluded, to obtain only the studies that were developed in one biosphere reserve. Research conducted in biosphere reserves that were not present in the UNESCO databases in June 2017 (UNESCO n.d., 2017) was also excluded, such as the study of Schmidt *et al.* (2017) that was developed in a biosphere reserve yet to be designated. The references of the 66 publications obtained are disclosed in Table A1. The search string used, and the selection process, ensured a high specificity for peer-reviewed literature related to management and governance of biosphere reserves. This explains why only a small part of the existing scientific literature was included. Similar results were obtained in a bibliometric analysis of biosphere reserves' research (Kratzer, 2018): most of the existing research is developed in the biosphere reserves, but not necessarily about them.

Definition of subcategories

To analyse the literature, a set of categories and subcategories were defined, related to four main topics: i) features of the publication; ii) scope, status and location of the biosphere reserve where the study was developed; iii) methods used in the research; and iv) management effectiveness (Table 3.1).

Table 3.1 Main categories used to review the publications related to biosphere reserves' management effectiveness: features of the publication, scope, status and location of the biosphere reserve, research methods and management effectiveness. MAB – UNESCO Man and Biosphere Programme; BR – biosphere reserve. Subcategories are listed in the Table B1.

Publication	Biosphere reserve scope, status and location	Research methods	Biosphere reserve' management effectiveness
Year of publication Journal subject area Affiliation of the author	BR name Transboundary BR? Withdrawn BR? Designation year Location	Methods - data collection Actors enrolled Methods - data analysis	Context Inputs Process Outcomes Scale*

*Context, inputs, process and outcomes subcategories were coded for their relevance at international or national/regional scales

A total of 147 subcategories were used to review the papers (Table B1). They were adapted from existing classifications, such as the classification of countries according to the UNESCO MAB regions (UNESCO, 2017), or inductively developed, e.g. the subcategories of research methods. To analyse the main findings concerning management effectiveness, the framework developed by Ferreira *et al.* (2018) was used. This framework describes 53 general factors, grouped in four main categories - context, inputs, processes and outcomes – which were identified as important for understanding biosphere reserves' management effectiveness. An overview of the framework subcategories is given in Table B2.

Data about the publication was retrieved from ELSEVIER (2017), and data about the biosphere reserves was retrieved from UNESCO databases (UNESCO n.d., 2017). Data about the research and biosphere reserves' management effectiveness was coded in the 66 papers using MAXQDA Plus 12 (VERBI Software, 2018). To accommodate information that did not fit in the defined subcategories, "other" options were included. Coding was only performed in the results section of each paper. Text from other parts of the paper was coded, if necessary, to understand the results. Multiple codes could be assigned to the same text segment. The text was interpreted in order to associate text chunks to the codes, guided by the definitions of each of the subcategories. All aspects of the social-ecological systems where biosphere reserves are implemented, and the management and governance systems in place, were coded.

3.2.2 Data analysis

To access the main patterns in the data, descriptive statistics was used in R version 3.4.3 (R Core Team, 2017); plots were developed using the ggplot2 package for R (Wickham, 2016). A cluster analysis (Everitt *et al.*, 2011, pp. 261–278) was performed to identify groups of publications that address

biosphere reserves' management effectiveness in a similar way. The variables, the clustering method and the number of clusters were determined in a back-and-forward procedure. A database with the presence/absence of context, processes, inputs and outcomes subcategories (n = 53) in the 66 papers was used (Table B1). A distance matrix was developed using the Jaccard Index, as implemented in the *vegdist* function of the vegan package for R (Oksanen *et al.*, 2018). After testing different clustering methods, the ward.D was selected to continue the cluster analysis because of its interpretability and the strong clustering structure, as revealed by the agglomerative coefficient (Table B3).

The optimal number of clusters was determined by evaluating and interpreting different cluster solutions in relation to the generality and specificity of the results. Multidimensional scaling (MDS) was also used to determine if groups in the data can be visually identified. Vectors of external variables significantly correlated with the clustering were fitted in the MDS, as implemented in the *envfit* function of the *vegan* package for R, in order to explore the influence of: i) the methods used for data analysis, ii) the MAB region where the study took place and iii) if the study was conducted in a biosphere reserve designated before or after the Statutory Framework.

The dissimilarities among the groups of papers obtained from the cluster analysis were investigated by conducting a permutational multivariate analysis of variance (PERMANOVA), using the Jaccard distance matrix and 999 permutations, as implemented in the *adonis* function of the vegan package for R (Oksanen *et al.*, 2018). The analysis was repeated for each pairwise comparison among clusters. The regression coefficients from each PERMANOVA were used to identify the subcategories that most contributed for the dissimilarities among the clusters tested.

The proportion of papers that refer each subcategory in each cluster was computed, to identify the common subcategories that are very frequently referred (in more than 70% of the papers included in each cluster).

To analyse the outcomes, the subcategories social benefits, empowerment and learning were merged in "positive social outcomes"; and the subcategories social impacts and inequality were merged in "negative social outcomes". Then, the number of papers that refer a given outcome in each biosphere reserve was summed.

To evaluate the importance of scales in management effectiveness, the proportion of papers that refer each subcategory at international or national/regional scales was calculated, in relation to the total number of papers that refer each subcategory.

3.3 Results

3.3.1 Characteristics of the publications

From 1998 to March 2017, the number of publications related with management and governance of biosphere reserves have generally increased, despite annual variations (Figure B1). The number of studies published in journals related to environmental or social sciences is higher than in other fields of research (Figure B2).

The first authors of the analysed papers have affiliations in Europe and North America (57.6%), Asia and the Pacific (25.7%) and Latin America and the Caribbean (16.7%). The relationship between the author's affiliations and the region where the study was developed is represented in Figure 3.1. Authors from Europe and North America developed studies in all the MAB regions; authors with other affiliations developed studies mainly in their own respective regions.

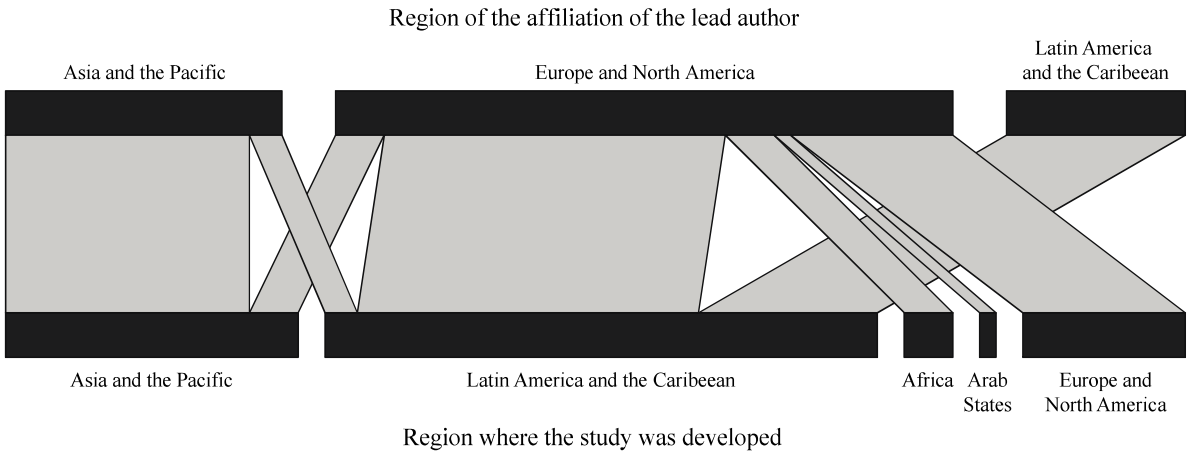

Figure 3.1 Network visualization of the MAB regions where the lead authors of the reviewed studies are affiliated (upper row) and the MAB regions where the studies were developed (inferior row).

3.3.2 The biosphere reserves studied

The papers analysed performed their research in a total of 38 different biosphere reserves (Table B4). The higher number of studies was conducted in the Maya (Guatemala), Nanda Devi (India), Wolong (China), Danube Delta (Romania/Ukraine) and El Vizcaíno (Mexico) biosphere reserves. Two transboundary biosphere reserves were analysed - Gerês/Xurés, in Portugal and Spain, and the Danube Delta, between Romania and Ukraine - however, only the study in Gerês/Xurés was performed for the entire transboundary biosphere reserve. At the time the data was analysed, none of the investigated biosphere reserves have withdrawn the network. The biosphere reserves studied were designated between 1977 and 2012; 42% before and 68% after the adoption of the Seville strategy.

In total, single case-studies about management/governance were performed in about 6% of the designated biosphere reserves. The countries where more than three studies were performed are: Mexico (n= 21), Guatemala (n=9), India (n=8) and China (n=7). Among the countries with a higher number of sites designated, only Mexico and China have studies developed in more than 10% of their biosphere reserves (Figure 3.2).

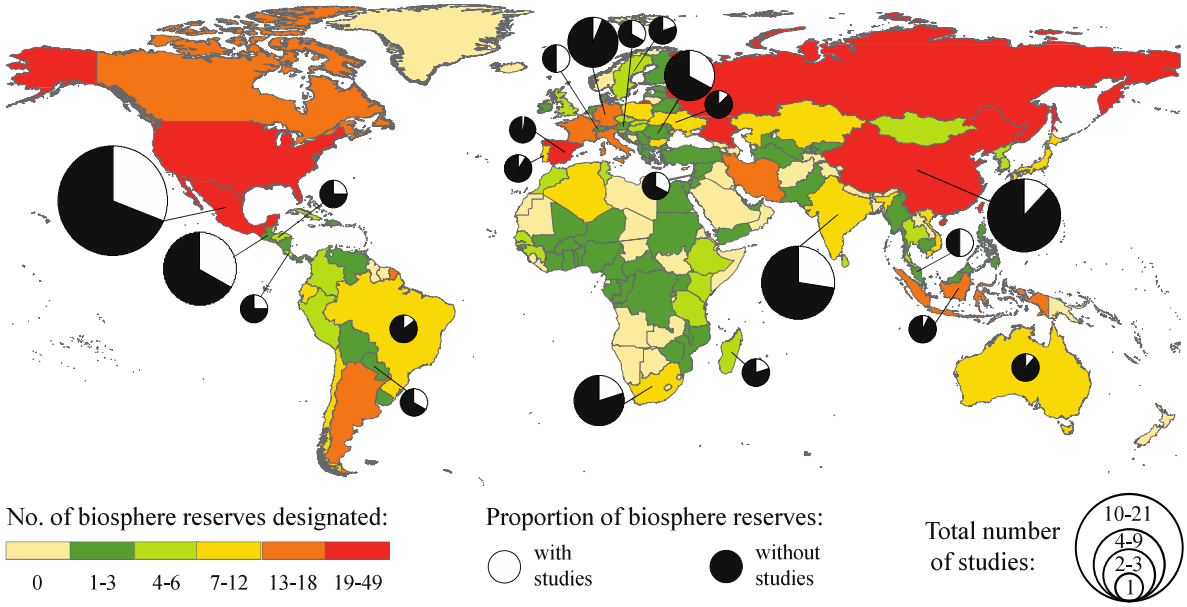

Figure 3.2 Number of biosphere reserves designated in relation to the number of case studies reviewed by country. The proportion of biosphere reserves with studies vs without studies by country is represented, respectively, by the white and black fill of the circles. The size of the circle represents the total number of studies by country. Each country is coloured according to the number of biosphere reserves designated.

3.3.3 Research methods

Studies related to biosphere reserves' management effectiveness have used a median number of three different methods for data collection (Figure B3a), mostly interviews, document analysis and observation (Figure 3.3a). Almost 91% of the studies involved actors in data collection. Half of the studies involved two different actors (median, Figure B3b), mainly local communities and governmental actors (Figure 3.3b).

Considering the data analysis, qualitative methods were used in about 58% of the papers alone; in about 29% of the papers mixed qualitative and quantitative methods were used; exclusive quantitative methods were used in only 13% of the papers.

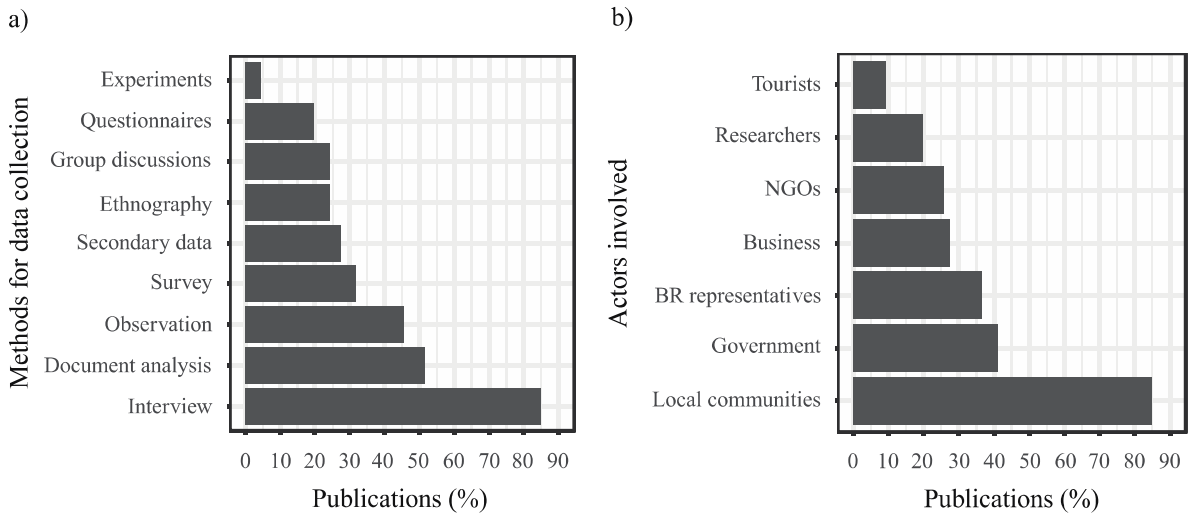

Figure 3.3 Proportion of the papers in relation to: a) the methods used for data collection; b) the actors involved in data collection. MAB – Man and Biosphere Programme; NGOs – Non-governmental organizations.

3.3.4 Biosphere reserve's management effectiveness

Cluster analysis

A cluster analysis was developed to assess how the scientific literature is related according to the subcategories of biosphere reserves' management effectiveness (Ferreira *et al.*, 2018) (Figure 3.4). A partitioning with three clusters provided the ideal trade-off between specificity and generality of the results (Figure B4). This solution achieved a high agglomerative coefficient (0.87; maximum of 1), however, according to the cluster evaluation statistics (Table B5) there is some uncertainty about which papers should be clustered together. The MDS (Figure 3.4b) also show some overlap between the groups, in particular between clusters number one and two. From the three external variables analysed - methods used for data analysis, the MAB region where the study was conducted, and the study being developed in a biosphere reserve designated before or after the Seville Strategy - only the first two are significantly correlated with the clustering. The methods used for data analysis are very strong predictors of the clustering ($P < 0.001$), as represented in Figure 3.4b: quantitative methods are more correlated with the third cluster (economic development), qualitative methods with the first cluster (capacity building) and mixed methods with the second cluster (biodiversity conservation). The MAB region where the study was performed is also correlated with clustering ($P < 0.01$), however the predictors are weaker: the cluster#3 is more correlated with studies developed in the Asia and the Pacific and cluster#1 in Latin America and the Caribbean. The second cluster includes studies conducted in a diversity of regions.

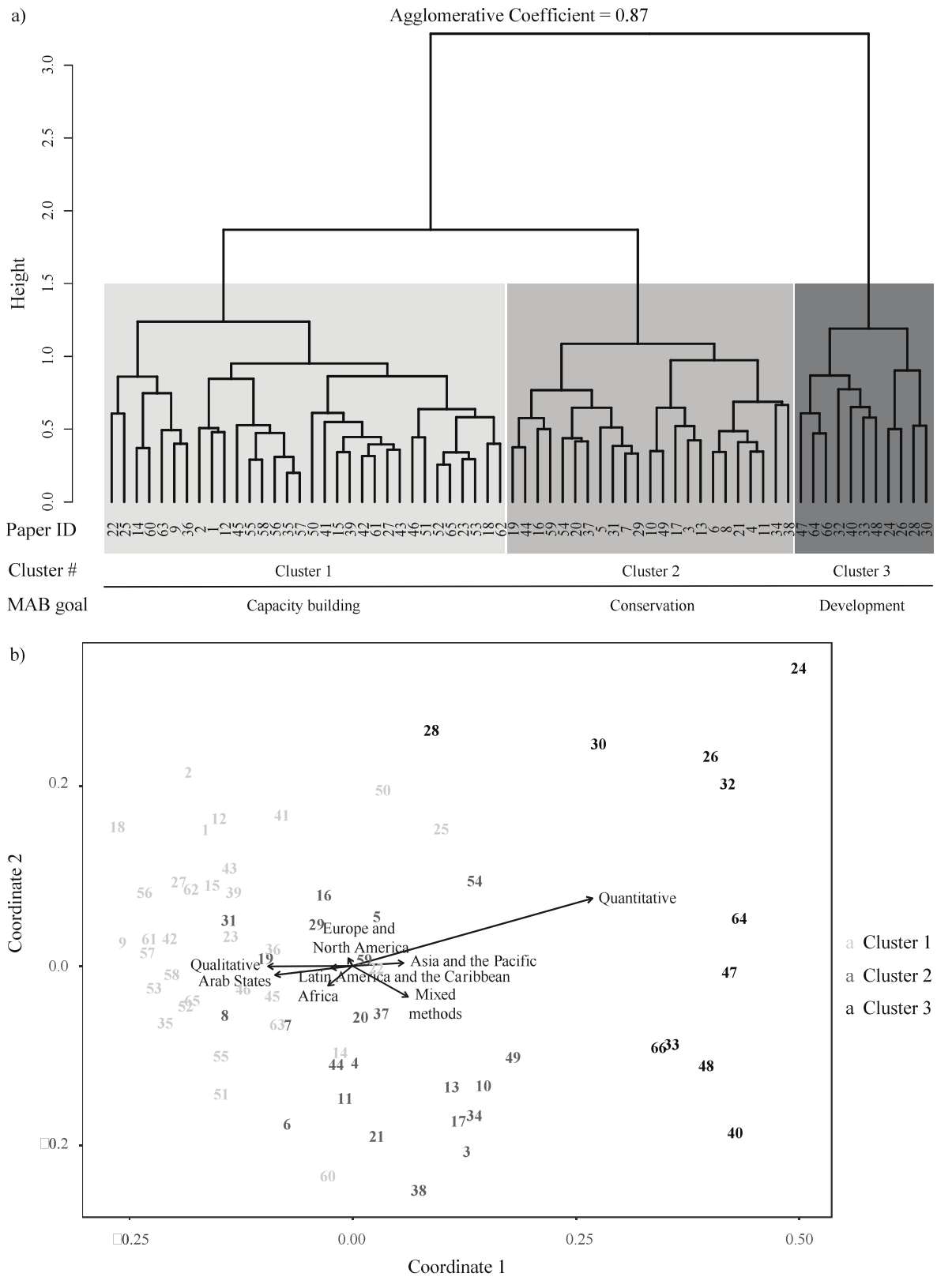

Figure 3.4 Cluster analysis of the scientific literature about biosphere reserves' management effectiveness: a) dendrogram showing three groups of papers; b) the three groups of papers in a multidimensional scaling (MDS). Only the variables that are significantly correlated with the clustering are represented: methods used for data analysis and MAB region.

There are, however, significant differences in the composition of the subcategories across all clusters ($P < 0.001$). The 20_{th} subcategories that most contribute to the dissimilarities between clusters are aggregated in Table 3.2. Comparing to the other clusters, the papers included in the cluster#1 (n=32) are more associated with subcategories of governance (empowerment, participatory processes, management body) and learning (information, type of knowledge, learning). Papers included in the cluster#2 (n=23) are more focused in subcategories related with biodiversity conservation (conservation and habitat management, economic and social impacts) and activities associated with it (cultural use of natural resources, material investments and infrastructure, cultural benefits). The subcategory that mostly contribute to the dissimilarities between papers included in the cluster#3 (n=11) and the others is economic benefits. The subcategories mainly associated with the papers in each cluster are, therefore, related with three goals of the biosphere reserves: capacity building, conservation of biodiversity and economic development.

More than 70% of the papers of the three clusters investigate the management/governance of a project in biosphere reserves. Other three subcategories that are very frequently referred in the three clusters are the socio-economic attributes of the context, and the restrictions and incentives implemented in the biosphere reserve being studied.

Table 3.2 Subcategories that most contribute to the dissimilarities between clusters, obtained from the coefficients of the PERMANOVA

Category/ MAB goal	Capacity building	Conservation	Development
Context	Historical factors		-
	Organizations		
	Formal rules		
	Informal institutions and culture		
	Impacts on natural resources		
	Information related	Power issues	
	Time	Economy and politics	
	-	Cultural use of natural resources	
		Extractive resource-based livelihoods	
Inputs	Non-material support/opposition		-
	Funding and material support/opposition		
	Attitudes		
	Beliefs		
	Type of knowledge	-	
Processes	Planning		-
	Public participation		
	Coordination and leadership		
	Information and capacity building		
	Institutions for management		
	Process scale BR	Material investments and infrastructure	
	Process spatial design	Conservation and habitat management	
	Process initiation	-	
	Characteristics of the management body		
	Characteristics of the participatory processes		
Outcomes	Empowerment	Cultural benefits	Economic benefits
	Social benefits	Economic impacts	-
	Learning	Social impacts	

Outcomes

From the 66 papers analysed, 43 report at least one benefit; 49 at least one impact, and 32 both benefits and impacts. The number of papers that report environmental, economic, cultural and social outcomes in each biosphere reserve is represented in Figure 3.5. For most of the biosphere reserves both impacts and benefits were reported.

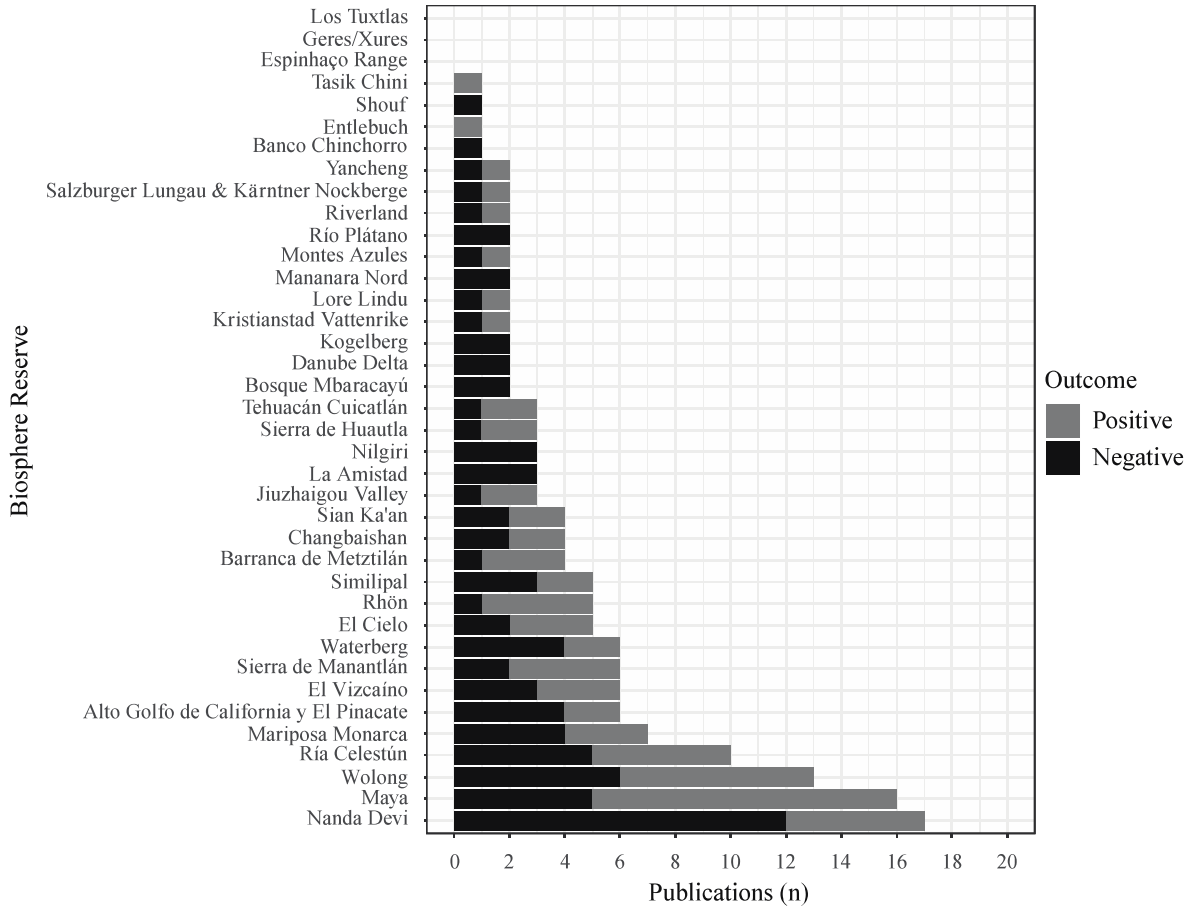

Figure 3.5 Sum of the number of publications that report positive or negative outcomes regarding social, economic, environmental and cultural aspects, in each biosphere reserve.

Scales

The subcategories most frequently identified at international or national/regional scales are represented in Table 3.3. The most frequently referred subcategories are related to the context and inputs to management/governance processes. Only cultural outcomes are frequently referred at international or national/regional scales, which reflect the benefits derived by tourists.

Table 3.3 Most frequent referred subcategories at international or national/regional scales. The proportion of papers refers to the number of papers in which a subcategory is present

Category	Subcategory	% of papers
Inputs	Funding and material support/ opposition	81.1
Context	Organizations	65.9
Context	Economy and politics	65
Context	Conservationist value	53.8
Outcomes	Cultural benefits	50
Context	Historical factors	45.5
Context	Power issues	44.4
Context	Socio-economic attributes	44.1
Context	Formal rules	44
Inputs	Non-material support/opposition	42.6

3.4 Discussion

3.4.1 General patterns of the literature

The scientific literature related to biosphere reserves' management effectiveness has increased in the last decades, following the general trend of the biosphere reserves' research (Kratzer, 2018). However, the number of papers that conduct studies related with biosphere reserves' management effectiveness in one biosphere reserve is very limited (Ferreira *et al.*, 2018). Complementing this literature with studies that were excluded, e.g. because they do not mention "biosphere reserve" in the abstract, title and keywords, and with grey literature, would be important to provide a more complete overview of biosphere reserves' management effectiveness.

As indicated by the journal subject area, environmental and social sciences are the main disciplines contributing to the research about biosphere reserves' management effectiveness. Therefore, despite the results of this study indicate a limited contribution of other disciplines, management effectiveness comprises a more heterogeneous field of study than biosphere reserves' research, which is manly related with natural and environmental sciences (Kratzer, 2018).

The results of this study also demonstrate that lead authors from Europe and North America have been responsible for a big part of the research about biosphere reserves' management effectiveness, including in other regions of the world. This result echoes the findings of other studies that examined the authors of sustainability-related research (Rokaya *et al.*, 2017), demonstrating the need of greater geographic diversity.

Research about biosphere reserves' management effectiveness is methodologically diverse, using multiple methods for data collection and analysis. In contrast with large scale studies about biosphere reserves' management effectiveness (Stoll-Kleemann & Welp, 2008; Schultz *et al.*, 2011; Cuong *et al.*,

2017b), local communities are the privileged actor included in the research. Most of the actors enrolled are, however, only consulted in interviews or surveys, and few studies have applied more profound methods of stakeholders' engagement.

3.4.2 The biosphere reserves studied

According to the results, studies related with biosphere reserves' management effectiveness have been developed in only about 6% of the designated sites, and are mainly concentrated in four countries: Mexico, Guatemala, India and China. These countries are also amongst those that have developed more research, in general, in biosphere reserves (Kratzer, 2018).

In the literature analysed, only one study covered the whole biosphere reserve - in the Gerês-Xurês between Portugal and Spain (Trillo-Santamaría & Paül, 2016). Within the WNBR there are actually 21 transboundary biosphere reserves (UNESCO, 2019a). A better understanding of the management and governance of transboundary biosphere reserves is necessary given their increased complexity.

Despite further information can be found in studies conducted at a global (Stoll-Kleemann & Welp, 2008; Stoll-Kleemann *et al.*, 2010; Cuong *et al.*, 2017b) and national scales (Reed & Egunyu, 2013; Cuong *et al.*, 2017a), existing data is insufficient to provide a comprehensive understanding of the effectiveness of the WNBR. The generalized lack of research related with management effectiveness in biosphere reserves reinforces the claim that biosphere reserves have been underutilized in terms of their potential contribution to the theory and practice of sustainability science (Reed, 2019).

3.4.3 The topics investigated

The literature related with biosphere reserves' management effectiveness frequently addresses the implementation of restrictions to reduce environmental harms (e.g. regulation and surveillance of the use of marine resources, Hoffman, 2014), incentives to promote more environmental friendly behaviours (e.g. a conservation-oriented language school, Langholz, 1999), as well as the socio-economic characteristics of the settings where these processes are implemented (e.g. demography and sources of income in the community, Silori, 2004). Moreover, three groups of papers were identified that investigate more profoundly topics related to: (1) governance and learning; (2) activities associated with biodiversity conservation; and (3) economic incentives to sustainable development. These groups are associated with the goals of biosphere reserves: (1) capacity building, (2) biodiversity conservation and (3) sustainable development.

The literature analysed do not cover, however, the four goals of biosphere reserves, according to the MAB Strategy 2015-2025 (UNESCO, 2015). Few studies were found about research activities (Alonso-

Yañez & Davidsen, 2014), environmental outcomes (Mehring & Stoll-Kleemann, 2011; Steinberg *et al.*, 2014), equity (Sundberg, 2003, 2004), health (Sylvester *et al.*, 2016) and climate change (briefly adressed in Durand *et al.*, 2014).

3.4.4 Methods and context

The results of this study indicate that the goals of biosphere reserves - capacity building, biodiversity conservation and sustainable development - have been mainly investigated using, respectively, qualitative, mixed and quantitative approaches. This result suggests that a holistic understanding of biosphere reserves' management effectiveness requires the use of multiple approaches. Other studies have highlighted that different lens and perspectives are required for the understanding and management of complex (Meadows, 2008, pp. 6–7) social-ecological systems (Berkes *et al.*, 2003, p. 8). Conceptual and methodological plurality may also increase the possibility of finding solutions for wicked problems (von Wehrden *et al.*, 2017). Research about biosphere reserves' management effectiveness should, therefore, combine different methodological approaches and a diversity of actors, in order to include different perspectives about the complex social-ecological systems being managed.

The results of this study also indicate that research related with capacity building and sustainable development have been mainly conducted in, respectively, the Latin America and the Caribbean and in Asia and the Pacific; the literature related with the goal biodiversity conservation is geographically more diverse. These results concur with previous works that underscore the importance of the context in biosphere reserves' management effectiveness (Ferreira *et al.*, 2018) and in integrated conservation strategies (Hirschnitz-Garbers & Stoll-Kleemann, 2011). The seminal work of Ostrom (2007) highlights the need to move beyond panaceas, i.e. simple universal recipes, to resolve the problems of overuse of natural resources. Research about biosphere reserves' management effectiveness should focus, therefore, on co-creating and investigating management and governance processes that are embedded in the social-ecological contexts in which biosphere reserves are implemented. The criteria for the designation of a biosphere reserve should also be critically analysed, in order to avoid the prescription of simple solutions (e.g. zoning or participatory management) to solve complex problems.

3.4.5 Main findings concerning biosphere reserves' management effectiveness

Goals

The cluster analysis conducted in this study revealed that the classification of the scientific literature according to subcategories of biosphere reserves' management effectiveness (Ferreira *et al.*, 2018) reflect the goals of the MAB Programme. Some of the subcategories associated with each goal are: (1) capacity building - information, knowledge, management body, participatory processes, empowerment

and learning; (2) biodiversity conservation - cultural and extractive use of natural resources, conservation and habitat management, socio-economic impacts and cultural benefits; and (3) economic development - economic benefits. This pattern suggests that the goals of biosphere reserves influence which processes are developed, which inputs are needed, and, consequently, the outcomes of their management, in a given context. The goals are, therefore, of central importance to biosphere reserves' management effectiveness. This result concurs with research about complex systems that underscores the importance of the goals of the system in determining its behaviour (Meadows, 2008, pp. 1–4; 161–162). Because of this, the goals are among the most important leverage points to change systems (Meadows, 2008, p. 161; Abson *et al.*, 2017). This suggests that closing the gap between biosphere reserves concept and practice (Ishwaran *et al.*, 2008; Price *et al.*, 2010; UNESCO, 2013) maybe more effectively achieved by addressing the goals of biosphere reserves. This result provides a different perspective about key factors for the success of biosphere reserves, which have been mainly associated with the participation, designation or the availability of resources (Stoll-Kleemann & Welp, 2008; Schultz *et al.*, 2011; Reed & Egunyu, 2013; Cuong *et al.*, 2017b).

The focus of biosphere reserves in sustainable development (UNESCO, 1996) and in the Sustainable Development Goals (SDGs) agenda (UNESCO, 2015, 2016a) may require, therefore, a critical analysis. These concepts have been criticized for promoting economic growth on a finite planet (Kothari *et al.*, 2014; Gómez-Baggethun, 2019) and for resulting from a Western construct that ignores existing cultural alternatives and worldviews of human-nature relationships (Kothari *et al.*, 2019). Therefore, it seems to be important to investigate alternative approaches that provide more fundamental and context-specific transformations in biosphere reserves, such as Buen Vivir (South America), Ubuntu (South Africa), Swaraj (India) and degrowth (Europe) (Kothari *et al.*, 2014; Stoll-Kleemann & O'Riordan, 2017).

Interdependencies between goals and across scales

In this study there were identified subcategories that are associated with specific goals of biosphere reserves and subcategories which seem to be important for multiple goals (e.g. the implementation of restrictions and incentives, and the socio-economic context). The results also indicate the presence of trade-offs among outcomes of biosphere reserves - in most of the biosphere reserves studied both positive and negative outcomes were reported. Many factors that influence management, but which control lies outside of biosphere reserves, were reported in the literature: funding to develop its activities (Devine, 2014; Martinez-Reyes, 2014), goals of the organizations (Lu *et al.*, 2006; Alonso-Yañez & Davidsen, 2014), economic crises (Trillo-Santamaría & Paül, 2016), power issues (Sundberg, 2004) and formal rules (Constantin, 2012). These results are indicative of the interdependencies between goals of biosphere reserves, and between biosphere reserves and the larger systems in which they are

contained. Managers of biosphere reserves have, therefore, to articulate different goals, in order to prevent that the achievement of one goal compromise others, or the purpose of the biosphere reserve, and also to consider factors that, despite originated outside of biosphere reserves, may influence its effectiveness. How biosphere reserves navigate these scale dynamics between the systems they contain and are contained is, therefore, an important topic for future research.

The existence of trade-offs in biosphere reserves concurs with existing research about win-win strategies, i.e. initiatives that aim to achieve conservation and development goals. Win-win situations rarely materialize; instead, gains and losses are the norm (Wells & McShane, 2004; McShane *et al.*, 2011). While some authors suggest that the irreconcilability between conservation and development have to be recognized in order to adequately deal with trade-offs and "hard decisions" (McShane *et al.*, 2011), others claim that the apparent incompatibility between environmental and economic activities is an artefact of neoliberal conservation approaches (Fletcher, 2012). By not considering the unequal access to natural resources, and relying in economic growth to end poverty, neoliberal conservation instruments exacerbate the conservation-development conflicts they were meant to resolve (Fletcher, 2012). Given the contested nature of this topic, and the importance of trade-offs to biosphere reserves' management effectiveness, more research about the causes of trade-offs in biosphere reserves, and how to overcome them, is necessary.

3.4.6 A research agenda

Building on the topics discussed above, a research agenda, and some recommendations, are proposed to advance inquiry about biosphere reserves' management effectiveness (Table 3.4). The proposed research agenda is in accordance with existing suggestions to advance investigation in sustainability of social-ecological systems (Fischer *et al.*, 2015) or sustainability science (Lang *et al.*, 2017), and also with the current action plan for biosphere reserves (UNESCO, 2016a). These similarities suggest that biosphere reserves can benefit from the advancement of these fields of research, and vice-versa. Collaborative work between these research communities, and with practitioners in biosphere reserves, can, therefore, contribute to leverage theory and practice of sustainability.

Table 3.4 A research agenda for biosphere reserves' management effectiveness

Main topic	Research question	Recommendations
Research	What mechanisms are needed in biosphere reserves to develop research programs that cover the geographic and methodological gaps found in the literature, namely a restricted spatial coverage and the absence of a holistic research perspective with a diversity of methodological approaches and actors?	- Analyse grey literature, including periodic reviews, to have a broader understanding of biosphere reserves' management effectiveness;
		- Conduct research in biosphere reserves where no study about management effectiveness was performed, including transboundary biosphere reserves;
		- Investigate which mechanisms may promote the development of collaborative research in biosphere reserves, including different disciplines (interdisciplinarity), methods (qualitative, mixed and quantitative) and actors (transdisciplinary);
		- When studying biosphere reserves outside of Europe and North America, empower researchers from the region to lead the investigation and publications.
Outcomes	i) How are biosphere reserves contributing their multiple goals: capacity building, biodiversity conservation, sustainable development and climate change adaptation and mitigation?	- Investigate the contribution of biosphere reserves to their multiple goals, including capacity building, biodiversity conservation, sustainable development and climate change adaptation and mitigation;
		- Investigate the contribution of biosphere reserves to the development of research, environmental outcomes, equity and health in the regions in which they are implemented;
	ii) What changes are needed to assure that management/governance of biosphere reserves is orientated to achieve a more balanced mix of social, cultural, economic and environmental outcomes?	- Investigate the causes of trade-offs in biosphere reserves and how to overcome them.
Social-ecological fit	What transformations are needed to assure that the goals of biosphere reserves, criteria for designation and management/governance processes, fit the social-ecological contexts in which they are implemented?	- Investigate the fit between biosphere reserves goals, criteria for designation and management/governance processes, and the social-ecological contexts in which they are implemented;
		- Critically analyse the pursue of sustainable development and the SDGs in biosphere reserves;
		- Investigate how context-orientated transformations can be incorporated in biosphere reserves.
Scales	What new institutional mechanisms, or changes in existing institutions, are required to facilitate the management and governance of scale dynamics in biosphere reserves?	- Study what mechanisms can facilitate the integrated management of the multiple goals of biosphere reserves;
		- Analyse how multi-scale and large-scale cooperation can be promoted to achieve social-ecological benefits in biosphere reserves, and the role of UNESCO in this regard.

Lastly, it is important to highlight the important role that UNESCO can play in potentiating research about biosphere reserves' management effectiveness. Existing databases containing information about biosphere reserves (UNESCO n.d., 2017) should be improved, in order to provide a more complete source of data. Current shortcomings include unavailability of data (e.g. periodic reviews and spatial boundaries), data that is not updated, and lack of systematic information between biosphere reserves (e.g. information about the main ecosystems) and between both databases. Despite progress being made regarding the systematization of literature about biosphere reserves (Shaw *et al.*, 2017), further work is still necessary to disclose and better understand topics related to management effectiveness. The categories and subcategories analysed in this study, including those of Ferreira *et al.* (2018), could be useful in this regard. Besides providing a characterization of the context, processes, inputs and outcomes associated with biosphere reserves' management/governance, the subcategories also allow to understand how and where data was collected in the first place. The systematization of such information would be useful not only to biosphere reserves' managers and researchers, but also, to build theory about how to sustainable manage and govern social-ecological systems at a regional scale.

3.5 Conclusion

Using a systematic literature review of the scientific literature, this study aimed to contribute to a better understanding about where and how the research about biosphere reserves' management effectiveness have been conducted, which topics have been investigated and what the main findings are. The results indicate that, in line with their multiple goals and complex processes of implementation, the research about biosphere reserves' management effectiveness is diverse - it investigates different topics in different locations - and plural, because it includes different conceptual perspectives and methodological approaches. Three groups of papers, that address different subcategories of the context, inputs, processes and outcomes of biosphere reserves, were identified. These groups are associated with different goals of the Programme: capacity building, biodiversity conservation and sustainable development. In general, the papers in each group use different methodological approaches and were developed in different regions of the world. Given the importance of the goals in structuring the scientific literature according to subcategories of management effectiveness, the goals of biosphere reserves maybe effective leverage points to increase their success. The results also suggest the importance of scale dynamics and interdependencies between goals in biosphere reserves' management effectiveness.

However, there were identified gaps and bias in the literature that prevent a more holistic understanding of biosphere reserves' management effectiveness. In order to advance inquiry in this important topic, a research agenda for the field, and some recommendations, are proposed, focusing on the need to investigate mechanisms for holistic research, outcomes and trade-offs, transformations for social-

ecological fit and institutions for an integrated management across scales. The pursue of this research agenda may contribute to biosphere reserves becoming real laboratories for sustainable development, in all its dimensions and diversity. Moreover, collaborative work between different research communities, and practitioners in biosphere reserves, would be important to leverage theory and practice of sustainability.

4 Management of social-ecological systems in the Portuguese Mediterranean Biome – what can biosphere reserves learn from grassroot approaches?

This chapter is being prepared to be submitted to a peer-reviewed journal:

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Author Contributions:

The first author has conceptualized and designed the study, carried out the field work and data analysis, and wrote the manuscript. Inês Cosme, Rui Santos and Henrik von Wehrden have supported the first author in the design of the research, discussion of the results and revision of the manuscript.

Abstract

Biosphere reserves are designated territories combining bio-cultural diversity with economic development. However, given the limited realization of the biosphere reserve enterprise, research about factors influencing their effectiveness has been developed. The identification of concrete strategies to overcome the barriers to the success of biosphere reserves, in particular from grassroot approaches, remains, however, less explored. This study addresses this gap in the literature with a systematic comparative analysis of three initiatives managing social-ecological systems in Portugal, located in the Mediterranean Basin biodiversity hotspot: the Paul do Boquilobo Biosphere Reserve, the Janas Ecovillage and the Minga Multisector Cooperative. A holistic understanding about the initiatives was developed using semi-structured interviews and a mixed deductive-inductive analysis. Differences between them were organized in four main topics: process initiation, goals, governance, management and outcomes. Barriers to the success of the biosphere reserve were also identified. Building on the analysis of Minga and Janas Ecovillage, recommendations to overcome the challenges of the biosphere reserve are proposed, regarding the need of financial sustainability, formal institutions, sociocratic governance and re-creation of an integrated and shared vision. Furthermore, because the three initiatives represent distinct sustainability pathways, collaborative work among them may contribute to mainstream sustainability in a global biodiversity hotspot.

Keywords

Biodiversity Conservation; Biodiversity Hotspot; Biosphere Reserve; Degrowth; Ecovillage; Grassroot Approaches; Management; Social-Ecological Systems; Sustainability Pathways; Sustainable Development;

4.1 Introduction

Current trajectories of development are resulting in environmental (Rockström & Klum, 2015; Díaz *et al.*, 2019, pp. 2–3) and social problems (Lawson *et al.*, 2019), requiring the implementation of alternative models that are better for people and nature (Jackson, 2009; O'Neill *et al.*, 2018; Raworth, 2018). Biosphere reserves are designated territories where models of sustainable development are implemented (UNESCO, 2015). The value of biosphere reserves in providing insights about how sustainability can be fostered in social-ecological systems is widely recognized (Schultz & Lundholm, 2010; Palomo *et al.*, 2014; Cumming *et al.*, 2015; Ferreira *et al.*, 2018):

"*There is perhaps no better set of internationally networked areas where conservation and sustainable use of biodiversity and its relationships to broader regional sustainable development perspectives could be studied and tested and the gained experience and knowledge shared amongst all nations of the world*." (Ishwaran *et al.*, 2008)

However, given the existing gap between the concept of biosphere reserves and its practical realization (Price, 2002; Ishwaran *et al.*, 2008; Price *et al.*, 2010; UNESCO, 2013), a better understanding of how the success of biosphere reserves can be promoted is necessary.

Biosphere reserves are designated by the UNESCO's Man and the Biosphere (MAB) Programme to demonstrate effective and functioning models for sustainable development at a regional scale, contributing to the implementation of the Sustainable Development Goals (SDGs) (UNESCO, 2015). There are currently 701 biosphere reserves designated in 124 countries (UNESCO, 2019a). Each biosphere reserve encompass a diversity of uses in the landscape, organized according to a zoning scheme: a core zone devoted to the long-term protection of natural resources; a buffer zone where activities compatible with the conservation goals are developed, such as ecotourism and environmental education; and a transition area where multiple stakeholders operationalize sustainable development (UNESCO, 1996, 2015). Biosphere reserves are "learning laboratories for sustainable development" (Ishwaran *et al.*, 2008), focusing on knowledge, innovation and experimentation (UNESCO, 2015). Besides that, each biosphere reserve should have a multi-stakeholder management body that gives particular importance to the participation of local communities (UNESCO, 2015). Governance of biosphere reserves is further integrated vertically in National MAB Committees, regional and thematic groups and, finally, in the International Coordinating Council (MAB-ICC), which is under authority of

UNESCO (UNESCO, 2015). This vertical integration facilitates the exchange of information in biosphere reserves from local to global scales.

Despite first biosphere reserves were designated in 1976 (Vernhes, 1987), only since 1996 they have embraced a more integrated approach to manage multifunctional landscapes, with the adoption of sustainable development as a major goal of the Programme (UNESCO, 1996). Regardless of this change, most biosphere reserves continued to lag behind the requirements of the Statutory Framework (Ishwaran *et al.*, 2008; Price *et al.*, 2010; UNESCO, 2013). According to a recent report (MAB Secretariat, 2018), many challenges persist in the implementation of the Lima Action Plan (UNESCO, 2016a) in biosphere reserves, mainly because of the lack of human and financial resources, and the lack of interest or awareness. However, given the importance of the social-ecological context to biosphere reserves' management effectiveness (Ferreira *et al.*, 2018), there is a need to investigate how initiatives that emerge in specific settings can help understand which processes are necessary to increase the success of biosphere reserves, as stressed in the research agenda proposed in Chapter 3. The analysis of grassroot initiatives is, therefore, particularly interesting in this regard.

Grassroots initiatives have been responsible for innovate ideas and processes for sustainable development such as repair-cafés, complementary currencies, energy cooperatives and garden-sharing (Smith & Stirling, 2018). According to Seyfang & Smith (2007), grassroots innovations are "networks of activists and organizations generating novel bottom-up solutions for sustainable development; solutions that respond to the local situation and the interests and values of the communities involved". Grassroots approaches are adapted to the context in which they are developed and, therefore, enact authentic worldviews and processes that maybe incorporated in biosphere reserves (Stoll-Kleemann & O'Riordan, 2017). Despite some studies have analysed how practices from other organizations can promote to the success of biosphere reserves (George & Reed, 2016, 2017), the potential contribution of grassroots approaches remains unexplored.

The social-ecological context of this study is the Portuguese Mediterranean Basin Biome. The Mediterranean Basin is a biodiversity hotspot, and is, therefore, a priority region for the conservation of biodiversity at a global level (Myers *et al.*, 2000; Olson & Dinerstein, 2002; Brooks *et al.*, 2006). There are currently 11 biosphere reserves in Portugal (UNESCO, 2019b). The first designated was the Paul do Boquilobo Biosphere Reserve, in 1981, and the most recent is Castro Verde, that was approved in 2017. Portugal is also home of a diversity of initiatives of the civil society related with sustainability (Rede Convergir n.d.; Balsa *et al.*, 2016; Santos *et al.*, 2016). A characterization of the Portuguese initiatives of social-ecological experimentation identified five main domains of action: exchange markets and fairs, cooperatives of renewable energy, agriculture supported by the community, the development of local common agendas and the promotion of continuous learning (Santos *et al.*, 2016). The existing scientific literature about management and governance of Portuguese biosphere reserves and grassroot approaches with a regional scope remains, however, very limited (but see: Trillo-

Santamaría & Paül, 2016; Esteves, 2017a,b). Despite information about these initiatives can be found in the grey literature, comparative analysis were mainly conducted among grassroot approaches (e.g. Balsa *et al.*, 2016; Santos *et al.*, 2016) or biosphere reserves (e.g. National Committee of the UNESCO MAB Programme, 2018). This study provides, therefore, an important contribution to better understand the differences between different models for managing social-ecological systems.

To develop a comparative analysis of different initiatives managing social-ecological systems in the Portuguese Mediterranean Biome, the social-ecological systems framework developed in Chapter 2 will be used. According to this framework, the management of social-ecological systems can be understood by considering its context, inputs, processes and outcomes (Ferreira *et al.*, 2018). As demonstrated in the study conducted in Chapter 3, the use of this framework allows to see the interactions, conflicts, synergies and trade-offs, across scales, among factors influencing the management of biosphere reserves, providing, therefore, a more holistic understanding. The framework was developed through the analysis of the scientific literature related with biosphere reserves' management effectiveness, but it may also be useful to investigate other initiatives managing social-ecological systems because of its holistic approach (Ferreira *et al.*, 2018). Therefore, this framework will be used to analyse biosphere reserves and grassroot approaches in this study, and to identify the main differences between them.

The main goals of this study are:

i) to identify the main differences in the management of grassroot initiatives and biosphere reserves located in the Portuguese Mediterranean Biome; and

ii) to discuss what changes may be needed to potentiate the success of biosphere reserves, building on insights from grassroot approaches.

The next section contains an outline of the methods used for data collection and analysis, followed by the presentation of the results (section 4.3), a discussion of the main findings regarding the two main goals of this work (section 4.4), and the conclusion (section 4.5).

4.2 Methods

A multiple case study strategy was used to explore the differences between initiatives managing social-ecological systems in the Portuguese Mediterranean Biome. Case study research focus in the profound investigation of one or more specific cases (e.g. individuals, organizations or social phenomena) using a diversity of sources of evidence (Jupp, 2006, pp. 20–21) to provide a holistic understanding of phenomena within its natural context (Saunders *et al.*, 2009, pp. 145–147; Coutinho, 2015, pp. 334–335). It is, therefore, particularly suited to understand current processes and why they occur (Saunders *et al.*, 2009, pp. 145–147).

4.2.1 Case-study selection

The initiatives included in this study comprise successful examples of integrated and participatory approaches, with an experimental focus, that manage multifunctional landscapes in the Portuguese Mediterranean Biome. The description of the criteria used to select the initiatives is given in Table 4.1.

Table 4.1 Criteria used to select the initiatives

Criteria	Definition
Integrated approaches	The initiative addresses multiple sectors of sustainability (e.g. economy, ecology, culture or society)
Multifunctional landscapes	The initiative envisions change from local to regional scales, not being focused on a small-scale project
Participatory	The initiative is being developed by a collective of people
Experimental approach	The initiative experiments innovative processes of management and/or governance
Success	The initiative is considered successful amongst its counterparts
Location in the Portuguese Mediterranean Biome	The initiative is located in the Mediterranean Forests, Woodlands, and Scrub Ecoregion (Olson & Dinerstein, 2002) and in Portugal

To find which initiatives correspond to the defined criteria, existing online databases and scientific and grey literature were investigated. This analysis was complemented with the development of scoping interviews, a focus group and informal conversations with a researcher with experience on grassroot initiatives for sustainability transitions in Portugal and 12 members of the Portuguese MAB Committee (Table C1). This approach was necessary to overcome the limited systematized information about integrated initiatives for the management of social-ecological systems in Portugal.

Four initiatives were initially selected: the Paul do Boquilobo Biosphere Reserve (PBBR), the Janas Ecovillage, Minga Multisector Cooperative and Tamera Healing Biotope 1. Because of the impossibility of developing the interviews in Tamera in the time period available for the field work, this initiative had to be excluded from the analysis. The location of the remaining three initiatives is displayed in Figure 4.1.

Figure 4.1 Location of the case studies. The Mediterranean biome corresponds to the "Mediterranean forests, woodlands and scrub" biome defined by Olson & Dinerstein (2002). Some Portuguese cities are also displayed.

4.2.2 Data collection

The field work took place between 24 of October and 16 of November 2019. The author stayed four days in each initiative and most of the semi-structured interviews were developed during this period. The time between interviews was used for informal conversations, observation and participation in activities related to the initiative. During the field work, notes were kept in a diary and photos taken. Secondary information was also included, such as newspapers, Facebook pages of the initiatives and reports. This information was used to complement and triangulate the data collected in the semi-structured interviews.

A total of 35 interviews were developed with a diversity of actors: i) managers: people that have the main responsibility of managing the initiative, which are the operational managers and the board members of the Dólmen Association (Janas Ecovillage); the board members of the Minga Multisector Cooperative; and executive body of the PBBR; ii) collaborators: people that develop activities in the initiative, such as volunteers, employees, cooperants, associates or advisors; and iii) others: people that do not participate in the initiatives but do have knowledge about them, such as previous collaborators or participants of other initiatives with similar goals in the region. When the respondents perform multiple functions, they were classified according to their main role. A good balance between the number of interviewees in each initiative and in each role was possible to be achieved, as represented in Table 4.2.

Table 4.2 Number of interviews performed by initiative and type of actor. In brackets it is displayed the total number of people with a management role in each initiative

Initiative / role	Managers	Collaborators	Others	Total
Minga Multisector Cooperative	5 (10)	4	3	12
Janas Ecovillage	3 (10)	7	2	12
Paul do Boquilobo Biosphere Reserve	4 (4)	6	1	11

All interviews were individual and developed face-to-face. A declaration of agreement with the terms of the interview and the use of the data was signed by the interviewer and each of the respondents, and copies sent to all interviewees by email. The interviews were conducted in Portuguese or English and took one hour on average (minimum of 12 minutes and maximum of two hours and 20 minutes). An application in a smartphone was used to record the interviews.

The interview protocol followed a semi-structured design, allowing to address the topics included in the framework used (Ferreira *et al.*, 2018), and also to let emerge new subjects. The interviews were designed and conducted following Leech (2002) and Coutinho (2015, p. 333). The interview protocol (Figure C1) includes a first group of questions that are focused in the relationship between the respondent and the initiative, followed by questions about the goals of the initiative, governance, main instruments for management, outcomes and factors for success. To wrap up, two questions related with visions for the future and lessons/recommendations were included. The interview finished with general questions about the respondent (e.g. education, age). The interviewees were also asked for suggestions regarding other actors that could be interviewed, following a snow-ball technique for the identification of relevant stakeholders.

4.2.3 Data analysis

Descriptive statistics were conducted in R version 3.4.3 (R Core Team, 2017) to analyse the gender, nationality, age, city of residence, educational stage and main discipline of studies of the respondents. The main land uses in the region of each initiative were also analysed, in geographic information systems, using the CORINE Land Cover (Copernicus Programme, 2018) and the software ArcMap version 10.2 (ESRI, 2010).

The interviews were qualitatively analysed in MAXQDA v12 (VERBI Software, 2018). Audio files with a total length of 38 hours (one interview was not recorded) were transcribed verbatim. Coding schemes including the categories and subcategories of the framework were initially used to code the transcripts (Figure 4.2). However, this method was inadequate to identify the major differences among initiatives because important elements of the grassroot approaches (e.g. being a cooperative or an association) were being excluded. There was, therefore, a need to have a more mixed approach, combining inductive analysis with some elements of the framework, in order to obtain a more flexible tool that allows to identify the major differences in the management among the initiatives. To this end, it was conducted a preliminary analysis focusing on re-reading the transcripts, re-listening the interviews, generating word clouds and taking notes to gain an overall understanding of the data. This resulted in the selection of five themes for a comparative analysis of the initiatives - process initiation, main goals, governance, management and outcomes. In each initiative, the most important elements regarding each theme were identified by comparing and interpreting the discourses. Coding schemes were inductively developed and adapted from the framework (Ferreira *et al.*, 2018) for each initiative and theme, to help organize the data. Codes were assigned to segments of the text without a pre-defined length, but in which a main idea is expressed (Srnka & Koeszegi, 2007). Field notes and secondary data were used when necessary to complement the data from the interviews. Following the same methodology, the main challenges/barriers to the success of the Paul do Boquilobo Biosphere Reserve were identified. The main characteristics of each initiative regarding each theme, including the main challenges/barriers to the success of the Paul do Boquilobo Biosphere Reserve, are summarized in the next section. Direct quotations in Portuguese were translated to English and included in the results. The original discourses in Portuguese are displayed in Table C2. Given the small number of interviewees in each initiative, respondents are identified at the level of the initiative (B – PBBR; J – Janas Ecovillage; M – Minga) to protect their identity. Important elements of the discourses are highlighted in bold.

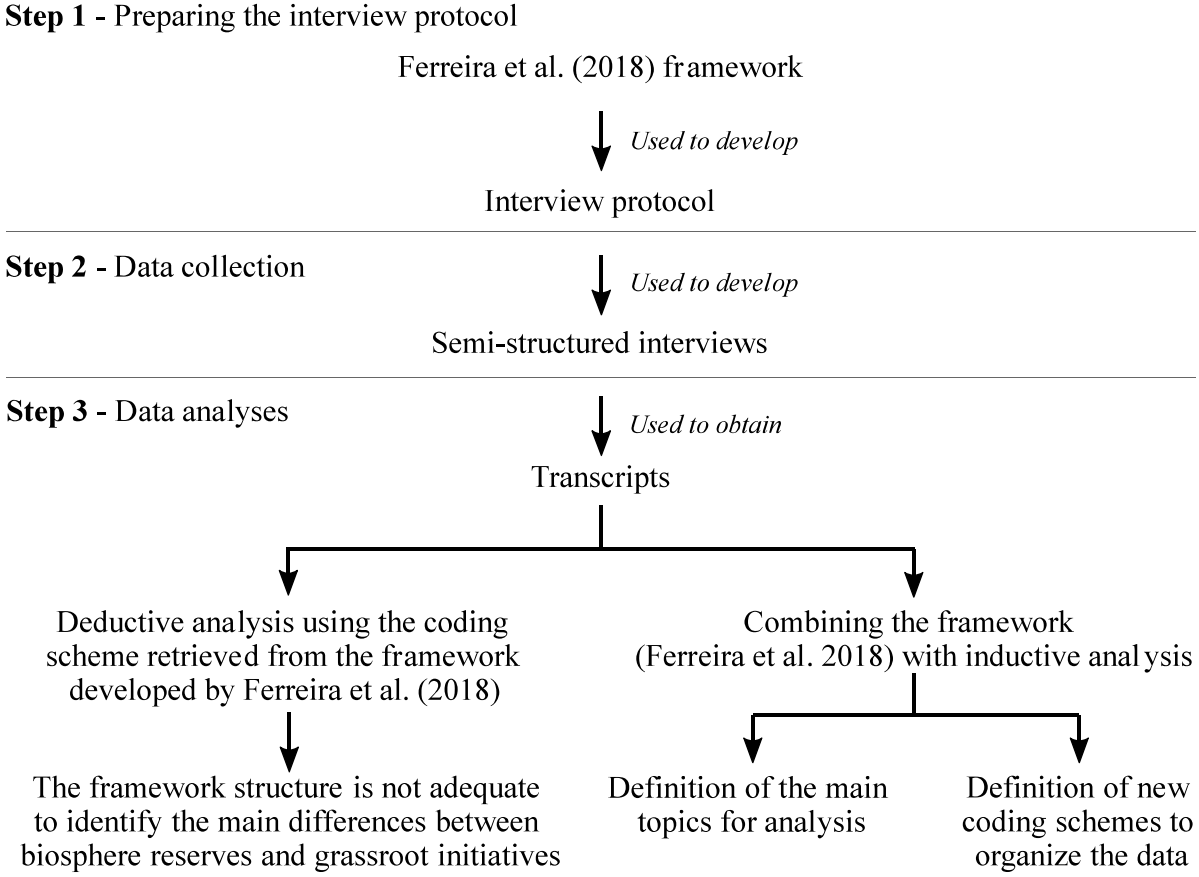
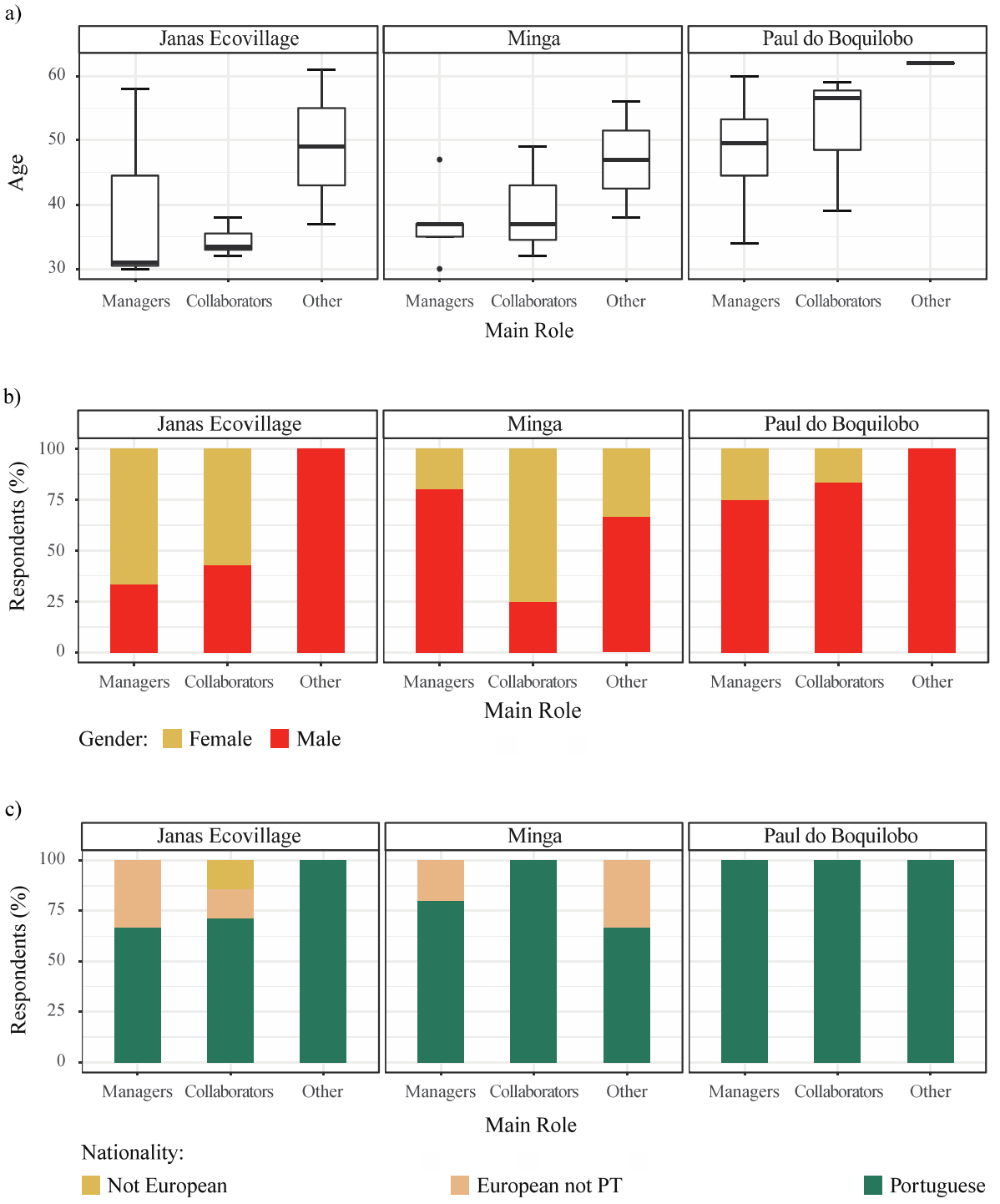


Figure 4.2 Main steps of the methodology used in this study in the data analysis.

4.3 Results

4.3.1 Characterization of the respondents

The characteristics of the respondents by role and initiative are displayed in Figure 4.3. Comparing to the grassroots initiatives, the managers and collaborators interviewed in the PBBR are less diverse in terms of gender and nationality, and older. Minga is the initiative that shows a bigger difference in terms of the gender of the participants in different roles: managers are mainly males and collaborators females. All the managers interviewed in the three initiatives are graduated, many have a master's degree, and, in Minga, two of the managers interviewed have a PhD. The grassroot approaches integrate more collaborators that are not graduated than the PBBR. The three initiatives are diverse regarding the field of studies of the respondents; however, they are more linked with environmental sciences in the PBBR and in Janas Ecovillage than in Minga. All the participants interviewed in Minga are residents of the municipality where the initiative takes place, while in the PBBR there are many collaborators from outside of Golegã or Torres Novas. Most of the participants in the Janas Ecovillage live in Sintra, however, there are also some participants from other places, namely from Lisbon.



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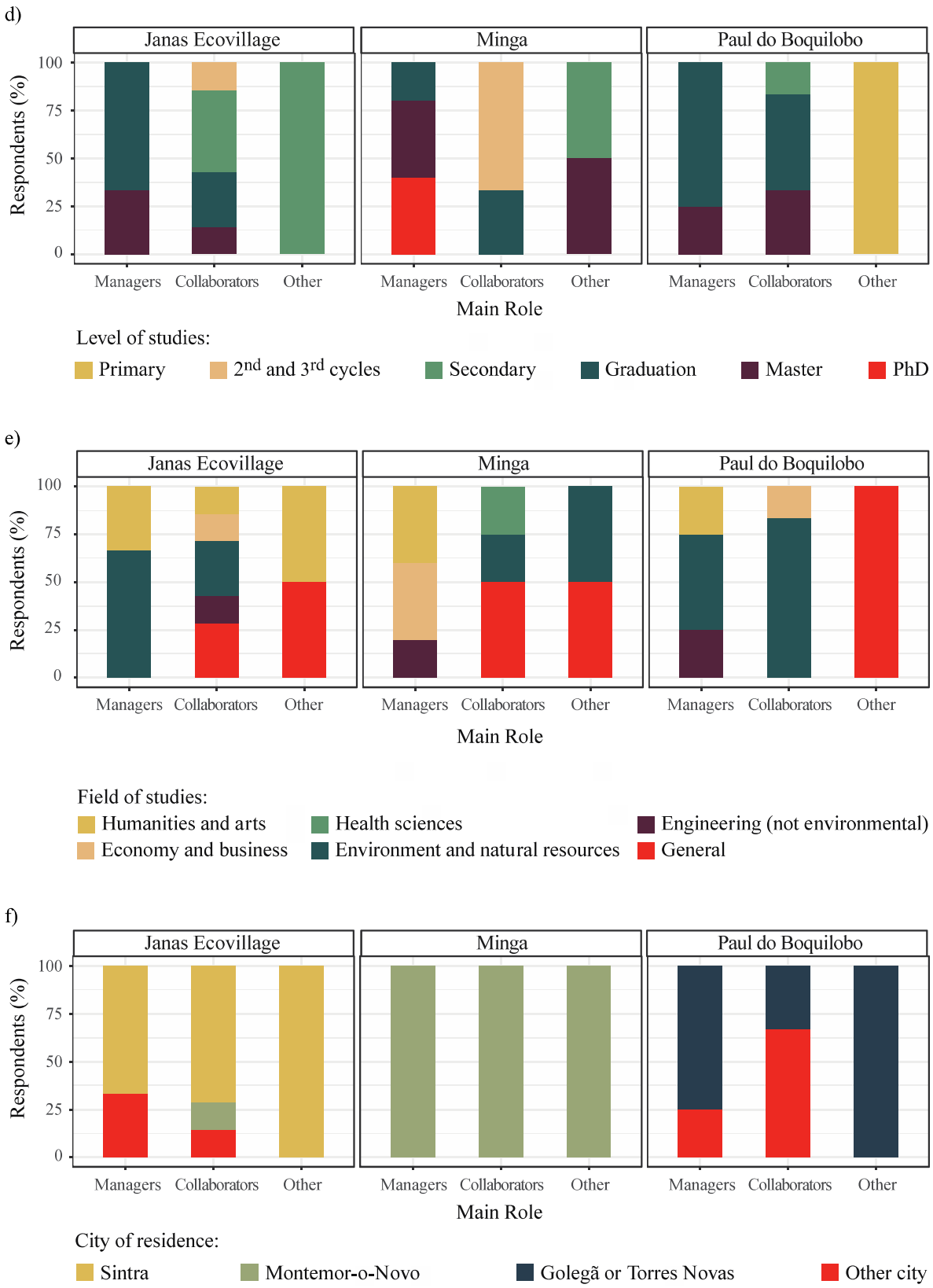

Figure 4.3 Characteristics of the respondents by role and initiative: a) age; b) gender; c) nationality; d) level of studies; e) field of studies; f) city of residence.

4.3.2 Main characteristics of the initiatives

Scope

The scope of the initiatives analysed is summarized in Table 4.3. The PBBR is the only initiative that includes two municipalities: Golegã and part of Torres Novas. The Janas Ecovillage is the initiative with a smaller area of intervention - it is mainly restricted to Janas, a small village belonging to the Union of Parishes of Sintra, in the Sintra municipality. Minga is the initiative that encompasses a larger population and area: the municipality of Montemor-o-Novo, including the city and the adjacent parishes.

Table 4.3 Scope of the initiatives analysed. Data about the Janas Ecovillage is given for the Union of Parishes of Sintra, where the Janas village is located. Data retrieved from: ONGATEJO (2015) (Paul do Boquilobo Biosphere Reserve), U.F.Sintra (2018) (Janas Ecovillage) and PORDATA (2018) (Minga)

Feature/initiative	Paul do Boquilobo Biosphere Reserve	Janas Ecovillage	Minga
Area (km^2)	58.96	24.28	1233
Population	9900	6226	15841

The area of intervention of each initiative presents different patterns of land uses (Figure 4.4). Almost 80% of the territory of the PBBR is occupied by permanently irrigated land; in Montemor-o-Novo, the land-uses are mainly associated with more extensive agricultural practices, including agroforestry areas (50.8%), non-irrigated arable land (11.8%) and pastures (9%); in the Union of Parishes of Sintra, where the Janas Ecovillage is located, the main land uses are forests and semi-natural areas (40%), but it also includes discontinuous urban fabric (15.1%) and land mainly occupied by agriculture, with significant areas of natural vegetation (15%).

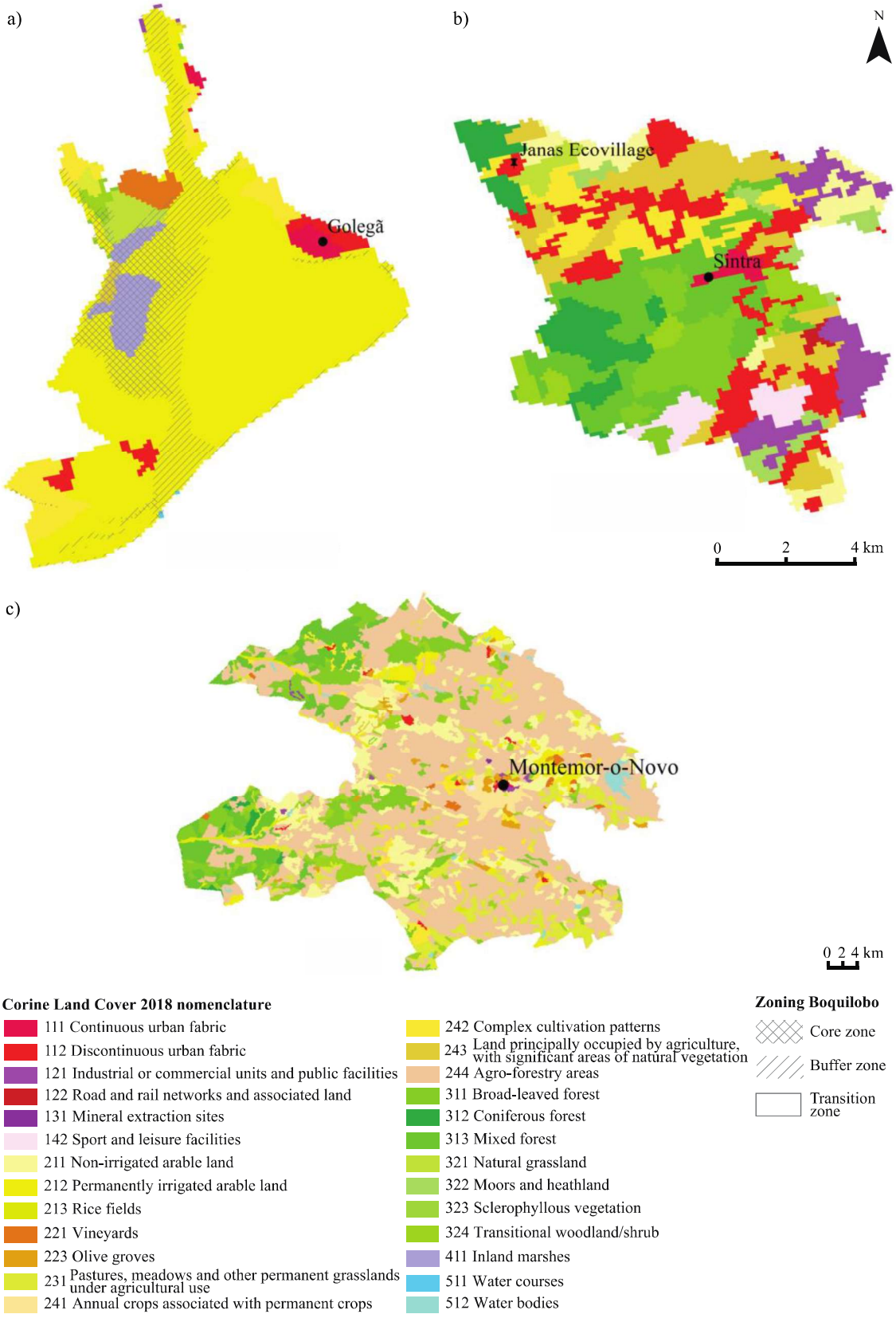

Figure 4.4 Land use cover (Copernicus Programme, 2018) in the: a) the Paul do Boquilobo Biosphere Reserve (including zoning); b) Janas Ecovillage (parish) and c) Minga Multisector Cooperative.

Process initiation

The projects that are today named "Cooperativa Integral Minga" (Minga Multisector Cooperative; Minga) and "Ecoaldeia de Janas" (Janas Ecovillage) both started in 2012 being called, respectively, "Centro de Investigação de Cultura e Sustentabilidade" (Center for Research in Culture and Sustainability; CICS) and "Quinta do Luzio" (Luzio Farm). After the 2008 financial crises there were many Portuguese young people immigrated or looking for new opportunities to create their own job. A group of immigrated Portuguese friends created Minga in order to have a tool that facilitate the development of their economic activities in Portugal. They selected Montemor-o-Novo to establish their life projects, cooperating, since the very beginning, with other cultural and social organizations already established in the territory. Minga was launched in 2015 after the separation of CICS. The creation of the Janas Ecovillage, with this new identity since 2014, was motivated by the existent need of unemployed adults to learn new professions. It was created by a group of friends that studied environmental engineering together and wanted to apply many of the concepts learned in the academy. The vision of the group for the project was established using "Dragon Dreaming", a tool that facilitate the development groups by "dropping your dream to become our dream" [J11].

The Paul do Boquilobo Biosphere Reserve (PBBR) was designated in 1981, encompassing a similar area of the already existing Paul do Boquilobo Nature Reserve (PBNR/park), and managed by the same entity - the Institute for the Conservation of Nature and Forests (ICNF - "Instituto da Conservação da Natureza e das Florestas"). Being a biosphere reserve of first generation, the PBBR was at risk of being declassified, because it did not adapt to the Statutory Framework (UNESCO, 1996). This situation motivated a collaborative work between the ICNF and a diversity of local entities, to adjust the PBBR to the MAB requirements. Having started the adaptation work in 2014, the new strategy for the PBBR was approved by UNESCO in 2016. Since then, the ICNF, the Golegã and Torres Novas municipalities and a non-governmental organization closely related with farmers (ONGATEJO) co-manage the PBBR.

Goals

More detailed information about the goals of the initiatives according to different dimensions of sustainability is given in Table C3. The main goal of the PBBR is to combine conservation of biodiversity with economic development in the designated territory. The need to develop economic activities that build on the preservation of the species and habitats of the nature reserve (PBNR) is widely recognized among the participants.

> "(…) since there is no industry here, that it will be from there [the Biosphere Reserve] that we will have **a way to potentiate the business and everything**, with tourist visits and tours in the Natural Park and in the rest of the Biosphere Reserve, and where there is contemplation. (…) But whatever happens within these zones, **everything must be done in harmony with what exists**, without destroying, both at the **environmental and architectural levels**" [B10]

Most of the interviewees of the Janas Ecovillage refer that the main goal of this initiative is to teach rural crafts to adults, in order to promote more autonomous and sustainable lifestyles. However, the Janas Ecovillage also aims to intervene at a local level, by increasing the environmental performance of the Janas village.

> "We are working in a village with more than 1,000 inhabitants and, therefore, the community that builds this project is an unintentional community. People do not know that they are participating in a project to build an ecovillage... It looks much more like a **project of environmental intervention**... in a community, in a village, so our goal is to increase the performance, **improve the environmental performance of the village**, it is our main objective." [J1]

Minga tries to re-create an economic model distinct from the mainstream, building on concepts and practices of localism, circular and solidarity economy, and degrowth movements. It aims to contribute to revert the lack of jobs, decrease of population and of economic activities in Montemor-o-Novo, through facilitating practical needs of everyday life. This explains the general opinion among respondents that Minga aims to help people and contribute to the local community.

> "(…) the role of the cooperative itself is **linking economic activities, or economic needs, with the state**. How can people do formally certain activities that are usually made in an informal way, because the costs that entails doing it formally don't pay off in small businesses (…). And so, the first side of this tool is that, by sharing the cost structure, an accountant, (…) it allows all its associates to invoice their products. (…) The second tool is that it allows, or eventually **facilitates, the coordination of collective things**, like a store. (…) The cooperative is not our cooperation, that is not an end in itself, but it **responds to concrete and practical needs in life**" [M2]

Management

The activities most frequently referred regarding the management of the PBBR is the promotion of the territory to increase visitation and the requalification of the visiting infrastructure in the park. Despite this requalification was promoted by the Golegã municipality, it also requalified infrastructures in Torres Novas, which is recognized as an important achievement of the PBBR, since usually the municipalities only invest within their own territories. Other activities promoted by entities included in the PBBR management body are the monitoring of bird populations in the PBNR, and the project "Milho Amarelo", that aims to demonstrate how economic and environmental sustainability can be achieved in intensive farming (Figure C2). Many interviewees had, however, difficulties in associating activities with the PBBR, referring that after the big accomplishment that was maintaining the UNESCO designation and the establishment of the participatory management body, nothing significant has been developed.

The main activities of the Janas Ecovillage are developed at their farm "Quinta do Lúzio" or the restaurant and grocery store ALDEA, in Janas downtown (Figure C3). The Ecovillage aggregates many smaller projects: the Centre for Education for Sustainability (CESA) develops courses about rural crafts for adults; the Centre for the Study and Development of Regenerative Agriculture (CEDAR) develops certified biologic agriculture at the farm; a rural incubator supports the development of small business; an Airbnb provides accommodation for tourists at the farm; there are also smaller projects such as a plant nursery ("Viveiros de Janas") and a wood business ("Madeiras de Sintra"). The Ecovillage is referred to be a privileged place to learn, since all the tools are available to demonstrate how to do a diversity of crafts, such as beekeeping and pruning. At "Quinta do Lúzio" there is a main house and smaller, satellite houses. Only one permanent family is currently living there, but there are also many temporary residents, including volunteers from all over the world that want to learn about the rural living.

Minga is multisector cooperative with four main sectors: services, agriculture, commercialization (non-agriculture products) and housing. The services sector provides the tools for people that work independently to have an employment contract with the cooperative, having social rights that otherwise would not be entitled; the agriculture sector aggregates and sell the production of local farmers and promotes the adoption of agroecological practices; the commercialization sector facilitates the development of new products and brands through sharing common expenses of creating and maintaining a business; the housing sector aims to support the access to affordable houses to the members of Minga. Minga has a store, with its own currency, focused in selling products from the region and the season. Upstairs of the store there is a multiuse room - "Espaço Integral" - where health and cultural activities are developed. Minga organizes collective moments of learning, including talks and "ajudadas", in which people help someone doing a task, while learning how to do it.

Governance

The PBBR shows a vertical interplay of organizations at different scales (Figure 4.5a): UNESCO-MAB, at a global scale, the Portuguese MAB Committee at a national scale, and many organizations with a local, regional and national scope are present in its executive and/or advisory boards. The PBBR executive body is composed by a governmental organization - the ICNF - and three local organizations: two municipalities (Golegã and Torres Vedras) and one environmental non-governmental organization (NGO) that is closely linked with local farmers associations – the ONGATEJO. The ONGATEJO is currently the chair of the management body, performing and delegating work related to the PBBR. The advisory body has 49 entities, which represent the main activities and actors in the territory that are formally organized. The executive and advisory boards meet once a year, however the frequency of the meetings has decreased since 2016, when the new strategy for the PBBR was approved. These meetings

consist of an informative session, followed by a general discussion. Given the difficulties in managing the participation of everyone in the meetings, working groups focused in specific topics are being developed:

> "When we talk in an extended meeting about tourism, nature conservation, agriculture, hunting, fishing, services... with fifty-six or fifty-seven people at the same time, many of them with different goals... sometimes we did not get the valid contribution of everyone. And what we understood was that **what makes sense is to create specific groups besides the extended meetings, in agriculture, education, tourism and conservation... and let themselves get organized**, informally or formally, in small meetings, and make proposals" [B4]

The Janas Ecovillage is the main project of the Dólmen Association. The Association has mainly a supervisory role since its board is composed by volunteers that have no economic activity linked with the Ecovillage, and do not live there. Decision-making is centralized in the two operational managers, as demonstrated by the high number of connections in Figure 4.5b, which are the only permanent residents in the farm. There is an extensive network of people linked with the Janas Ecovillage, including employees, volunteers, entrepreneurs, tourists and students. To organize everyone, and the several projects, a pragmatic decision-making model is followed:

> "(…) there is a decision to be made, there is a decision that needs several people to decide, we [operational managers] make phone calls or send an e-mail. **After twenty-four hours if there is no answer, we decide on our own**, that is to say... it is a model of decision very similar to a company, in that aspect. (…) we are a very vast team, with a lot of things... sometimes the information is very difficult to transmit, it is very difficult to put everyone communicating, therefore we have to have this pragmatism." [J1]

The decision-making in Minga is highly decentralized, but it also includes many moments of collective decision-making, following the principles of sociocracy (Figure C4). Each person is responsible for its own project, which should be developed according to the regulations of each sector. Minga has about 18 cooperants, which have capital titles, and 40 associates. Cooperants have the right to one vote, independently of the capital tiles possessed. The direction meets every month to share advances in each sector and discuss common aspects of the cooperative. The meetings are well structured, despite the informal character, and are open to everyone. The openness of Minga do not translate, however, in broad participation. Some respondents refer that "they are so open that they are closed" [M12], which means that the distinct habits of recreation and working of Minga turn local communities apart:

> "My idea of Minga is that it remains a very closed thing. (…) **It is still a project of people from outside with few people of Montemor**. The ideas are good. But when you introduce yourself to the community, which is a small community, with a certain appearance and a certain social behaviour, it is not easy. (...) certain habits of consumption, food… And then it is not easy to attract people from outside because… it gives an idea that it is... well **it is something perhaps not very serious**." [M10]

In Minga, besides the meetings of the direction there are also sectorial meetings, such as the meetings with farmers, in which experiences regarding the production of different goods are shared, connections made (e.g. between a cooperant that has a plant nursery and those that need to cultivate the plants) and joint decisions made, such as ordering manure together. Another important aspect of the governance of Minga is the strong cooperation it has with many other organizations, mainly from Montemor-o-Novo. These characteristics contribute to a more horizontal model of decision-making in Minga than in the other initiatives analysed, as it is displayed in Figure 4.5.

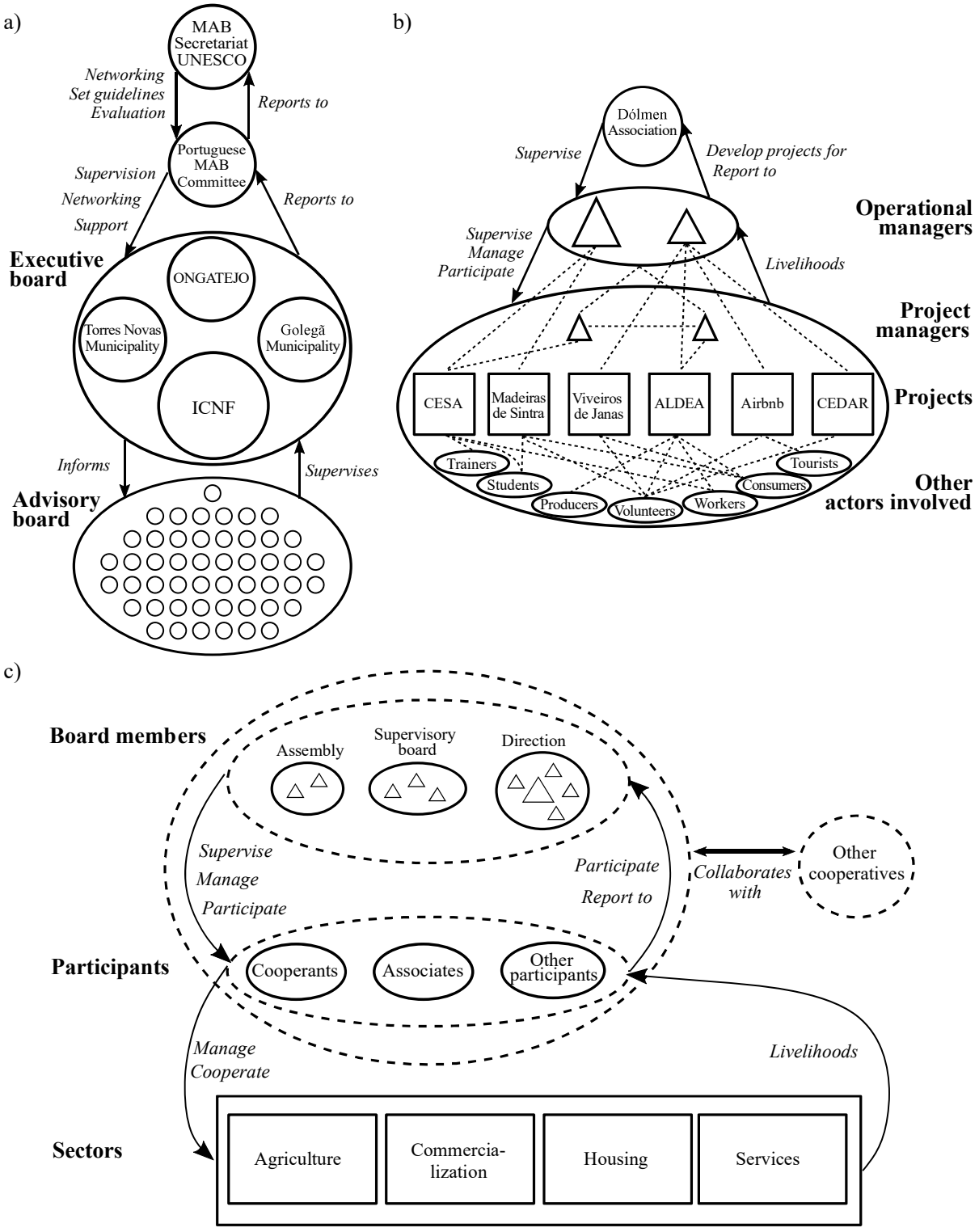

Figure 4.5 Main elements of the governance of the: a) the Paul do Boquilobo Biosphere Reserve; b) Janas Ecovillage; c) Minga Multisector Cooperative. Triangles symbolize individuals, circles groups of people and squares projects. Dashed circles indicate a lack of rigid borders. The main dynamics are explained next to the solid arrows. The presence of particularly powerful persons/entities is represented by the bigger size of the objects.

Outcomes

The outcomes identified in each initiative in relation to the subcategories of Ferreira *et al.* (2018) are displayed in Table C4. The major achievement of the PBBR was the decrease of conflicts between conservationists and farmers, and a better communication between their organizations. The co-management of the PBBR has resulted in a changing of attitudes between farmers and conservationists, as it is evidenced by the following discourse:

> "My idea was to make a channel... his idea was that it should stay more or less the same, the machine pretending that… And after all these years, neither does he think that it should be just to go there with the machine to pretend that some things are done, nor do I think that it should be a channel. And so, there was an approximation, and I think that this **closeness between the environment, agriculture and other activities** was an important trajectory that has been made since then, but concretely and in great evidence, since this new management model has been implemented." [B4]

One of the most important positive outcomes of the Janas Ecovillage is the cultural exchange between a diversity of participants with different roles and nationalities in the initiative. At an environmental level the Ecovillage contributed to the soil regeneration and higher biodiversity in the farm. The Ecovillage shows that is possible for a person to be self-sustainable with few means, having, therefore, an important demonstrative dimension. However, the Janas Ecovillage is also associated with health impacts, such as stress, frustration and injuries. The high productivity demands leave no space for real learning opportunities and, in favour of work, other aspects of life fail:

> "(…) they have a lot of people, at first I didn't know who is volunteer, who is guest, I didn't know who the owner is. I was really confused with this and a little bit afraid of this big project, with many people. (…) **I don't mean that my first day I was waiting for "Oh, hi. Who are you?" but there was nothing. (…) you are really jumping to the ocean**. (…) for example, when we cook, it's not just for us, **we cook for guests and it's also work but it's after our six hours** (…). At first it was a little bit... too much. I mean... I really like the people I met here, but mainly in the first time **I really missed my time**. (…) It was my first day and I cooked dinner for sixteen people. Three people we worked more than two hours in the kitchen." [J10]

Minga is the initiative that contributes to a higher diversity of positive outcomes, despite at a small scale. The most important outcomes are socio-economic, given the opportunities that Minga provide for people to develop economic activities. Minga helps the integration of people that arrive to Montemor and is promoting changes at a community level: people are creating habits of conversation and cooperation and changing habits of consumption and production. There is also evidence of social learning that results from the participatory processes developed:

> "It is interesting to listen to other opinions and you always learn a lot. (…) I have never studied; my studies have always been learning in the farm. And **it's interesting to learn from people who studied**, isn't it? (...) **There are many things and tips that they teach us** that we don't know. **Other things we, that are used to work the land, teach them**." [M5]

At an environmental level Minga contributes to the decrease of emissions associated with the transport of products, since their store sells mainly goods produced locally.

4.3.3 Barriers to the success of the Paul do Boquilobo Biosphere Reserve

The respondents of the PBBR identified many challenges that constitute barriers to the success of this initiative. Not having a budget allocated to the PBBR and human resources fully dedicated to the management and implementation of the biosphere reserve are among the most frequently referred barriers. However, because the PBBR is not an entity legally constituted, it cannot hire collaborators or have its own budget:

> "(...) there's a patron who wants to give money, but gives money to whom? For what? Who's going to manage that money? Is there a face to manage the money? Is there an entity called "I don't know how", with the taxpayer number "I don't know which", to whom to give the money? (...) **there should be a constituted legal entity here that can serve as a... well, justification for people to be able to give money**. This is the same as Henry Kissinger in the United States, because someone asked him a famous question and he said, "But I, to speak to Europe, I speak to whom?" Here is a little bit like that. **If I want to give money to the reserve, I give money to whom?**" [B7]

Some interviewees demonstrated a lack of trust in other institutional solutions, e.g. the money being donated to one of the organizations of the executive body, that would not require the establishment of a dedicated organization to manage the PBBR. Besides that, the current governance model was criticized for a slow decision-making, which is partly caused by the centralization of ICNF decision-making process and to the political cycles in municipalities. Even when the same party is re-elected for the municipality, as it happened in the last elections in Golegã and Torres Novas, there can be an exchange of functions or the loss of key persons which results in the decrease of the momentum about the biosphere reserve, and the beginning of a new period of learning, which was supported by the other entities of the executive body that are not so influenced by political cycles. The ICNF was also criticized for not investing in the development of infrastructures and services in the PBNR, which are necessary to promote tourism, and for having a more powerful position than the other entities in the executive body. This imbalance of powers can be explained by the focus of the PBBR in promoting tourism in the PBNR, in which the ICNF is the management authority, and where restrictions to use of natural resources apply.

The increase of environmental standards in the PBBR is constrained by the lack of successful projects to demonstrate how farmers can change their practices. However, it is widely shared among respondents that a major problem of the PBBR is the pollution of the Almonda river, which, besides the environmental impacts, creates constrains to the promotion of the territory:

> "Part of the problems are being solved, and others result from the **environmental liabilities... of the industrial activities** that were there, especially in the Riachos area, which must be solved in order to get people walking there... and not to **take photographs to a sewer or a completely black water** as it was only a short time ago... which does not give a good image. And so, in that sense, it is good not to advertise that" [B3]

However, respondents disagree regarding the need of the PBBR to interfere in the resolution of this problem, because, despite the main sources of pollution are located in the Torres Novas municipality, they are outside of the territory of the biosphere reserve. Some suggestions given by the respondents regarding how the PBBR could contribute to decrease the pollution in the Almonda river include the creation of an award for industries of the region that promote good environmental practices in their activity, and lobbying the public authorities responsible for the protection of the environment in Portugal to act in the resolution of this problem.

Despite the creation of a certification scheme is a major goal of the PBBR, most of the products produced in the region are commodities, which are difficult to label as one respondent explains:

> "(...) **we are the first part of a very long chain** that dilutes the responsibility until reaching the final consumer. (…) Until someone eats the corn that I produce it has already passed through fifty industries, so **the origin of my product is completely diluted**. Is the same thing if it comes from here or from Ukraine. (...) It will be transformed and then a chicken is going to eat it and then it is a pig and... afterwards you will make a pork steak and it will be packed and will appear in the Continente [supermarket] of Golegã, but no one else knows that the production was from here. It is the **lack of traceability** that does not... the market does not yet require it. We are still far from that and this is, perhaps, one of the things that does not make the virtuous cycle of investment and return of that investment" [B6]

Further challenges are related with a prejudice associated with the name "reserve", because of previous conflicts that resulted from the implementation of the Paul do Boquilobo Nature Reserve. Criticisms were also raised regarding the biosphere reserve model per se, which, comparing to other UNESCO programmes, is less demanding:

> "UNESCO, for the Geoparks, has huge specifications. And then there are management indicators and they come to confirm. And if you do not fulfil all those little indicators, you have a yellow card and then you have x time to repair and... you know? (...) the biosphere reserves have always been... it is a medal, an award. And they have never defined obligations or associated structures. Therefore, **while UNESCO does not provide financial support, nor a big technical and material support for the implementation, then it demands in the same extent**. (…) There is no model for the management body. There is no template for a structure associated. And that, in the end, is a handicap for the success of the process." [B8]

Respondents also identified the need to support the creation of new jobs that use natural resources in a sustainable way (medicinal plants, herbs for tea, beekeeping), to increase the advertisement of the PBBR and create indicators of the performance of the PBBR.

4.4 Discussion

4.4.1 Different pathways for social-ecological systems management and their complementarities

The holistic analysis of the PBBR, the Janas Ecovillage and Minga revealed that these initiatives are very distinct. These differences can be interpreted according to different sustainability pathways (Luederitz *et al.*, 2017).

The PBBR is more related with a "green economy" pathway because it envisions a more environmental-friendly economy, but without significant changing the current economic systems. It is focused on technology to increase efficiency of farming (project "Milho Amarelo"), and on labelling and ecotourism to promote the regional economy. The PBBR also concurs with the characteristics of the "green economy" pathway described by Luederitz *et al.* (2017), regarding who are the main promoters of this initiative: legislators (ICNF and municipalities) and intergovernmental organizations (UNESCO), following existing rules and power structures. The Janas Ecovillage is an "ecotopian solution": it builds on the construction of living spaces outside of the system ("Quinta do Luzio") in which people experiment and implement sustainable lifestyles. Minga is a transition movement because it challenges globalized structures and growth dependency through a focus on localism, degrowth and the use of local currencies. Contrary to the ecotopian solutions that create spaces outside the system, the transition movements operate using the structures of the system, which can be demonstrated by the focus of Minga in connecting economic needs with the state, and their participation in the definition of the new Portuguese housing law. Despite the similarities between the three initiatives analysed and the sustainability pathways (Luederitz *et al.*, 2017), the results also indicate that boundaries between the different narratives are not strict: despite labelling is more associated with a "green economy" pathway, Minga and the Janas Ecovillage also use biologic labels in their products. Moreover, despite the Janas Ecovillage is more associated with the creation of spaces outside of the system, it also has a restaurant and grocery store (ALDEA) open to the public. The management body of the PBBR also diverges, to some extent, from the "green economy" narrative, because it requires the cooperation among different organizations that usually work independently. Therefore, despite the PBBR, the Janas Ecovillage and Minga present many characteristics associated with the, respectively, green economy, ecotopian solutions and transition movements pathways, the results also demonstrate that interventions associated with different sustainability narratives are diverse and overlap with each other in some elements.

Different sustainability pathways address different leverage points for sustainability (Luederitz *et al.*, 2017). The green economy narrative mainly addresses shallow leverage points (parameters and flows) that are easier to implement but have a limited capacity to foster systemic change (Abson *et al.*, 2017; Luederitz *et al.*, 2017). The certification of goods and services and the implementation of a participatory management body are two of the main strategies of the PBBR that address, respectively, the parameters

and flows of a system. Deep leverage points are harder to reach (Luederitz *et al.*, 2017) because there is a higher resistance from the system to change them (Meadows, 1999). The ecotopian solutions and transition movements have the capacity to address deep leverage points, including self-organization (design) and the values and goals of the system (intent) (Abson *et al.*, 2017; Luederitz *et al.*, 2017). Minga changed the goals the systems from growth to degrowth having a higher potential to foster systemic change, because the intent influences the design, flows and parameters of a system (Abson *et al.*, 2017; Luederitz *et al.*, 2017). However, following Luederitz *et al.* (2017), mainstreaming sustainability requires all the sustainability pathways, because they target different leverage points in a system. Besides that, there is a need to connect the different pathways, since they complement each other: radical ideas from transition movements can be tested in ecotopian solutions and further applied at a larger scale in green economy initiatives (Luederitz *et al.*, 2017). Despite there is already collaborative work between Minga and the Janas Ecovillage, relationships between these grassroots initiatives and the PBBR seem to be absent. This analysis suggests that a stronger connection with grassroots initiatives may provide the source of innovation that the PBBR currently requires, in order to increase its dynamics and effectiveness. Besides that, the PBBR may constitute the platform in which large scale application of grassroot innovations are tested, contributing for the effective mainstreaming of sustainability in the Portuguese Mediterranean Biome. To achieve this, biosphere reserves should prioritize the incorporation of grassroot initiatives in their management bodies, functioning as nurseries that promote the development of projects from bottom-up and contributing to up-scale their impact. Biosphere reserves are privileged places to accomplish this because they can provide the arena where grassroot approaches, governmental and intergovernmental organizations interact (Ferreira *et al.*, 2018).

4.4.2 Differences among initiatives regarding their scope and the participants interviewed

Despite this study is mainly focused on the analysis of the management of different initiatives, the characterization of their scope and participants revealed some differences that are also important to consider. These differences help to better understand the context in which the goals of the initiatives are set, the management and governance processes adopted, the outcomes obtained and the challenges they are facing.

Minga has a much bigger area of intervention than the other initiatives, that includes the whole municipality of Montemor-o-Novo, while the Janas Ecovillage is restricted to the small village of Janas. The PBBR differentiates from the other initiatives because its area of intervention is included in two different municipalities, which brings an increased level of complexity. The areas of intervention are also different regarding the main land uses present in the territory. The PBBR comprises a highly altered landscape, dominated by intensive agriculture. Minga and the Janas Ecovillage comprise a more

heterogeneous territory and the main land uses are also less intensive, being, respectively, agroforestry and semi-natural areas. The PBBR is, therefore, the initiative that presents more challenges regarding the increase of the environmental standards of their territory, despite the presence of a nature reserve.

The analysis of some characteristics of the participants interviewed in each initiative reveal that participants in the PBBR differentiate from those of the grassroots approaches for being older (median) and less diverse: most of the managers and collaborators are males, all of them Portuguese, mainly graduated and most of them have obtained academic degrees related with environment and natural resources. The PBBR also presents more participants that live outside of the municipalities where the initiative is established than the grassroot initiatives. This characterization builds on the interviews developed with a limited number of managers and collaborators from each initiative. However, the results suggest the existence of important differences, and, therefore, the need to develop a more profound study that cover a higher number of participants and further explore the implications of these characteristics to the success of the initiatives.

4.4.3 Learning with grassroot initiatives and identifying opportunities to the success of the Paul do Boquilobo Biosphere Reserve

The comparative analysis of the PBBR, Minga and the Janas Ecovillage revealed potential problems and interesting practices which would not be possible to identify by studying a single initiative. Despite the utility of this approach to better understand the challenges and potential sources of improvement in the initiatives, this analysis is limited by the small number of case studies included. Therefore, as a future work, it would be important to expand the analysis to include more case studies, and also different models of social-ecological systems management, such as eco-regions (IN.N.E.R. International Network of Eco Regions, 2020). Future research should also be developed to explore in a more profound way the barriers to the success of the grassroot approaches and opportunities for improvement.

The remaining of this section describes the main opportunities identified to resolve some of the current challenges of the PBBR, building on insights from Minga and the Janas Ecovillage, and also from the experiences of other biosphere reserves present in the literature.

Defining ways of keeping the management of the PBBR financially sustainable

Lack of funding and human resources has been referred as one of the key barriers to the success of biosphere reserves worldwide (Stoll-Kleemann & Welp, 2008; Cuong *et al.*, 2017a,b) and the PBBR is no exception. In many biosphere reserves the management is secured by public funds (Borsdorf *et al.*, 2014), which are dependent of the existing political will and may cease at any time, as it was reported in Canadian biosphere reserves (George & Reed, 2016). However, biosphere reserves funded by grants

or the provision of services reported their own challenges as well, including a drift in the mission towards the priorities of projects and clients, and a high competition with other NGOs for limited funds (George & Reed, 2016).

In order to have a more sustainable funding, more employees and a higher dynamics, the Manicouagan-Uapishka Biosphere Reserve started providing sustainability services which are useful for the stakeholders in the region and, at the same time, advance the mission of the biosphere reserve (George & Reed, 2016). In a similar way, Minga works as a tool which can be used to meet the daily needs of the community. The provision of services is also very important to finance the Janas Ecovillage, that sells touristic and educational opportunities related with the rural living. Therefore, while the provision of services is not a panacea to finance biosphere reserves (George & Reed, 2016), the advantages and limitations of this model, contemplating the needs of the region and the mission of the PBBR, should be evaluated. The development of the PBBR label to certify products and services of the region is an example of a service that could be provided by the PBBR, and which could be funded by the interested entities (hotels, restaurants, etc.). Furthermore, the PBBR should explore the potential of grants and donations as complementary sources of funding, in a similar way of other biosphere reserves (George & Reed, 2016). These suggestions would complement the existing sources funding and contribute to its diversification.

The lack of human resources fully dedicated was also identified as an impediment to a higher dynamic in the PBBR, because paid staff would have the responsibility to apply for projects and search for donors, and would contribute to a faster decision-making. Contrary to the PBBR, Minga and the Janas Ecovillage have an extensive workforce that includes volunteers, interns, staff and entrepreneurs. The PBBR could also benefit from broadening the participation in its implementation, e.g. through the creation of volunteer and research programs.

Definition of formal institutions

The lack of an institution that is legally constituted to manage the PBBR was referred as a barrier to its success because there is no entity that can receive money (donations), hire employees or make applications to projects on behalf of the PBBR. Within the existing biosphere reserves, there is a high diversity regarding their institutional forms, including NGOs, foundations, companies, public administrations or joint ventures (Schliep & Stoll-Kleemann, 2010; Borsdorf *et al.*, 2014; George & Reed, 2016; Bridgewater, 2020; Těšitel & Kušová, 2020). There is no single model that is associated with more successful biosphere reserves: positive results have been reported for not-for-profit organizations (e.g. in the Dolní Morava Biosphere Reserve in Poland, Těšitel & Kušová, 2020), public administrations (e.g. in the Kristianstads Vattenrike Biosphere Reserve in Sweden, Hahn, 2011) and in joint management models (e.g. in the Šumava biosphere reserve in the Czech Republic, Těšitel &

Kušová, 2020). Therefore, the establishment of a new organization to manage the PBBR should be explored considering the potentialities and limitations of different models in the context of the PBBR.

The definition of which kind of institution is more advantageous for the PBBR has to consider the potential contributions to the institutional capacity (e.g. sustainable funding) and the goals (e.g. broad participation) of the PBBR. Cooperatives are enterprises that are owned and managed by their members, driven by values of equality, democracy and cooperation (International Co-operative Alliance, 2017). They contribute to a diversity of sustainable development goals (International Co-operative Alliance, 2017) and they are key to bioregional economies (Cato, 2013, pp. 71–74). Given the importance of the cooperative model in the grassroot initiatives studied, and the presence of successful cooperatives in the PBBR (e.g. AGROMAIS), this institutional setting could also be a solution to implement in the PBBR. Despite biosphere reserves are not traditionally associated with business models, George & Reed (2016) have identified some advantages of adopting social entrepreneurship practices in biosphere reserves, comparing to more traditional models, including: targeting expertise, providing an outcome-oriented strategy and helping addressing funding issues.

Moreover, other institutions maybe also necessary: in Minga and the Janas Ecovillage the existence of regulations that are accessible to everyone and define the rules of participation were considered very important to their success. However, in the PBBR there are no clear regulations: the definition of the responsibilities of each organization in advancing each task is negotiated between the four entities of the executive body and no clear guidelines exist regulating participation in the advisory board. This informal character has been important to advance some projects in the PBBR, however, it is also inefficient, as demonstrated by the need of ONGATEJO to be constantly remembering the other parties of the executive and advisory boards to advertise the PBBR in their activities. Therefore, regulations determining the duties and rights of the organizations participating the PBBR should be created.

Sociocracy for effective, broad and equal decision-making processes

In this study there were identified many challenges in the PBBR that are related to its governance: i) the executive body presents power imbalances, lack of effectiveness and a slow decision-making; and ii) meetings between the executive and the advisory bodies are becoming less frequent and it's hard to balance the participation of everyone, given the high diversity of interests present. The Janas Ecovillage is very dynamic, presenting a high effectiveness and fast decision-making. However, the centralized decision-making that do not foster a broad participation seem to be hampering the delivery of social benefits, such as empowerment and learning, and contributing to the lack of long-term collaborators. How can governance of the PBBR become more efficient while maintaining a broad and equal participation? The processes used by Minga, based in sociocratic principles, may provide some insights.

Sociocratic governance combines effectiveness with broad and inclusive participation in the decision-making in organizations (Buck & Villines, 2017). It builds on three main principles: (1) consent, i.e. absence of objection, (2) circles and (3) double-links (Buck & Villines, 2017, pp. 58–60). In a nutshell, principle (1) ensures that everyone in an organization is of equal value; principle (2) provides the structure where people can participate in the decision-making; and principle (3) guarantees that information is communicated between all levels of the organization (Buck & Villines, 2017). While the PPBR is currently organizing smaller groups to discuss specific topics, this may not be enough to a more effective governance. Following the principles of sociocracy, there is a need to ensure that communication between groups is effective, in order to constantly adapt the management to the circumstances (feedback loops). Additionally, decisions have to be made with the consent of those responsible to execute them, in order to increase the commitment towards its implementation (Buck & Villines, 2017, p. 68). Besides conceptually attractive, sociocracy is already in place in a diversity of organizations worldwide (Buck & Villines, 2017, pp. x–xi; 34), including municipalities (Romme *et al.*, 2018) and schools (van Dijk, 2016). In Portugal, sociocratic structures are implemented in other sustainability organizations besides Minga: in the farm Herdade do Freixo do Meio and in the ecovillage Tamera (Conceição, 2017). While the three main principles of sociocracy are relatively easy to understand, its successful implementation may require training and support from an expert, especially in complex organizations (Buck & Villines, 2017, pp. 146–147; Romme *et al.*, 2018). Therefore, while there is a high potential for sociocratic principles to create more equal and effective decision-making in the PBBR, its usefulness and implementation should be adequately evaluated and supported.

Recreating an integrated and shared vision

Despite the recommendations referred above may help addressing specific challenges of the PBBR, a major barrier underlying the discourses analysed was identified: the lack of an integrated and shared vision for the region. There is a need for an integrated vision because the current one emphasizes the separation of conservation and development, instead of its interdependencies. The conservation function is mainly achieved at the park, and development in its surroundings, in which intensive agriculture and urban settlements are located. However, these functions are not independent from each other, quite the opposite: the ecosystems included in protected areas provide many functions that benefit our well-being (Palomo *et al.*, 2014), but the capacity of ecosystems to maintain these functions is influenced by ecological and socio-economic processes at different scales (Cumming *et al.*, 2015). Minga and the Janas Ecovillage present more integrated strategies to promote sustainable local economies and lifestyles, such as the development of non-intensive agriculture, strengthening circular systems through recycling, reuse, sharing and repairing, implementation of local currencies, and training and support to the creation of local business which contribute to decrease the pollution associated with long-distance transport. Similar practices were also implemented in biosphere reserves,

e.g. organic farming (Moreno-Ramos & Müller, 2020; Onaindia *et al.*, 2020) and the intensification of regional value chains (Kraus *et al.*, 2014). Therefore, the PBBR needs to develop a more integrated understanding about the territory and, in accordance, implement more processes for the holistic management of social-ecological systems, as the ones referred above.

The development of a shared understanding in the PBBR can be facilitated with the use of participatory methods for environmental decision-making. Participatory system dynamics modelling can be particularly interesting because this method allows the visualization of complex ideas and the cause-effect relationships between many variables, the provision of a holistic view of the systems being managed, the possibility to test alternative management scenarios and the creation of a shared vision (Videira *et al.*, 2003; Cunico *et al.*, 2016; Lopes & Videira, 2017). However, processes to constantly work on the collective vision should also be established. In the Janas Ecovillage, despite a collective vision for the project was initially developed, it ended up being lost, with negative consequences for the group, including the departure of one of the founders. Minga has many tools that seem to be contributing to constantly build the collective vision: frequent meetings open to everyone, talks about a diversity of topics in "Espaço Integral" and "ajudadas". The implementation of more processes to help building a shared understanding about the PBBR is necessary in order to avoid conflicts related with different visions for the territory (more conservation vs more development) and ensure that everyone is working towards the same direction, without the need of constant supervision.

4.5 Conclusion

With the formation of the new management body, the Paul do Boquilobo Biosphere Reserve was able to join a diversity of entities with different interests in the territory and to put an end in a war between conservationists and farmers that occurred in the region for decades. However, after this achievement the dynamics of the project decreased. This situation has echo in other biosphere reserves from all over the world, which are having difficulties in finding ways to advance their mission after their designations or extensions according to the Statutory Framework (Cuong *et al.*, 2017a, 2020; Matsuda *et al.*, 2020). In contrast, grassroot approaches show a high dynamism and capacity to create small-scale innovate solutions for sustainable development (Seyfang & Smith, 2007; Smith & Stirling, 2018). In this study, four main topics in which insights from grassroot approaches may provide solutions to the challenges of the PBBR were identified: financial sustainability, definition of formal institutions, sociocratic governance and recreation of an integrated and shared vision. While the recommendations proposed are not blueprints, they allow to reflect on possible ways to advance the work of the PBBR, and contribute to a better understanding of how to overcome the current gap between biosphere reserves' concept and practice.

The profound analysis developed in this study of the management of the PBBR, Janas Ecovillage and Minga also revealed that these initiatives broadly follow different sustainability pathways, as defined by Luederitz *et al.* (2017). The PBBR is more associated with a green economy pathway, the Janas Ecovillage with ecotopian solutions and Minga with transition movements. Because different sustainability pathways address distinctive leverage points for changing systems (Luederitz *et al.*, 2017), collaboration among a diversity of initiatives is necessary. This could provide biosphere reserves with a source of innovation that allows them to avoid stagnation, and, at the same time, scale-up practices from grassroot initiatives, contributing more effectively to mainstream sustainability.

However, in order to contribute in a more effective way to the resolution of the challenges of the PBBR and the grassroot approaches alike, a follow-up phase of this study is necessary. It would be important to discuss the results of this study with the stakeholders in each initiative, and develop, in a collaborative way, action plans. Participatory methods and the principles of transdisciplinary research (Lang *et al.*, 2012) should be used in this phase to build a more collective understanding of the initiatives, and to contribute in a more effective way for their success.

5 General discussion and conclusions

5.1 Theoretical contributions for the management of social-ecological systems and limitations of the framework

A major assumption of this research was that social-ecological systems should be managed not only for maintaining future possibilities of extracting natural resources, but also to foster human well-being and the conservation of biodiversity. Because of this, and of the more limited scope of existing frameworks to analyse social-ecological systems' management (Ostrom, 2007, 2009), I found a need of developing a new, more holistic, structure of analysis. The framework developed in Chapter 2 comprise my main conceptual contribution to a better understanding of the factors that influence the management of social-ecological systems. This framework is holistic because it considers several social and ecological goals, inter-scale dynamics, a diversity of resources and actors, and the multiple values of biodiversity (Ferreira *et al.*, 2018). It has an empirical support, because it was developed through the analysis of empirical studies, but it also integrates concepts from previous frameworks (Ostrom, 2009; Cumming *et al.*, 2015). It includes, therefore, a diversity of perspectives over social-ecological systems' management, being more comprehensive than frameworks that are rooted in specific disciplines.

The added value of using a holistic framework to analyse the management of social-ecological systems was demonstrated in Chapters 3 and 4 with the study of, respectively, the implementation of biosphere reserves worldwide and of one biosphere reserve and two grassroot initiatives in Portugal. In these studies, it was possible to realize the importance of interactions between different processes, of factors which control relies outside of the systems being managed, trade-offs between outcomes and of the social-ecological contexts in which processes are implemented. Having all these dimensions in a framework allowed to understand the relationships, and to see conflicts and synergies that would not be possible to identify by analysing a single dimension. Consequently, different factors for the success of biosphere reserves from those frequently referred in the literature, e.g. funding and public participation (Stoll-Kleemann & Welp, 2008; Schultz *et al.*, 2011; Cuong *et al.*, 2017b), were identified, namely the goals of biosphere reserves (Chapter 2) and the lack of an integrated vision (Chapter 3). Building on literature of systems thinking (Meadows, 2008; Abson *et al.*, 2017; Luederitz *et al.*, 2017), I argue that these factors are more effective leverage points for the success of biosphere reserves, because they influence which processes are going to be developed, which inputs are needed and the outcomes in a given context.

In order to analyse the main differences between a biosphere reserve and two grassroot initiatives - a multisector cooperative and an ecovillage - the framework had to be combined with an inductive

analysis (Chapter 4). The framework provided an important structure that guided the investigation during the data collection and analysis. Therefore, despite the framework was developed through the analysis of biosphere reserves, it was also useful to build a holistic understanding of other initiatives managing social-ecological systems with very different approaches, as initially hypothesized in the Chapter 2. The added value of using this framework, is that it provides a tool to develop a more holistic understanding of the management of social-ecological systems and to analyse and deal with its complexity. Further applications of the framework may include, therefore, protected areas, with different management categories (Borrini-Feyerabend *et al.*, 2013), and eco-regions (IN.N.E.R. International Network of Eco Regions, 2020).

There are, however, some elements that limit the utility of the framework in the analysis of the management of biosphere reserves and other social-ecological systems.

The main challenge I found in the implementation of the framework was its complexity - the framework comprises 53 subcategories, many of them including multiple factors, and boundaries among subcategories are not always well defined. This complexity may create an impediment to the use of the framework by managers of biosphere reserves and other initiatives alike. One possible way to overcome this, is to implement the framework in biosphere reserves in several stages, with increased levels of complexity. In a first stage, the framework can be used to identify the factors that are limiting the success of a biosphere reserve, in a similar way of the work performed in Chapter 4. A second stage could include the development of participatory workshops in which the most important factors to increase success are prioritized. This will require the identification of the relationships between different factors, e.g. through the development of a matrix of interactions and/or causal loop diagrams (e.g. Marques *et al.*, 2014; Lopes & Videira, 2017). In a more advanced stage, a collaborative work to implement the priority actions previously identified can be developed. The framework can be used in this stage to report what outcomes are associated with the different processes implemented, what inputs are needed, and which are the variables of the context that are particularly important. This advanced stage provides, therefore, an opportunity to reflect upon the processes implemented, learn and disseminate experiences.

Another shortcoming of the framework is that it is more focused in social than environmental outcomes. Environmental outcomes are all aggregated in two subcategories (environmental impacts and benefits), while social outcomes are more numerous and more specific, e.g. empowerment. This result reflects, in part, a lack of information in the literature analysed about environmental outcomes, as identified in Chapter 3. However, in order to prevent that environmental aspects are undervalued in biosphere reserves' management, the framework should include more specific subcategories for the environment, such as biodiversity loss, climate change or freshwater use. In this regard, the framework developed by Raworth (2018) - a doughnuts representing social and ecological goals for the humanity - can be useful. By replacing the outcomes category of the framework with the doughnuts, it is possible to balance

environmental and social outcomes. The doughnuts also provides biosphere reserves with a new goal - to get into the "safe and just space for humanity" that stands between the social foundation and the ecological ceiling (Raworth, 2018, p. 44). This topic is discussed in more detail in section 5.2.1.

Finally, because the framework builds on the existing scientific literature related with biosphere reserves' management effectiveness, it leaves outside grey literature, such as reports of the national committees or the periodic reviews, which comprise an important source of information about biosphere reserves. Even within the scientific literature, many studies may have been excluded because they do not mention "biosphere reserve" in the title, abstract or keynotes, because they are not written in English or not present in the Scopus database. Therefore, this framework should be used as a first step towards a more holistic understanding of biosphere reserves' management effectiveness, and, as future work, data from other sources of information should be used to complement it.

5.2 Recommendations for policy

A main motivation of this research is to contribute to the success of new models of development that are better for humans and nature, with a special focus in biosphere reserves, but also including grassroot approaches. Therefore, the provision of recommendations for policy is an important part of this work. This section summarizes recommendations that emerged from this study and which seem to be important to the implementation of the MAB Programme, the Paul do Boquilobo Biosphere Reserve, the Janas Ecovillage and the Minga Multisector Cooperative.

5.2.1 The MAB Programme

Recommendation#1: Availability and quality of data

As I described in Chapter 3, the databases of biosphere reserves available in UNESCO websites (UNESCO n.d., 2017) present many shortcomings, including unavailability of data, data that is not updated or that is inconsistent between databases. It would be important that UNESCO provide databases of the designated biosphere reserves and which contain a diversity of resources, up to date and widely available, that allow to develop comparative analysis and to be consulted by a diversity of stakeholders. As an example, using data contained in the periodic reviews, the diversity of institutions (foundations, NGO's, governmental organizations) currently being used to manage biosphere reserves could be identified; and shapefiles could be used in geographic information systems to determine the main land uses currently included in the transition zones of biosphere reserves. Moreover, as suggested in Chapter 2, the framework developed in this thesis can provide a structure to report a diversity of elements which allow to better understand what works where and why. The existence of a database with

such information allows the development of more studies about biosphere reserves' management effectiveness, contributing to a more successful application of the Programme.

Recommendation#2 – Provision of incentives to reporting and learning

A database that builds on the framework developed, reporting experiences in the management of biosphere reserves worldwide, is not only interesting for research; it can provide opportunities for learning among biosphere reserves and incentivize the adoption of good practices. However, considering that the Programme has been characterized by a lack of reporting from biosphere reserves (Price, 2002; UNESCO, 2013; Matar & Anthony, 2017), a mechanism to incentivize the provision of data is necessary.

One idea to overcome this problem is the development of a mechanism, in which the performance of biosphere reserves is displayed regarding different components of the framework, and which is widely available, allowing biosphere reserves all over the world to be compared. This mechanism, inspired in benchmarking processes, would motivate reporting and improvement through continuous comparing among biosphere reserves. Moreover, a monetary prize could also be given to the best biosphere reserves in each category to support and stimulate participation. For this mechanism to work, biosphere reserves would have to send to the MAB Secretariat information about a diversity of indicators that would be selected from the framework (e.g. funding, participatory processes, environmental, cultural, social and economic outcomes) and about which variables were important to achieve them. A system of colours (e.g. green, yellow, red) would indicate the performance of each biosphere reserve in respect to each indicator in a website, allowing to see which biosphere reserves have performed better in different elements. Moreover, the information provided would also allow to understand why a biosphere reserve have a certain performance, because of the information reported about the context, processes and inputs. Biosphere reserves with the best performances in each category could be identified with a badge, and their achievements widely disseminated, including in social networks. Such a mechanism would increase the dynamism of the WNBR, originating contents that are of interest for the media and social networks, which contributes for a constant and wider dissemination, increasing the interest about biosphere reserves. It could also increase the motivation in biosphere reserves to work every year to improve their performance in the different indicators, providing a more effective method of evaluation and learning than the periodic review process. Despite periodic reviews could be still developed every 10 years to provide a more profound analysis of the implementation of biosphere reserves, the mechanism proposed is more suited to stimulate learning and increase the dynamics of the network.

Recommendation #3: From sustainable development to the doughnuts

In Chapter 3 I argue that the goals of biosphere reserves are effective leverage points to promote their success, and that sustainable development and the Sustainable Development Goals Agenda are not the adequate frameworks to guide biosphere reserves towards thriving social and natural systems. These concepts have been previously criticized for promoting economic growth on a finite planet (Kothari *et al.*, 2014; Gómez-Baggethun, 2019) and for resulting from a Western construct that ignores existing cultural alternatives and worldviews of human-nature relationships (Kothari *et al.*, 2019).

A possible alternative to the sustainable development panacea in biosphere reserves is the framework developed by Kate Raworth (Raworth, 2018) - a doughnut representing the "safe and just space for humanity" which lies between the ecological limits of Earth and humanity social needs (Figure 5.1).

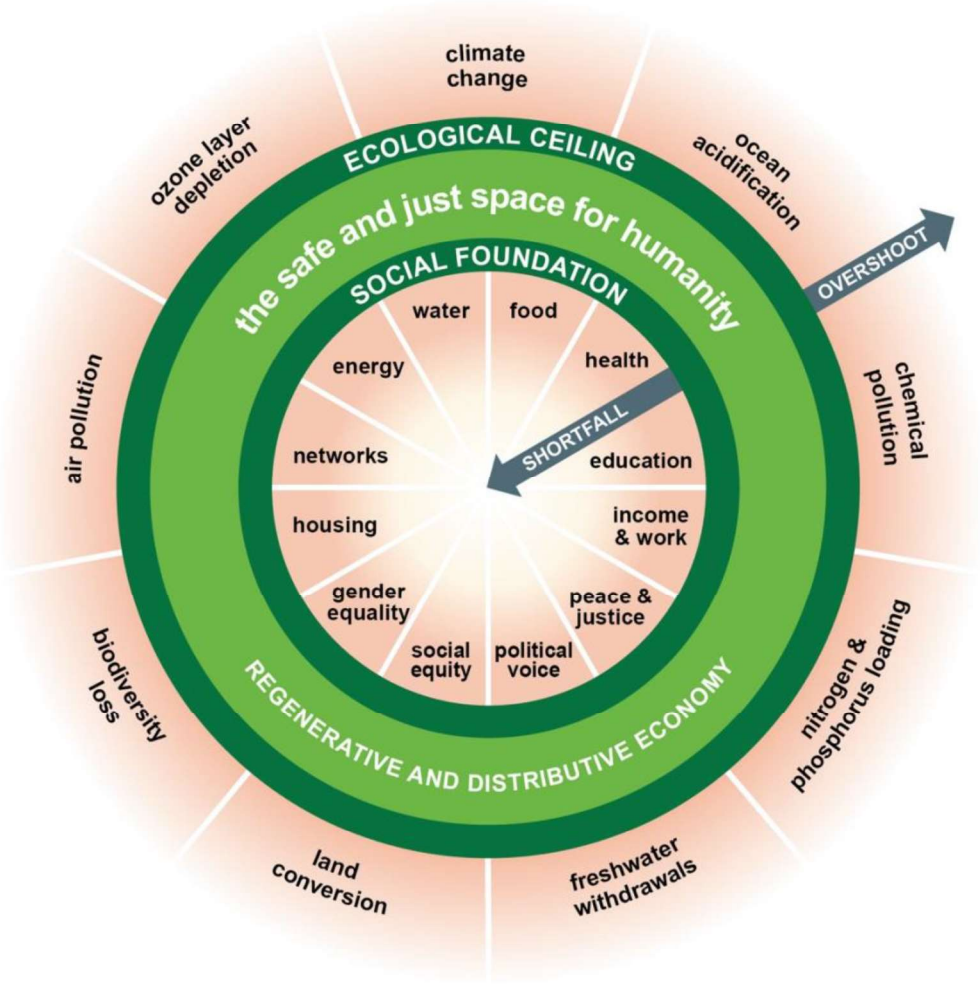

Figure 5.1 The doughnut representing the safe and just space for humanity developed by Raworth (2018). By DoughnutEconomics - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=75695171

The Earth system includes the planetary boundaries identified by Rockström & Klum (2015) (e.g. climate change and biodiversity), which should not be overcome, or the ecological foundation that supports live on Earth is at risk. Humanity social needs includes critical aspects no one should be deprived, such as health, food, peace and justice. The doughnuts allows to represent, in an integrated way, social and ecological requirements of different contexts (e.g. O'Neill *et al.*, 2018), without the prescription of panaceas such as economic growth (SDG#8). Moreover, it allows to see the trade-offs between social development and environmental degradation (O'Neill *et al.*, 2018). The potential of the doughnuts in guiding more sustainable and equal societies have been widely recognized (Raworth, 2018), and regional applications of the concept were already developed (Dearing *et al.*, 2014). This framework provides, therefore, a tool to continuously evaluate at what point the regional economies of biosphere reserves potentiate the well-being of their inhabitants within ecological boundaries. Its potential application in the WNBR should be considered, in order to replace the current focus in the SDGs, and the lack of an evaluation framework that allows to determine the added value of biosphere reserves for humans and nature. Despite comprising very complex information, the picture of the doughnut can be widely understood, providing clearer information about what biosphere reserves are meant to be.

Recommendation#4: Provide consultation to biosphere reserves for the development of regional sustainable economies

The definition of the goals of biosphere reserve and of which strategies and activities are needed to build a regional sustainable economy in biosphere reserves have to be co-created at a local level, as I argue in Chapter 4. However, because this requires a broad understanding of many interrelated topics (e.g. economy and ecology) and the use of complex methodologies, such as participatory system dynamics, for which there may not exist the knowledge or capacity in a biosphere reserve, the MAB Secretariat should provide adequate support. Teams of experts in bioregional economies, participatory processes and systems dynamics could help the management bodies of biosphere reserves co-creating holistic strategies for their regions. They could teach and help the development of processes to facilitate the co-creation of a shared vision and collective decision-making. This consultation is important to help stimulate biosphere reserves already designated, but which are currently in more latent stage, such as the Paul do Boquilobo Biosphere Reserve and biosphere reserves elsewhere (Matsuda *et al.*, 2020, p. 199). It is also of major importance in the initial stages of the designation of a biosphere reserve, in which the vision is created, the main processes for management defined and the human and financial resources available evaluated. Teams could be established for each of the MAB regions and being in constant communication, to exchange strategies and ideas of possible ways of overcoming the challenges of specific biosphere reserves, avoiding the prescription of panaceas, but focusing on learning and experimentation.

5.2.2 The Paul do Boquilobo Biosphere Reserve

After the creation of a management body that combines a diversity of sectors, including conservationists and farmers which had a problematic relationship in the region for decades, the Paul do Boquilobo Biosphere Reserve lost dynamic. The holistic analysis of this initiative (Chapter 4) revealed a diversity of challenges preventing its success. In order to overcome them, I propose, in Chapter 4, four main recommendations: define ways of keeping the management of the PBBR financially sustainable; define formal institutions; implement sociocratic processes for effective, broad and equal decision-making; and recreate an integrated and shared vision. Two other considerations can be added to these recommendations. First, the doughnut representing social and ecological goals for humanity (Raworth, 2018), that I proposed to be adopted in the WNBR (Section 5.2.1), could be implemented in the Paul do Boquilobo Biosphere Reserve, to help building an integrated strategy for the territory. Second, the Paul do Boquilobo Biosphere Reserve should collaborate with grassroot approaches, such as Minga, the Janas Ecovillage and other bottom-up initiatives being developed in the territory of this biosphere reserve, in order to increase its dynamic and facilitate the up-scaling of processes that contribute to mainstream sustainability.

5.2.3 The Janas Ecovillage

According to the analysis of the Janas Ecovillage (Chapter 4), the main challenge of this initiative is related with its social component. The project is focused on productivity, leaving no time for real learning opportunities, for the development of participatory mechanisms of decision-making, to think and discuss the processes and to engage the residents of the Janas village. Moreover, there is a lack of consideration for social relations and for the working conditions of the collaborators. These elements have contributed to a lack of long-term participants, besides the main managers of the project, and for negative outcomes, such as stress, injuries and frustration.

In order to increase the positive social outcomes of the project, the Janas Ecovillage should find ways of engaging participants, and the Janas community, in a more profound way, in order to have a collective of people that is more committed to the project, and to be able to expand good environmental practices beyond the farm. Changing the governance of the project seems to be a key aspect to achieve this and it can also contribute for the re-creation of the shared vision that some respondents refer was lost. Sociocratic processes, that are implemented in Minga and in other sustainability organizations in Portugal, including ecovillages, e.g. Tamera (Conceição, 2017), could also be useful in the Janas Ecovillage. Sociocracy provides a structure to promote a more inclusive, equal and effective decision-making (Buck & Villines, 2017). By promoting decentralized structures, social benefits, such as empowerment and learning, could be achieved. Moreover, the organization in circles allows the creation of a group that includes the Janas community, which could, in this way, be integrated in the project.

Strengthening the collaboration with the local community, and also with other sustainability organizations of the region and beyond, e.g. the Minga Multisector Cooperative and the PBBR, would also be important for the Janas Ecovillage to have a higher impact.

5.2.4 The Minga Multisector Cooperative

The holistic analysis of the Minga Multisector Cooperative revealed a diversity of challenges including legislation, communication, lack of participants, the need for new infrastructures and climate change. The lack of participants is particularly important, as it undermines the capacity of Minga to deal with many of the other challenges. In particular, it is necessary that the local community of Montemor-o-Novo is increasingly engaged. In order to promote a wider participation in Minga, increased attention to the way the work is communicated is important. Communicating the work in a professional way can increase trust in the project and contribute to a wider participation. Moreover, Minga should incorporate small changes in their processes to make people from Montemor feel more welcomed and comfortable in their participation. As an example, the talks that are organized at Mingas' "Espaço Integral" could take place in another space, where locals are more used to be, and at a time that is also more adequate to the customs of the local community.

It would also be important to advance with projects that are currently on hold because of the lack of infrastructures, such as a unit of transformation of food and a laboratory to produce cosmetics and detergents. These projects would contribute to increase the autonomy of the region, creating more possibilities of local business, and are determinant to increase the integration of different sectors, namely agriculture and commercialization. To overcome the lack of these infrastructures, Minga could make collaborations with other organizations in the region that already have them. This is the case of the Herdade do Freixo do Meio and the University of Évora, which are very closed located from Montemor-o-Novo. Finally, Minga should also strength its collaboration with other sustainability organizations, such as the Janas Ecovillage and the Paul do Boquilobo Biosphere Reserve, in order to up-scale its impact and contribute to mainstream sustainability, as discussed in Chapter 4.

5.3 Contributions for the research field of biosphere reserves' management effectiveness

Early in this research I realized that a major factor limiting the success of biosphere reserves is the lack of scientific literature that provides a better understanding about their implementation. This information is very important to determine what processes work where and why. Therefore, besides the conceptual and empirical elements already discussed in sections 5.1 and 5.2, another important contribution of this research to the success of biosphere reserves is a research agenda for the field of biosphere reserves'

management effectiveness (Chapter 3). This agenda builds on the gaps and bias found in a very comprehensive analysis of the scientific literature related with biosphere reserves' management effectiveness (Chapter 3), that, to my knowledge, has never been developed, providing, therefore, a significant contribution for the field.

In this agenda, four main priorities for research were identified: development of holistic research programs, investigation of outcomes and trade-offs of biosphere reserves, transformations for social-ecological fit and mechanisms for an integrated management of biosphere reserves across scales. Furthermore, given the similarities between their objects of investigation, I recommended strengthening collaborations between research communities working on biosphere reserves' management effectiveness, sustainability science and sustainable social-ecological systems. In addition, considering the changes to the framework discussed in this chapter, it would be important to start investigating how to implement the doughnuts economy (Raworth, 2018) in biosphere reserves.

5.4 Concluding remarks and future research

I conclude revisiting the research questions that have guided the development of this work, and proposing some directions for future research. The main conclusions of this research regarding the research questions listed in Section 1.3 are summarized in Table 5.1. These results provide insights about how to manage social-ecological systems to achieve multiple social and environmental goals, including the conservation of biodiversity. The first insight is that management of social-ecological systems is complex, but not infinitely complex – it can be understood by analysing the context, inputs, processes and outcomes of the management. Second, analysis of the management of social-ecological systems requires holistic approaches, in order to understand the relationships, and to see conflicts and synergies that would not be possible to identify by analysing a single dimension. Third, research about management of social-ecological systems requires the integration of a diversity of disciplines and actors, in order to integrate different perspectives about these complex systems. Moreover, given the complexity and the urgency of the current social-ecological crises, a close relationship between conceptual and empirical research, and the practice, is necessary. Forth, there are no one-size-fit-for-all solutions. Initiatives for the management of social-ecological systems have to be co-created in the contexts in which they are implemented, and to respond to local needs. Fifth, the purposes of the management of social-ecological systems has to be clearly identified and trade-offs between different goals understood. Lack of consideration for the goals of social-ecological systems' management can result in the pursuit of objectives that ultimately exacerbate the problems that are meant to be resolved. Sixth, the management of social-ecological systems requires collaborative work between initiatives that follow very different sustainability pathways, such as biosphere reserves and grassroot approaches, in order to mainstream sustainability.

Table 5.1 Revisiting the research design including the main findings to the research questions

General goal	Contribute for a better understanding of how social-ecological systems can be managed to achieve multiple social and environmental goals, including the conservation of biodiversity		
Chapter	**Chapter # 2**	**Chapter # 3**	**Chapter # 4**
Title	A social-ecological systems framework as a tool for understanding the effectiveness of biosphere reserve management	Biosphere reserves' management effectiveness – a systematic literature review and a research agenda	Management of social-ecological systems in the Portuguese Mediterranean Biome – what can biosphere reserves learn from grassroot approaches?
Research questions	RQ#1: Which factors influence biosphere reserves' management effectiveness?	RQ#2: How are factors of the context, inputs, processes and outcomes related? What variables influence this relationship?	RQ#3: What are the main differences in the management of biosphere reserves and grassroot approaches? RQ#4: How can experiences of grassroot approaches contribute to the success of biosphere reserves?
Methods	Systematic literature review of scientific literature; Qualitative content analysis (mixed deductive and inductive)	Systematic literature review of scientific literature; Quantitative content analysis (deductive); Descriptive and multivariate statistics	Multiple case-study analysis of the Paul do Boquilobo Biosphere Reserve, Janas Ecovillage and Minga Multisector Cooperative; Semi-structured interviews; Qualitative content analysis (mixed deductive and inductive)
Main findings	The factors that influence biosphere reserves' management effectiveness can be organized in 53 subcategories and 4 main categories: context, inputs, processes and outcomes, which interact at different scales.	Factors of the context, inputs, processes and outcomes can be grouped according to the goals of biosphere reserves: biodiversity conservation, sustainable development and capacity building. The main drivers influencing this relationship are the region where was the study developed and the methods used for data analysis. However, there are bias and gaps in the scientific literature that prevent a more holistic understanding.	The main differences in the management of the Paul do Boquilobo Biosphere Reserve and the two grassroot initiatives studied are related with how the initiatives started, their goals, processes of governance and management, and outcomes; Grassroot approaches provide innovative ideas to overcome the challenges of the PBBR regarding: financial sustainability, formal institutions, sociocratic governance and re-creation of an integrative and shared vision.

In a future work it would be important to investigate the following topics:

1) Two grassroot initiatives were analysed in Chapter 4, however, the main challenges for their success were not profoundly discussed. It would be important to develop this work in order to provide more specific recommendations to increase their success and also, to contribute to a better understanding of the challenges of ecovillages and multisector cooperatives in Portugal;

2) A more profound analysis of the challenges to the success of the Minga Multisector Cooperative and the Janas Ecovillage would also allow to identify which barriers they have in common with the Paul do Boquilobo Biosphere Reserve. This information could be used to design public policies that will potentially benefit a diversity of sustainability organizations, contributing to effectively mainstream sustainability in Portugal;

3) In order to contribute to the success of the initiatives investigated in this work, it is necessary to develop a follow-up phase, in which the results are discussed with the practitioners, make available in a format that can be widely understood, and collaboratively implemented. This requires strengthening the collaboration with stakeholders of the MAB Programme, the Paul do Boquilobo Biosphere Reserve, the Janas Ecovillage and the Minga Multisector Cooperative through, e.g. the development of participatory workshops. Tangible products could be collaboratively developed to empower and motivate the practitioners towards the implementation of the solutions identified (Lang *et al.*, 2012), such as action plans and policy briefs;

4) It would also be important to extend the analysis developed in Chapter 4 to other case studies, including not only more biosphere reserves, ecovillages and multisector cooperatives, but also other approaches to manage social-ecological systems, such as eco-regions (IN.N.E.R. International Network of Eco Regions, 2020) and protected areas with different management categories (Borrini-Feyerabend *et al.*, 2013). This work would allow to have a more comprehensive understanding about the diversity of sustainability pathways being pursued in the Portuguese Mediterranean Biome;

5) The presence of a nature reserve, of an organized society, or being close to an urban centre are key elements to understand why, respectively, the Paul do Boquilobo Biosphere Reserve, Minga and the Janas Ecovillage are particularly suited to the social-ecological contexts in which they are implemented. A more systematic identification of which are these aspects could allow the development of a "typification" of contexts, that would be important to better understand which general models of management of social-ecological systems (biosphere reserves, multisector cooperatives or ecovillages) maybe more appropriate in different regions.

5.5 Outputs

This section includes a list of the main outputs of this work.

Peer-reviewed publications

The first author of the papers was the leading responsible for the development of the investigation, that was supported by the co-authors, mainly regarding the design of the research, discussion of the results and revision of the manuscripts.

1. Ferreira, A.F., Cosme, I., von Wehrden, H. & Santos, R. n.d. Management of social-ecological systems in the Portuguese Mediterranean Biome - what can biosphere reserves learn from grassroot approaches? *In preparation.*

2. Ferreira, A.F., Zimmermann, H., Santos, R. & von Wehrden, H. n.d. Biosphere reserves management effectiveness - a systematic literature review and research agenda. *Submitted.*

3. Ferreira, A.F., Zimmermann, H., Santos, R. & von Wehrden, H. 2018. A social-ecological systems framework as a tool for understanding the effectiveness of Biosphere Reserve management. Sustainability, 10: 3608. doi:10.3390/su10103608

Presentations in scientific conferences

1. Ferreira, A.F., Zimmermann, H., Santos, R. & von Wehrden, H. A global systematic literature review of biosphere reserves management. Second Biennial Conference of the Political Ecology Network, June 19-22, 2018. Oslo. *Oral presentation*.

2. Ferreira, A.F., Santos, R. & von Wehrden, H. Factors influencing biosphere reserves management: A systematic literature review. 12th Conference of the European Society for Ecological Economics, June 20-23, 2017. Budapest. *Oral presentation*.

3. Ferreira, A.F. Success of biosphere reserves in South Europe: A socio-ecological approach. 12th Conference of the European Society for Ecological Economics, June 18-20, 2017. Budapest. *Poster*.

Research visits

1. HvW Lab, Faculty of Sustainability, University of Leuphana. February 2017 to April 2019. Lüneburg, Germany.

Participation in meetings with practitioners

1. European Meeting of the Man and Biosphere Programme (EuroMAB). Bassin de la Dordogne Biosphere Reserve, Sarlat, France, April 3-7, 2017. *In representation of the Paul do Boquilobo Biosphere Reserve.*

2. UNESCO MAB Youth Forum. Po Delta Biosphere Reserve, Italy, September 18-22, 2017. *In representation of the Paul do Boquilobo Biosphere Reserve.*

3. Second Meeting of the Portuguese MaB Committee. Paul do Boquilobo Biosphere Reserve, Golegã, Portugal, November 22, 2016. *Participation as an observer.*

Publications in journals without peer-review

1. Ferreira, A.F. 2018. Gestão de Reservas da Biosfera - Que fatores influenciam o seu sucesso? Revista Agrotejo União Agrícola do Norte do Vale do Tejo, 28: 52.

6 Appendix

6.1 Appendix A

Search string used to identify studies for the review in Scopus database (Chapters 2 and 3):

TITLE-ABS-KEY (“biosphere reserve”) AND (LIMIT-TO (DOCTYPE, “ar”) OR LIMIT-TO (DOCTYPE, “ip”)) AND (LIMIT-TO (LANGUAGE, “English”))

Tables

Table A1 Reviewed articles (Chapters 2 and 3). ID – Identification number (Chapter 3)

ID#	Reference
1	Alonso-Yañez, G., & Davidsen, C. (2014). Conservation science policies versus scientific practice: evidence from a mexican biosphere reserve. Human Ecology Review, 20(2), 3–30. http://doi.org/http://www.jstor.org/stable/24707624
2	Alonso-Yanez, G., Thumlert, K., & de Castell, S. (2016). Re-mapping integrative conservation: (Dis) coordinate participation in a biosphere reserve in Mexico. Conservation & Society, 14(2), 134–145. http://doi.org/10.4103/0972-4923.186335
3	Azcárate, M. C. (2010). Contentious hotspots: ecotourism and the restructuring of place at the Biosphere Reserve Ria Celestun (Yucatan, Mexico). Tourist Studies, 10(2), 99–116. http://doi.org/10.1177/1468797611403033
4	Behnen, T. (2011). The man from the biosphere - exploring the interaction between a protected cultural landscape and its residents by quantitative interviews: the case of the UNESCO Biosphere Reserve Rhön, Germany. Eco.Mont, 3(1), 5–10. http://doi.org/10.1553/eco.mont-3-1s5
5	Boja, V., & Popescu, I. (2000). Social ecology in the Danube Delta: theory and practice. Lakes and Reservoirs: Research and Management, 5(2), 125–131. http://doi.org/10.1046/j.1440-1770.2000.00107.x
6	Brenner, L., & Job, H. (2006). Actor-oriented management of protected areas and ecotourism in Mexico. Journal of Latin American Geography, 5(2), 7–27. http://doi.org/10.1353/lag.2006.0019
7	Catalán, A. K. R. (2015). The Monarch Butterfly Biosphere Reserve: an exemplary participative approach? Environmental Development, 16, 90–103. http://doi.org/10.1016/j.envdev.2015.04.005
8	Constantin, M. (2012). On the ethnographic categorization of biodiversity in the Danube Delta “Biosphere Reserve.” Eastern European Countryside, 18(1), 49–60. http://doi.org/10.2478/v10130-012-0003-x

Table A1 (continuation)

ID#	Reference
9	Devine, J. (2014). Counterinsurgency ecotourism in Guatemala's Maya Biosphere Reserve. Environment and Planning D: Society and Space, 32(6), 984–1001. http://doi.org/10.1068/d13043p
10	Durand, L., Figueroa, F., & Trench, T. (2014). Inclusion and exclusion in participation strategies in the Montes Azules Biosphere Reserve, Chiapas, Mexico. Conservation and Society, 12(2), 175–189. http://doi.org/10.4103/0972-4923.138420
11	Durand, L., & Lazos, E. (2008). The local perception of tropical deforestation and its relation to conservation policies in Los Tuxtlas Biosphere Reserve, Mexico. Human Ecology, 36(3), 383–394. http://doi.org/10.1007/s10745-008-9172-7
12	Elgert, L. (2014). Governing portable conservation and development landscapes: reconsidering evidence in the context of the Mbaracayú Biosphere Reserve. Evidence and Policy, 10(2), 205–222. http://doi.org/10.1332/174426514X13990327720607
13	Fazito, M., Scott, M., & Russell, P. (2016). The dynamics of tourism discourses and policy in Brazil. Annals of Tourism Research, 57, 1–17. http://doi.org/10.1016/j.annals.2015.11.013
14	Fu, B., Wang, K., Lu, Y., Liu, S., Ma, K., Chen, L., & Liu, G. (2004). Entangling the complexity of protected area management: the case of Wolong Biosphere Reserve, Southwestern China. Environmental Management, 33(6), 788–798. http://doi.org/10.1007/s00267-004-0043-8
15	Gerritsen, P., & Wiersum, F. (2005). Farmer and conventional perspectives on conservation in Western Mexico. Mountain Research and Development, 25(1), 30–36. http://doi.org/10.1659/0276-4741(2005)025[0030:FACPOC]2.0.CO;2
16	Grandia, L. (2009). Raw hides: hegemony and cattle in Guatemala's northern lowlands. Geoforum, 40(5), 720–731. http://doi.org/10.1016/j.geoforum.2009.01.004
17	Habibah, A., Er, A. C., Mushrifah, I., Hamzah, J., Sivapalan, S., Buang, A., … Sharifah Mastura, S. A. (2013). Revitalizing ecotourism for a sustainable Tasik Chini Biosphere Reserve. Asian Social Science, 9(14), 70–85. http://doi.org/10.5539/ass.v9n14p70
18	Hagan, K., & Williams, S. (2016). Oceans of discourses: utilizing Q methodology for analyzing perceptions on marine biodiversity conservation in the Kogelberg Biosphere Reserve, South Africa. Frontiers in Marine Science, 3, 188. http://doi.org/10.3389/fmars.2016.00188
19	Hahn, T. (2011). Self-organized governance networks for ecosystem management: Who is accountable? Ecology and Society, 16(2), 18. http://doi.org/10.5751/ES-04043-160218
20	Hill, W., Byrne, J., & Pegas, F. de V. (2016). The ecotourism-extraction nexus and its implications for the long-term sustainability of protected areas: what is being sustained and who decides? Journal of Political Ecology, 23(1), 307–327. http://dx.doi.org/10.2458/v23i1.20219
21	Hill, W., Byrne, J., & Pickering, C. (2015). The 'hollow-middle': why positive community perceptions do not translate into pro-conservation behaviour in El Vizcaíno Biosphere Reserve, Mexico. International Journal of Biodiversity Science, Ecosystem Services & Management, 11(2), 168–183. http://doi.org/10.1080/21513732.2015.1036924
22	Hoffman, D. M. (2014). Conch, cooperatives, and conflict: conservation and resistance in the Banco Chinchorro Biosphere Reserve. Conservation and Society, 12(2), 120–132. http://doi.org/10.4103/0972-4923.138408
23	Humer-Gruber, A. (2016). Farmers' perceptions of a mountain biosphere reserve in Austria. Mountain Research and Development, 36(2), 153–161. http://doi.org/10.1659/MRD-JOURNAL-D-15-00054.1

Table A1 (continuation)

ID#	Reference
24	Kent, K., Sinclair, A. J., & Diduck, A. (2012). Stakeholder engagement in sustainable adventure tourism development in the Nanda Devi Biosphere Reserve, India. International Journal of Sustainable Development and World Ecology, 19(1), 89–100. http://doi.org/10.1080/13504509.2011.595544
25	Knaus, F., Bonnelame, L. K., & Siegrist, D. (2017). The economic impact of labeled regional products: the experience of the UNESCO Biosphere Reserve Entlebuch. Mountain Research and Development, 37(1), 121–130. http://doi.org/10.1659/MRD-JOURNAL-D-16-00067.1
26	Kraus, F., Merlin, C., & Würzburg, H. J. (2014). Biosphere reserves and their contribution to sustainable development. Zeitschrift Für Wirtschaftsgeographie, 58(2–3), 164–180.
27	Langholz, J. (1999). Exploring the effects of alternative income opportunities on rainforest use: insights from Guatemala's Maya Biosphere Reserve. Society and Natural Resources, 12(2), 139–149. http://doi.org/10.1080/089419299279803
28	Lee, A. E. (2014). Territorialisation, conservation, and neoliberalism in the Tehuacán-Cuicatlán Biosphere Reserve, Mexico. Conservation and Society, 12(2), 147–161. http://doi.org/10.4103/0972-4923.138413
29	Li, W. (2006). Community decisionmaking - participation in development. Annals of Tourism Research, 33(1), 132–143. http://doi.org/10.1016/j.annals.2005.07.003
30	Liu, W., Vogt, C. A., Lupi, F., He, G., Ouyang, Z., & Liu, J. (2016). Evolution of tourism in a flagship protected area of China. Journal of Sustainable Tourism, 24(2), 203–226. http://doi.org/10.1080/09669582.2015.1071380
31	Lu, Y., Fu, B., Chen, L., Xu, J., & Qi, X. (2006). The effectiveness of incentives in protected area management: an empirical analysis. International Journal of Sustainable Development & World Ecology, 13(5), 409–417. http://doi.org/10.1080/13504500609469690
32	Lyon, A., Hunter-Jones, P., & Warnaby, G. (2017). Are we any closer to sustainable development? Listening to active stakeholder discourses of tourism development in the Waterberg Biosphere Reserve, South Africa. Tourism Management, 61, 234–247. http://doi.org/10.1016/j.tourman.2017.01.010
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35	Maikhuri, R. K., Nautiyal, S., Rao, K. S., Chandrasekhar, K., Gavali, R., & Saxena, K. G. (2000). Analysis and resolution of protected area-people conflicts in Nanda Devi Biosphere Reserve, India. Environmental Conservation, 27(1), 43–53. http://doi.org/10.1017/S0376892900000060
36	Martinez-Reyes, J. E. (2014). Beyond nature appropriation: towards post-development conservation in the Maya Forest. Conservation and Society, 12(2), 162–174. http://doi.org/10.4103/0972-4923.138417

Table A1 (continuation)

ID#	Reference
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38	Méndez-Contreras, J., Dickinson, F., & Castillo-Burguete, T. (2008). Community member viewpoints on the Ría Celestún Biosphere Reserve, Yucatan, Mexico: suggestions for improving the community/natural protected area relationship. Human Ecology, 36(1), 111–123. http://doi.org/10.1007/s10745-007-9135-4
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41	Nautiyal, S., & Nidamanuri, R. R. (2010). Conserving biodiversity in protected area of biodiversity hotspot in India: a case study. International Journal of Ecology and Environmental Sciences, 36(2–3), 195–200.
42	Olson, E. A. (2012). Notions of rationality and value production in ecotourism: examples from a Mexican biosphere reserve. Journal of Sustainable Tourism, 20(2), 215–233. http://doi.org/10.1080/09669582.2011.610509
43	Pfueller, S. L. (2008). Role of bioregionalism in Bookmark Biosphere Reserve, Australia. Environmental Conservation, 35(2), 173–186. http://doi.org/10.1017/S0376892908004839
44	Pulido, M. T., & Cuevas-Cardona, C. (2013). Cactus nurseries and conservation in a biosphere reserve in Mexico. Ethnobiology Letters, 4, 96–104. http://dx.doi.org/10.14237/ebl.4.2013.58
45	Rao, K. S., Nautiyal, S., Maikhuri, R. K., & Saxena, K. G. (2003). Local peoples' knowledge, aptitude and perceptions of planning and management issues in Nanda Devi Biosphere Reserve, India. Environmental Management, 31(2), 168–181. http://doi.org/10.1007/s00267-002-2830-4
46	Richardson, T. (2015). On the limits of liberalism in participatory environmental governance: conflict and conservation in Ukraine's Danube Delta. Development and Change, 46(3), 415–441. http://doi.org/10.1111/dech.12156
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50	Singh, R. B., Mal, S., & Kala, C. P. (2009). Community responses to mountain tourism: a case in Bhyundar Valley, Indian Himalaya. Journal of Mountain Science, 6(4), 394–404. http://doi.org/10.1007/s11629-009-1054-y

Table A1 (continuation)

ID#	Reference
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53	Solberg, M. (2014). Patronage, contextual flexibility, and organisational innovation in Lebanese protected areas management. Conservation and Society, 12(3), 268–279. http://doi.org/10.4103/0972-4923.145138
54	Steinberg, M., Taylor, M., & Kinney, K. (2014). The El Cielo Biosphere Reserve: forest cover changes and conservation attitudes in an important neotropical region. The Professional Geographer, 66(3), 403–411. http://doi.org/10.1080/00330124.2013.799994
55	Sundberg, J. (1998). Strategies for authenticity, space, and place in the Maya Biosphere Reserve, Petén, Guatemala. Yearbook. Conference of Latin Americanist Geographers, 24, 85–96. http://doi.org/http://dx.doi.org/10.1108/17506200710779521
56	Sundberg, J. (2002). Conservation as a site for democratization in Latin America: exploring the contradictions in Guatemala. Canadian Journal of Latin American and Caribbean Studies, 27(53), 73–103. http://doi.org/10.1080/08263663.2002.10816815
57	Sundberg, J. (2003). Conservation and democratization: constituting citizenship in the Maya Biosphere Reserve, Guatemala. Political Geography, 22(7), 715–740. http://doi.org/10.1016/S0962-6298(03)00076-3
58	Sundberg, J. (2004). Identities in the making: conservation, gender and race in the Maya Biosphere Reserve, Guatemala. Gender, Place and Culture, 11(1), 43–66. http://doi.org/10.1080/0966369042000188549
59	Sundberg, J. (2006). Conservation encounters: transculturation in the “contact zones” of empire. Cultural Geographies, 13(2), 239–265. http://doi.org/10.1191/1474474005eu337oa
60	Sylvester, O., Segura, A. G., & Davidson-Hunt, I. J. (2016). The protection of forest biodiversity can conflict with food access for indigenous people. Conservation and Society, 14(3), 279–290. http://doi.org/10.4103/0972-4923.191157
61	Trillo-Santamaría, J.-M., & Paül, V. (2016). Transboundary protected areas as ideal tools? Analyzing the Gerês-Xurés Transboundary Biosphere Reserve. Land Use Policy, 52, 454–463. http://doi.org/10.1016/j.landusepol.2015.12.019
62	Vaidianu, N., Tofan, L., Braghina, C., & Schvab, A. (2015). Legal and institutional framework for integrated governance in a biosphere reserve. Journal of Environmental Protection and Ecology, 16(3), 1149–1159.
63	Velez, M., Adlerstein, S., & Wondolleck, J. (2014). Fishers’ perceptions, facilitating factors and challenges of community-based no-take zones in the Sian Ka’an Biosphere Reserve, Quintana Roo, Mexico. Marine Policy, 45, 171–181. http://doi.org/10.1016/j.marpol.2013.12.003
64	Xu, J., Chen, L., Lu, Y., & Fu, B. (2006). Local people’s perceptions as decision support for protected area management in Wolong Biosphere Reserve, China. Journal of Environmental Management, 78(4), 362–372. http://doi.org/10.1016/j.jenvman.2005.05.003

Table A1 (continuation)

ID#	Reference
65	Young, E. (1999). Local people and conservation in Mexico's El Vizcaino Biosphere Reserve. The Geographical Review, 89(3), 364–390. http://doi.org/10.2307/216156
66	Yuan, J., Dai, L., & Wang, Q. (2008). State-led ecotourism development and nature conservation: a case study of the Changbai Mountain Biosphere Reserve, China. Ecology and Society, 13(2), 55. http://doi.org/10.5751/ES-02645-130255

Table A2 Definition of the main categories related to the management and governance of biosphere reserves (BRs)

Category	Definition
Context (C)	Place-based and multiscale features of which the presence or absence shape the settings where BRs are implemented. They can have a direct or indirect influence in the process, the inputs or the outcomes. The context is not about the BR implementation (process) but about the characteristics of the settings, *independently* of the BR.
Inputs (I)	What was invested in the process? Material and immaterial support or opposition at different scales.
Process (P)	How is management/governance being conducted? The actions and mechanisms by which management and governance takes place.
Outcomes (O)	Impacts and benefits in social and ecological systems, that followed the implementation of the process.

Table A3 Definition of the subcategories included in the "Context" category. BR - biosphere reserve

Subcategory	Definition
C1 Regulations—formal rules	The written rules, i.e., legislation, regulatory structure, land tenure. This does not mean that they are the rules in use, since actors can ignore them and use informal rules. Legislatures, regulatory agencies and courts usually determine the formal rules in place (Ostrom, 2005).
C2 Informal institutions and culture	Rules that are self-organized by informal gatherings, appropriation teams or private associations (Ostrom, 2005). It also includes norms, i.e., shared perceptions/beliefs among a social group which define the proper or improper behaviours. They are closely related to cultural prescriptions and, therefore, issues related to culture are also included here (McGinnis & Ostrom, 2014). Trust-reciprocity/social capital is also associated with existing social norms. Here only the social context is observed - if the use of natural resources is considered to be part of the culture, this is included in the subcategory "Use of natural resources cultural purposes" (C11).
C3 Power issues	Power is related to the "ability to force people to do things they would not independently choose to do" (Meadows, 1998). Power issues are referred to by the term "power" and/or linked with the identification of some group with power (e.g. men) and a group without power (e.g. women), in a defined context.

Table A3 (continuation)

Subcategory	Definition
C4 Organizations	An organization refer to a group of people which are bounded to achieve some common objective, including political bodies, economic bodies, social bodies and education bodies (North, 1990). All aspects related to the organizations in place - organizations structure, inter-organizations relationships, organizations goals, and other organization features, such as if organizations are corrupt, are included here. This includes also factors related to the ability, or lack of ability, of organizations to meet their goals, e.g. lack of funding, human resources or human resources without skills.
C5 Historical factors	Historical factors are events that occurred in the past which still impact how things happen today, e.g. previous communist regime, colonization. If the event is very recent or is still happening, it is included in one of the other context subcategories (possibly "Socio-economic attributes" - C8).
C6 Time	Do time restrictions influence management? E.g. the need to do something fast; time restrictions influenced the participatory processes.
C7 Economy and politics	The economic and political systems in place - markets, financial crises, regimes (democratic vs. autocratic), political philosophies (e.g. liberalism).
C8 Socio-economic attributes	Includes social and economic phenomena such as: (1) social phenomena, i.e. migrations, conflicts; political phenomena, i.e. the fall of a president; illegal activities, e.g. the illegal exploitation of natural resources, human trafficking, drugs, etc.; (2) general attributes of the society: unemployment, poverty, population size, etc.; (3) infrastructure in place - access to water or electricity services (not information infrastructure); (4) specific characteristics of the communities, e.g. level of education, skills, resources.
C9 Information related	Existing communication infrastructure and the quality of information sources, such as media; e.g. if there is access to internet or telephone, or if local media report news about a BR.
C10 Use of natural resources for livelihoods	The exploitation of natural resources is reported to be important for livelihoods; i.e., fishing, logging or subsistence agriculture is fundamental to provide food, shelter or medicinal plants. This requires the extraction of the natural resource.
C11 Use of natural resources for cultural purposes	Natural resources are reported to be important for cultural purposes, e.g. recreation and religion. Includes both extractive and non-extractive use of natural resources for cultural purposes. Therefore, if it is reported that the extractive use of natural resources (e.g. fishing) is part of a community culture, it is also included here.
C12 Impacts on natural resources	Includes references of impacts on natural resources, e.g. less fish, pollution, etc.
C13 Human–wildlife conflicts	Conflicts between people and wildlife, e.g. wildlife attacks on livestock or humans.
C14 Cultural landscape	The historical/traditional use of the landscape makes it dependent on these human-nature interactions. This dependency is reported.
C15 Conservationist value	The species or ecosystems in place are reported to have conservationist value, e.g. species are highly endangered or the presence of a unique habitat.
C16 Bio-physical attributes	Bio-physical attributes, such as altitude or climate, including the occurrence of extreme weather events, or ecological disasters such as pests.

Table A3 (continuation)

Subcategory	Definition
C17 Resource mobility	The presence of resources with high mobility which influence management/governance/outcomes, e.g. migratory species.

Table A4 Definition of the subcategories included in the "Inputs" category. BR - biosphere reserve

Subcategory	Definition
I1 Attitudes	According to Ajzen & Fishbei (1980) "An attitude can be defined as a positive or negative evaluation of an object or quality". Only manifested attitudes were included, i.e., negative or positive evaluations people express about the process, and not behaviours, e.g. because people don't like the management body (attitude), they do not go to the meetings (behaviour, in this case, is a lack of non-material support).
I2 Beliefs	Beliefs underlie "a person's attitudes and subjective norms, and they ultimately determine intentions and behaviour" (Ajzen & Fishbei, 1980). Coded beliefs include perceived benefits or impacts, values and worldviews, which explain why people have a determined attitude or behaviour.
I3 Funding and material support/opposition	Includes concrete assistance, such as funding and performing assigned work for others. Opposition do not require active opposition, i.e., when lack of support/funding was reported to have some important effect, it was also included as "passive opposition".
I4 Non-material support/opposition	Includes all forms of support/opposition that are not tangible goods and services, including emotional (caring, empathy, love and trust), informational support (provision of information for problem-solving) and appraisal/affirmational support (Langford *et al.*, 1997). Appraisal/affirmational support/opposition also includes lobbying for or against someone else's cause. Actors can influence process's policies in many different ways, including attending and organizing protests or other social movements, participating or not in public meetings on the subject, influencing the media, etc. (Stern *et al.*, 1986), by facilitating connections between different governmental organizations and influencing decisions. Opposition do not require active opposition, i.e., when lack of support was reported to have some important effect it was also included as "passive opposition".
I5 Type of knowledge	This includes scientific knowledge but also experiential knowledge, i.e., local ecological knowledge, indigenous knowledge and traditional knowledge (Schultz & Lundholm, 2010).

Table A5 Definition of the subcategories included in the "Process" category. BR - biosphere reserve

Subcategory	Definition
P1 Process scale	Is the paper about the management/governance of the BR (management/governance body), task/project management/governance, or both?
P2 Spatial design	Spatial design of the area where the process takes place. Includes characteristics such as the total area, zoning and location.
P3 Process initiation	Includes aspects related to how the process was initiated: top-down - the initiative came from the "top" and was imposed in the local settings; participatory - the initiative came from the "top" but its implementation was discussed with local communities since the beginning; bottom-up - self-mobilization of the local communities.
P4 Public participation	Is civil society participating in the BR management/implementation? Includes whether civil society is consulted for BR management and/or projects; participate in BR activities (e.g. as staff) or participate in BR management, e.g. through access to the discussions, dialogue, or influencing BR decisions (adapted from Agarwal, 2001; Rowe & Frewer, 2005).
P5 Participatory processes	Design and organization of participatory meetings, including pre-, during, and post-meeting settings; who is included, balance of power and participatory exclusions (Agarwal, 2001). Pre-meeting settings include who participates in the agenda setting, if the information is available to everyone before the meeting and how are invitations to the meeting disseminated; during the meeting settings include how are decisions made, if the information was provided in an adequate format, if there are mechanisms to ensure that everyone has time to speak; post-meeting settings include if there are mechanisms to monitor the implementation of the decisions (Durand *et al.*, 2014).
P6 Management body	Is there a proper (formal) BR management body in place? What is its degree of centralization? References about the centralization of decision-making (e.g. the managers offices are very far away from the BR). What is the structure of the management body - who is included/excluded? How many actors? Power balance.
P7 Coordination and leadership	This includes features related to the quality of the management - bad management is characterized by a lack of functionality, mismanagement and lack of coordination of the activities inside the BR. It's related with lack of collaboration, cooperation, communication and clear mandates for BR management. Characteristics of the decision-makers, such as leadership, are also included.
P8 Institutions for management	This includes the use of formal and/or informal institutions. Formal rules are the written rules, i.e., legislation, regulatory structure, etc. Informal institutions include traditions, customs, beliefs and social networks.
P9 Material investments and infrastructure	This includes the development of infrastructure and acquisition of other tangible materials, such as vehicles.

Table A5 (continuation)

Subcategory	Definition
P10 Human resources related	This includes hiring human resources as staff or managers, and their working conditions - i.e., references to wages, full-time vs. part-time work, seasonality, etc.
P11 Conservation and habitat management	Includes active management of habitats and species in order to achieve conservation goals: habitat restauration through e.g. revegetation, species reintroduction, invasive species control, etc.
P12 Restrictions	Decrease of environmental harms through restrictions: prohibitions, restrictions, taxes, fees (e.g. park entry), charges, quotas, compensations for environmental damages (e.g. biodiversity offsets), etc.
P13 Enforcement and control	Enforcement and control of natural resource use and development. Monitoring of activities which harm the environment and sanctioning (e.g. park patrols).
P14 Incentives	Incentives refer to the reduction of environmental harms through the promotion of more environmentally friendly behaviours, e.g. payments for ecosystems services, tax breaks, compensation for wildlife damage, subsidies, forest concessions; promotion of markets for green goods and services by stimulating producers adopting environmentally friendly methods, and consumers buying green goods and services (e.g. certification). It includes all the activities related to sustainable development, such as such as ecotourism, sustainable agriculture, etc.
P15 Economic development	This includes the development of initiatives which are mainly related to economic goals, e.g. mining. Fishing and grazing are only considered if some action was made in order to promote these kinds of activities, e.g. revert previous restrictions on natural resource use.
P16 Research and monitoring	Research and monitoring of natural or social resources.
P17 Information and capacity building	This includes: (i) provision of training or consultancy; (ii) development of BR image and platforms with information about the BR or BR policies (website, radio programs, etc.); (iii) information materials, such as flyers and signage; (iv) provision of platforms for dialogue through the organization of participatory meetings and other networking opportunities (such as barbecues, cultural festivals); (v) collaboration, partnerships.
P18 Planning	Planning of processes at different levels (e.g. project or BR; BR management plan). Plans establish the vision, goals and strategies of the process.

Table A6 Definition of the subcategories included in the "Outcomes" category. BR - biosphere reserve

Subcategory	Definition
O1 Economic benefits	Reported increase of monetary wealth or employment; increase of business and industries productivity (Kaplan-Hallam & Bennett, 2017) as a result of management actions.
O2 Social benefits	Improvement of social infrastructure (schools, etc.); increase social capital by an increase of trust, cooperation and better communication; decrease in conflicts.
O3 Empowerment	Less powerful actors gain (or are given) increase control over their "lives and livelihoods"; if local communities are given the responsibility and decision-making of management of their own resources (Oldekop *et al.*, 2016).
O4 Health benefits	Includes emotional (motivation, feeling of happiness, satisfaction, sense of live security) and other health related benefits.
O5 Learning	If, after some management/governance action (e.g. participatory processes, training, networking), some of the following occur: (i) there is a change in the strategies/actions, goals or governance mechanisms resulting from social interaction - social learning; (ii) there is a change in people's and/or group perceptions or values - transformative communicative learning; (iii) acquisition of knowledge that is task-orientated/problem solving and aim to improve the performance of the current activity - transformative instrumental learning; (iv) knowledge that results from experience/learning-by-doing - experiential learning; (v) if the paper reports "learning" (adapted from Armitage et al., 2008).
O6 Cultural benefits	Enhancement of cultural identity (cultural revitalization), preservation of traditional knowledge, access to livelihoods and recreation opportunities and promotion of traditional practices or customs (Kaplan-Hallam & Bennett, 2017).
O7 Environmental benefits	Environmental benefits including an increase in species populations, recruitment of plants, resilience, decrease in overharvesting natural resources.
O8 Economic impacts	Reported decrease in monetary wealth or increase of unemployment; decrease of business and industry productivity (Kaplan-Hallam & Bennett, 2017) as a result of management/governance actions.
O9 Social impacts	Displacement; decreased social capital - lack of trust, communication and cooperation; occurrence of conflicts as a result of management/governance actions.
O10 Inequality	Uneven distribution of the benefits and costs of BR management/governance actions.
O11 Health impacts	Includes emotional (stress, frustration, dissatisfaction, insecurity) and other health-related impacts resulting from management/governance actions.
O12 Cultural impacts	Impacts on cultural identity, e.g. by separating people from their traditional livelihoods or culturally important sites and resources, erosion of traditional knowledge and other traditional practices or customs (Kaplan-Hallam & Bennett, 2017).

Table A6 (continuation)

Subcategory	Definition
O13 Environmental impacts	Environmental impacts including a decrease in species populations or distribution, overharvesting natural resources or decrease of resilience, as a result of management/governance actions.

Figures

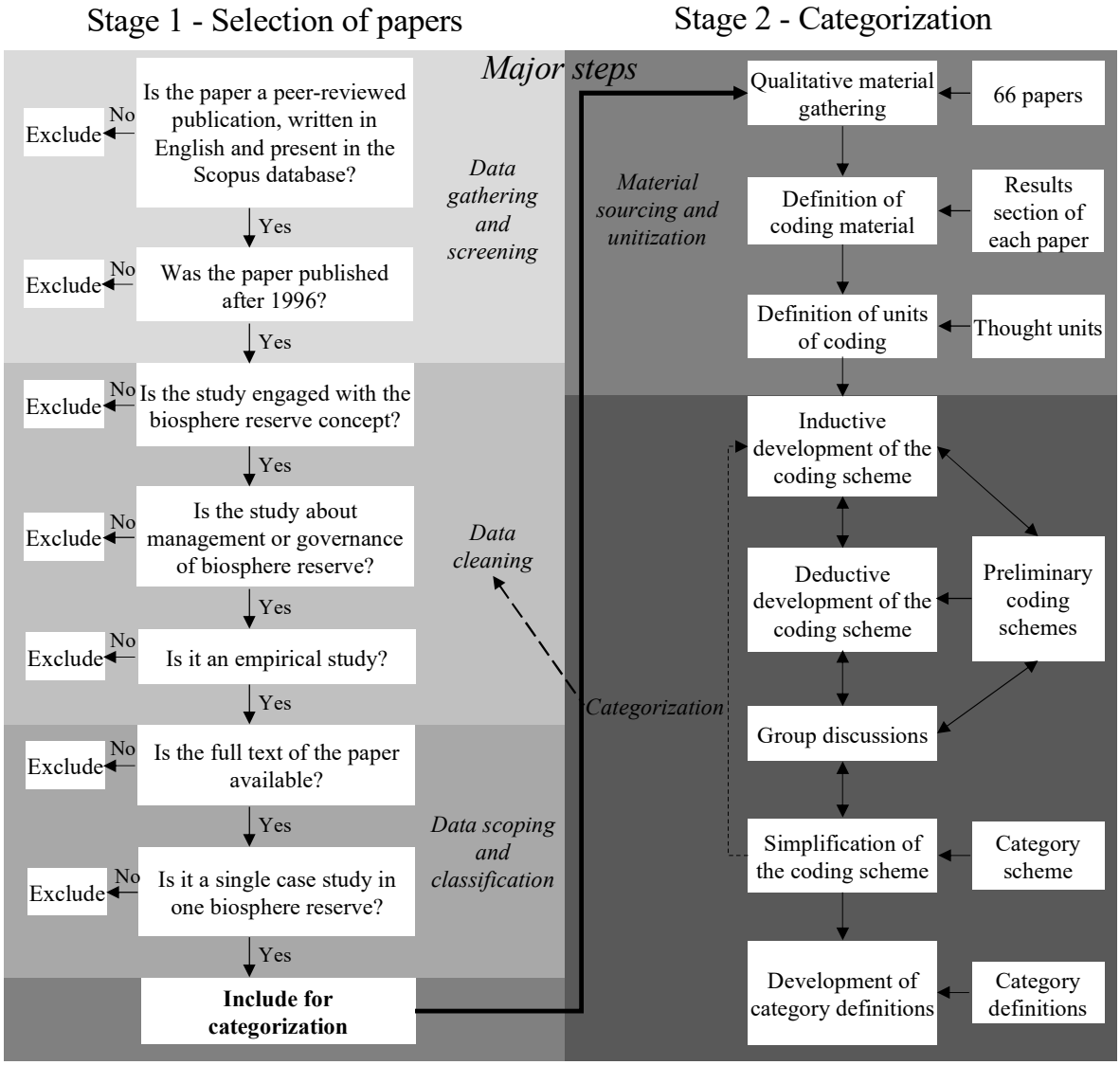

Figure A1 Main steps of data analysis, following Srnka & Koeszegi (2007).

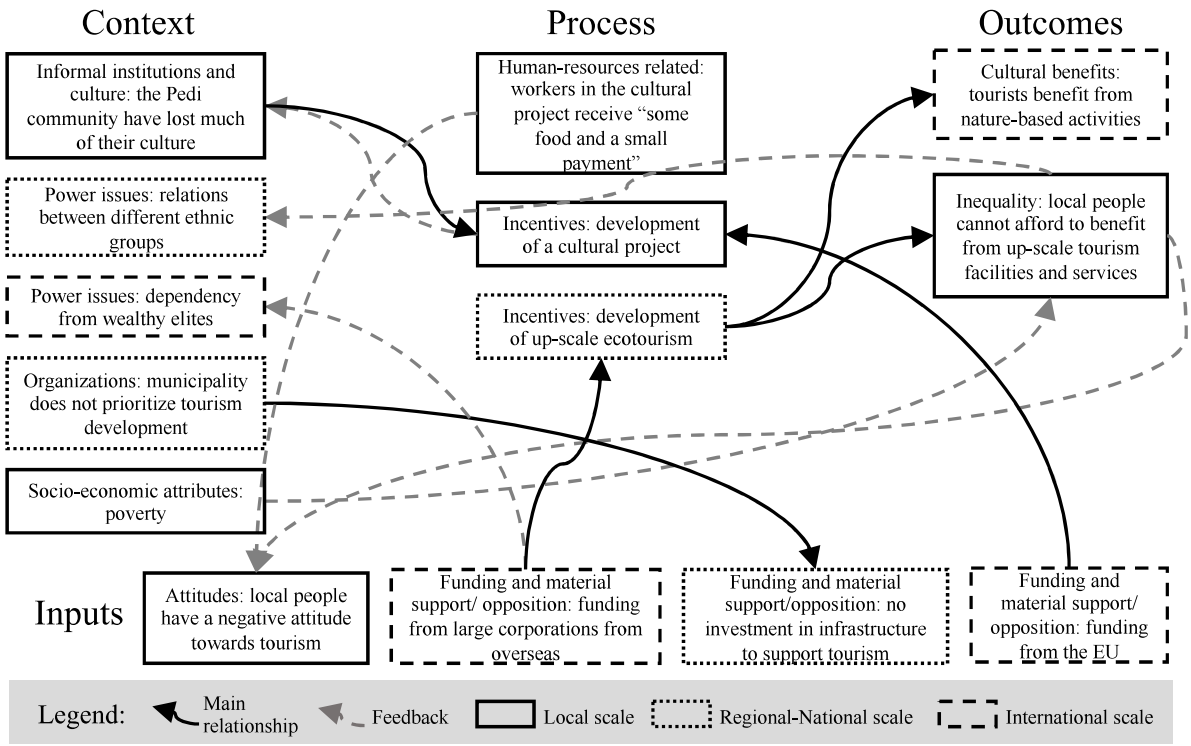

Figure A2 Demonstration of how the components of the proposed framework can interact with each other. The figure is illustrative of some relationships between factors found in the study of Lyon et al. (2017). Feedback between factors within the same category were omitted for better visualization of interactions between the different categories.

6.2 Appendix B

Tables

Table B1 Categories and subcategories used to review the publications. Subcategories used in the cluster analysis are identified with "1" in the last column ("C"). The subcategory "health benefits" was not used in the cluster analysis because it was not coded in any paper. NA – Not applicable; BR – biosphere reserve; MAB – UNESCO Man and Biosphere Programme; NGO – Non-governmental organizations

#	Category	Subcategory	Value	C
1	Year of publication	NA	Year	0
2	Journal subject area[1]	Earth and Planetary Sciences	0/1	0
3		Environmental Science	0/1	0
4		Agricultural and Biological Sciences	0/1	0
5		Economics, Econometrics and Finance	0/1	0
6		Business, Management and Accounting	0/1	0
7		Social Sciences	0/1	0
8		Arts and Humanities	0/1	0
9		Other subject area	0/1	0

Table B1 (continuation)

#	Category	Subcategory	Value	C
10	Affiliation of the author[2]	NA	Africa; Arab States; Asia & the Pacific; Europe & North America; Latin America & the Caribbean	0
11	Name of the BR[2]	NA	BR name	0
12	Transboundary BR?[3]	NA	0/1	0
13	Withdrawn BR?[4]	NA	0/1	0
14	BR year of designation[2]	NA	Year	0
15	Research location[2]	Country	Country name	0
16		Region	Africa; Arab States; Asia & the Pacific; Europe & North America; Latin America & the Caribbean	0
17	Methods for data collection	Experiments	0/1	0
18		Questionnaires	0/1	0
19		Survey	0/1	0
20		Secondary data	0/1	0
21		Document analysis	0/1	0
22		Interview	0/1	0
23		Group discussions	0/1	0
24		Observation	0/1	0
25		Ethnography	0/1	0
26		Other	0/1	0
27	Actors enrolled	Local communities	0/1	0
28		Government	0/1	0
29		NGOs	0/1	0
30		Researchers	0/1	0
31		Tourists	0/1	0
32		Business	0/1	0
33		MAB representatives	0/1	0
34		Other	0/1	0
35	Methods for data analysis	NA	Qualitative; quantitative; mixed methods	0
36	Context	Historical factors	0/1	1
37		Organizations	0/1	1
38		Formal rules	0/1	1
39		Informal institutions and culture	0/1	1
40		Power issues	0/1	1
41		Socio-economic attributes	0/1	1
42		Economy and politics	0/1	1
43		Information related	0/1	1
44		Time	0/1	1
45		Impacts on natural resources	0/1	1
46		Extractive resource-based livelihoods	0/1	1
47		Cultural use of natural resources	0/1	1
48		Human-wildlife conflicts	0/1	1

Table B1 (continuation)

#	Category	Subcategory	Value	C
49	Context	Cultural landscape	0/1	1
50		Bio-physical attributes	0/1	1
51		Conservationist value	0/1	1
52		Resource mobility	0/1	1
53		Other	0/1	0
54	Inputs	Attitudes	0/1	1
55		Beliefs	0/1	1
56		Funding and material support/opposition	0/1	1
57		Non-material support/opposition	0/1	1
58		Knowledge	0/1	1
59		Other	0/1	0
60	Process	Process scale BR	0/1	1
61		Process scale Task	0/1	1
62		Process spatial design	0/1	1
63		Process initiation	0/1	1
64		Public participation	0/1	1
65		Participatory processes characteristics	0/1	1
66		Management body characteristics	0/1	1
67		Coordination and leadership	0/1	1
68		Human resources related	0/1	1
69		Material investments and infrastructure	0/1	1
70		Conservation and habitat management	0/1	1
71		Restrictions	0/1	1
72		Enforcement and control	0/1	1
73		Incentives	0/1	1
74		Economic development	0/1	1
75		Research and monitoring	0/1	1
76		Information and capacity building	0/1	1
77		Planning	0/1	1
78		Institutions for management	0/1	1
79		Other	0/1	0
80	Outcomes	Economic benefits	0/1	1
81		Social benefits	0/1	1
82		Empowerment	0/1	1
83		Health benefits	0/1	1
84		Learning	0/1	1
85		Cultural benefits	0/1	1
86		Environmental benefits	0/1	1
87		Economic impacts	0/1	1
88		Social impacts	0/1	1
89		Inequality	0/1	1
90		Health impacts	0/1	0
91		Cultural impacts	0/1	1
92		Environmental impacts	0/1	1

Table B1 (continuation)

#	Category	Subcategory	Value	C
93	Outcomes	Other	0/1	0
94 - 110	Scale	Context subcategories (#36 to #52)	National/regional; international; not local	0
111 - 115		Inputs subcategories (#54 to #58)	National/regional; international; not local	0
116 - 134		Process subcategories (#60 to #78)	National/regional; international; not local	0
135 – 147		Outcomes subcategories (#80 to #92)	National/regional; international; not local	0

1 - Retrieved from ELSEVIER (2017); 2 - Retrieved from UNESCO (2017); 3 - Retrieved from UNESCO (2016b). 4 - Retrieved from UNESCO (2016c).

Table B2 Examples of factors included in each subcategory used to evaluate biosphere reserves' management effectiveness. Detailed descriptions of each subcategory can be found in the Tables A2-A6

Category	Subcategory	Examples
Context	Historical factors	Previous communist regime, colonization
	Organizations	Structure, goals, capacity, inter-organization relationships, corruption
	Formal rules	Legislation, land tenure
	Informal institutions and culture	Social norms, culture, trust
	Power issues	Race, class, gender
	Socio-economic attributes	Migrations, conflicts, unemployment and education rates, infrastructure
	Economy and politics	Markets, financial crises, democratic regimes, liberalism
	Information related	Availability of internet or phones. Media
	Time	Time restrictions
	Impacts on natural resources	Less fish, less trees, pollution
	Extractive resource-based livelihoods	Fishing, logging, harvest of medicinal plants, agriculture
	Cultural use of natural resources	Recreation, religion
	Human-wildlife conflicts	Predators attacks on livestock or humans
	Cultural landscape	Landscapes that result from the traditional use of the land
	Conservationist value	Highly endangered species or habitats

Table B2 (continuation)

Category	Subcategory	Examples
Context	Bio-physical attributes	Altitude, climate, pests
	Resource mobility	Migratory species
Inputs	Attitudes	Positive/negative evaluations about the process
	Beliefs	Perceived benefits or impacts, values, worldviews
	Funding and material support/ opposition	Financial resources
	Non-material support/opposition	Provision of emotional support, information or lobbying.
	Knowledge	Scientific knowledge, traditional knowledge
Process	Process scale BR	Management/governance of the biosphere reserve
	Process scale Task	Management/governance of a task, e.g. park monitoring
	Process spatial design	Zoning, total area, location
	Process initiation	How were processes initiated, e.g. if local communities were enrolled
	Public participation	Participation of civil society in process implementation or management
	Participatory processes characteristics	Who have created the agenda for the meeting? How and when were communities invited? Was the information given to the participants clear?
	Management body characteristics	Degree of centralization of the management body. Who is included/excluded? Power balance
	Coordination and leadership	Coordination of activities inside the biosphere reserve. Leadership, cooperation
	Human resources related	Availability of staff and working conditions - wages, seasonality, part-time vs full-time
	Material investments and infrastructure	Development of new infrastructure (e.g. visitor centre), or acquisition of new equipment, e.g. vehicles
	Conservation and habitat management	Habitat restauration, invasive species control, species reintroduction
	Restrictions	Prohibitions of natural resource use, park fees, fisheries quotas, biodiversity offsets
	Enforcement and control	Park patrols, fines
	Incentives	Payments for ecosystem services, compensation for wildlife damage, certification schemes

Table B2 (continuation)

Category	Subcategory	Examples
Process	Economic development	Mining, tourism infrastructure (hotels, restaurants), aquaculture
	Research and monitoring	Species surveys, scientific research projects
	Information and capacity building	Training, networking opportunities, partnerships, information materials
	Planning	Management plan
	Institutions for management	Use/production of legislation and/or existing informal rules
Outcomes	Economic benefits	Provision of jobs, increase in the number of businesses
	Social benefits	Decrease of conflicts, increase of cooperation
	Empowerment	Women are given project management functions in a culture where only men usually have decision-making powers
	Health benefits	Happiness, motivation, satisfaction
	Learning	Change in strategies, actions, or values
	Cultural benefits	Cultural revitalization, recreation opportunities
	Environmental benefits	Increase of species populations, decrease of overexploitation of natural resources
	Economic impacts	Decrease of jobs available, decrease of households' income
	Social impacts	Displacement of people, conflicts
	Inequality	Economic benefits are only available for some social groups
	Health impacts	Stress, frustration, insecurity
	Cultural impacts	Erosion of traditions, lack of access to cultural important sites or activities
	Environmental impacts	Overexploitation of natural resources, decrease of species numbers or distribution

Table B3 Criteria used to select the clustering method. The interpretability was considered hard when the dendrograms form long chains or reversals (Borcard *et al.*, 2011). The cluster analysis was performed using the *hclust* function of the *stats* package for R

Clustering method	Interpretability	Agglomerative coefficient	Decision
single	Hard	Not evaluated	Not used
average			
mcquitty			
median			
centroid			
ward.D2	Good	0.78	
complete		0.56	
ward.D		0.87	Used

Table B4 Information about the location of the biosphere reserves (MAB region and country), number of studies performed in each biosphere reserve (n), and if the biosphere reserve is transboundary (T = 1) or not (T = 0). Information about transboundary biosphere reserves was retrieved from UNESCO (2016b)

BR name	MAB region	Country	n	T?
Mananara Nord	Africa	Madagascar	1	0
Kogelberg	Africa	South Africa	1	0
Waterberg	Africa	South Africa	1	0
Shouf	Arab States	Lebanon	1	0
Wolong	Asia and the Pacific	China	4	0
Jiuzhaigou Valley	Asia and the Pacific	China	1	0
Yancheng	Asia and the Pacific	China	1	0
Changbaishan	Asia and the Pacific	China	1	0
Nanda Devi	Asia and the Pacific	India	6	0
Similipal	Asia and the Pacific	India	1	0
Nilgiri	Asia and the Pacific	India	1	0
Lore Lindu	Asia and the Pacific	Indonesia	1	0
Tasik Chini	Asia and the Pacific	Malaysia	1	0
Salzburger Lungau& Kärntner Nockberge	Europe and North America	Austria	1	0
Rhön	Europe and North America	Germany	2	0
Geres/Xures	Europe and North America	Portugal/Spain	1	1
Danube Delta	Europe and North America	Romania/Ukraine	4	1
Kristianstad Vattenrike	Europe and North America	Sweden	1	0
Entlebuch	Europe and North America	Switzerland	1	0
La Amistad	Latin America and the Caribbean	Costa Rica	1	0
Maya	Latin America and the Caribbean	Guatemala	9	0

Table B4 (continuation)

BR name	MAB region	Country	n	T?
Río Plátano	Latin America and the Caribbean	Honduras	1	0
Sierra de Huautla	Latin America and the Caribbean	Mexico	2	0
Mariposa Monarca	Latin America and the Caribbean	Mexico	2	0
Ría Celestún	Latin America and the Caribbean	Mexico	2	0
Montes Azules	Latin America and the Caribbean	Mexico	1	0
Los Tuxtlas	Latin America and the Caribbean	Mexico	1	0
Sierra de Manantlán	Latin America and the Caribbean	Mexico	2	0
El Vizcaíno	Latin America and the Caribbean	Mexico	3	0
Banco Chinchorro	Latin America and the Caribbean	Mexico	1	0
Tehuacán-Cuicatlán	Latin America and the Caribbean	Mexico	1	0
Sian Ka'an	Latin America and the Caribbean	Mexico	2	0
Barranca de Metztilán	Latin America and the Caribbean	Mexico	1	0
Alto Golfo de California y El Pinacate	Latin America and the Caribbean	Mexico	2	0
El Cielo	Latin America and the Caribbean	Mexico	1	0
Riverland	Latin America and the Caribbean	Australia	1	0
Espinhaço Range	Latin America and the Caribbean	Brazil	1	0
Bosque Mbaracayú	Latin America and the Caribbean	Paraguay	1	0

Table B5 Cluster evaluation statistics. To evaluate the internal quality of the clustering the average silhouette width - s(i) - was used, as computed in the *silhouette* function of the *cluster* package for R. Values around 0 indicate that observations lie between two clusters; well clustered solutions have an average s(i) close to 1. To evaluate the robustness of the clustering, the clusterwise Jaccard bootstrap mean was used, as computed in the *clusterboot* function of the *fpc* package for R with 100 resampling runs. Following Zumel & Mount (2014), clusters with stability values lower than 0.6 are unstable and values of stability between 0.6 and 0.85 indicate patterns in the data, but there is a high uncertainty about which observations should be clustered together

Cluster validity type	Cluster validity measure	Cluster 1	Cluster 2	Cluster 3
Internal quality	Average silhouette width s(i)	0.1	0.07	0.03
Robustness	Clusterwise Jaccard bootstrap mean	0.69	0.57	0.79

Figures

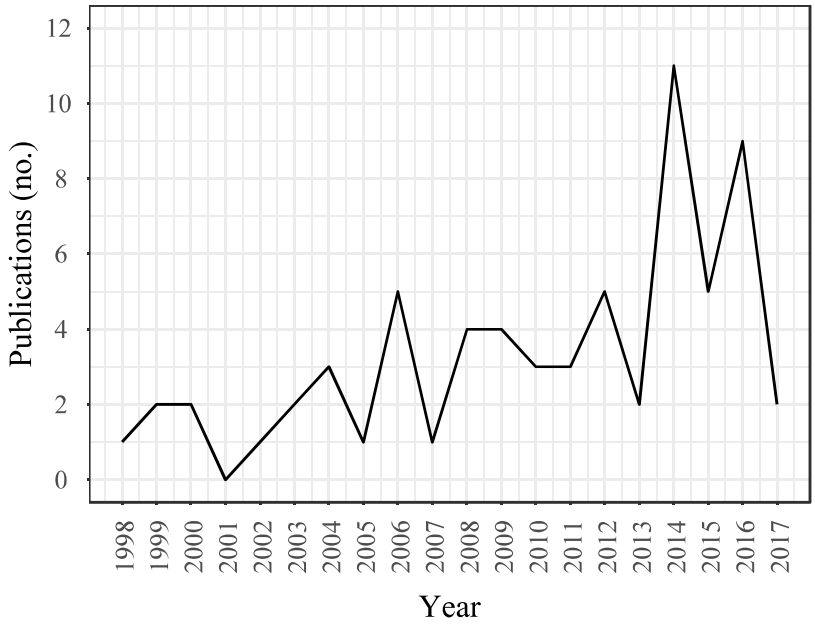

Figure B1 Temporal evolution of the number of studies about biosphere reserves' management effectiveness. Only English, peer-reviewed papers, which are developed in one biosphere reserve, and published between 1996 and March 2017 in the Scopus database were included.

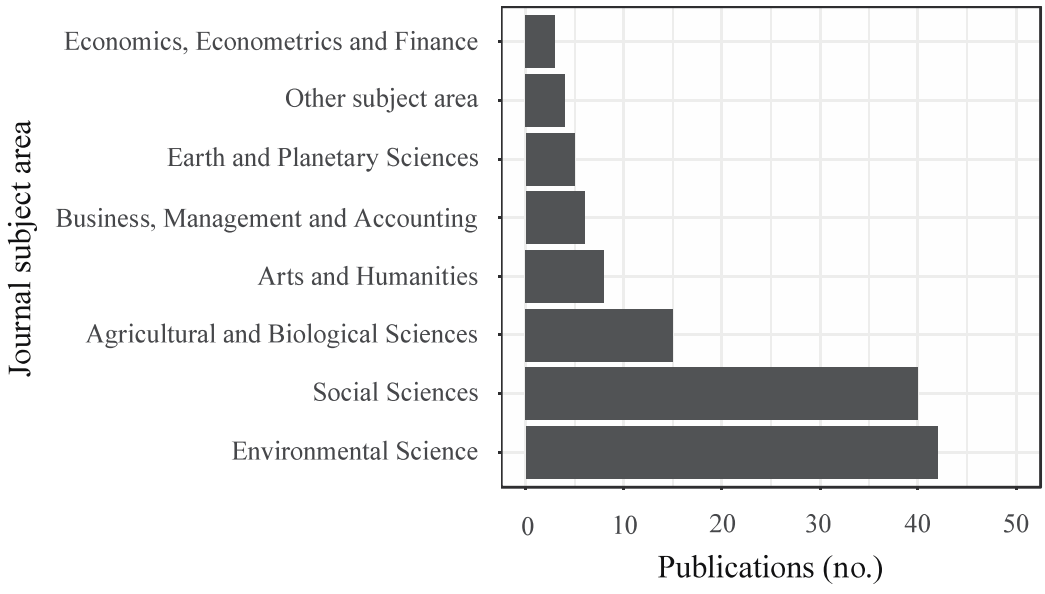

Figure B2 Subject area of the journals where the studies about biosphere reserves' management effectiveness were published, according to ELSEVIER (2017). Journals can belong to more than one subject area.

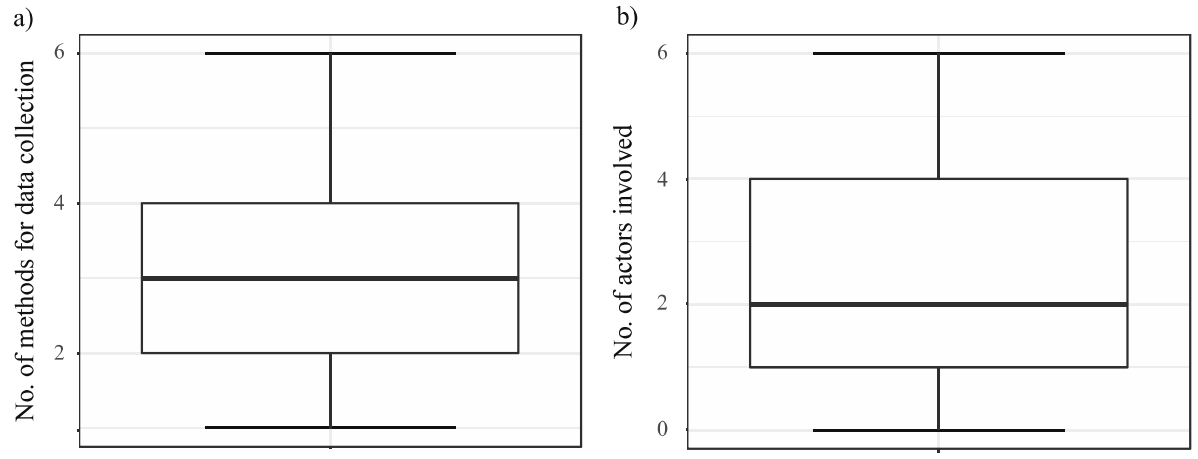

Figure B3 Methods for data collection used in the literature analysed: a) boxplot displaying the number of different methods used in the data collection; b) boxplot displaying the number of different actors involved in the data collection.

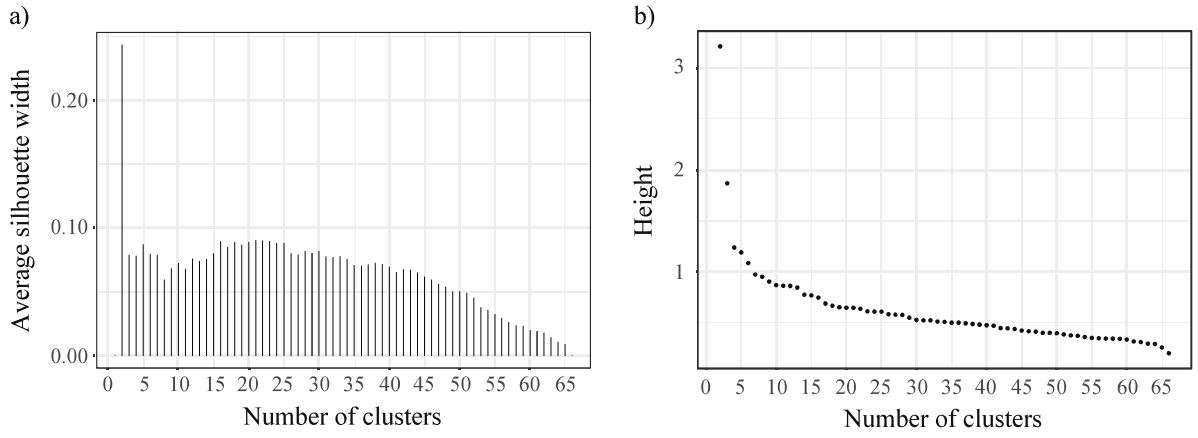

Figure B4 Definition of the optimal number of clusters according to: a) the silhouette index (Borcard *et al.*, 2011) and b) a scree plot. The different solutions were also interpreted to decide which one provide a better relationship between the specificity and generality of the results.

6.3 Appendix C

Tables

Table C1 Actors that participated in the scoping interviews to select the case studies. Other informal conversations took place with members of the Portuguese MAB Committee during their Second Meeting, which took place in the Paul do Boquilobo Biosphere Reserve in 22 of November 22, 2016

Type	Date	Name (organization)
Semi-structured interview	7/7/16	Fernando José Velez Serrão de Faria Pereira *Interlocutor Reserva Natural do Paul do Boquilobo* *Instituto da Conservação da Natureza e das Florestas (ICNF)* Mário Antunes *ONGATEJO* *Chair da Reserva da Biosfera do Paul do Boquilobo*
Focus group	21/11/16	Rui MV Sequeira *Diretor do Parque Natural de São Jorge e da Reserva da Biosfera de São Jorge* Pedro Raposo *Diretor do Serviço de Ambiente da Graciosa* *Diretor do Parque Natural da Graciosa* *Presidente do Conselho de Gestão da Reserva da Biosfera da Graciosa* José GF Eduardo *Diretor do Parque Natural das Flores e da Reserva da Biosfera das Flores*
Informal conversation	22/11/16	Joana Branco *Coordenadora para o Território Português da Reserva da Biosfera Transfronteiriça Meseta Ibérica* *Agrupamento Europeu de Cooperação Territorial ZASNET* Helena Videira *Diretora do Agrupamento Europeu de Cooperação Territorial ZASNET* *Órgão de gestão da Reserva da Biosfera Transfronteiriça Meseta Ibérica* Dinarte Fernandes *Presidente da Câmara Municipal de Santana & da Reserva da Biosfera de Santana Madeira* Sónia Fragoso *Liga para a Proteção da Natureza (LPN) – órgão de gestão da Reserva da Biosfera de Castro Verde*

Table C1 (continuation)

Type	Date	Name (organization)
Informal conversation	22/11/16	Carlos Pedro *Câmara Municipal de Castro Verde – órgão de gestão da Reserva da Biosfera de Castro Verde* Maria Jesus Silva Fernandes *Diretora do Departamento Regional de Conservação da Natureza e Biodiversidade de Lisboa e Vale do Tejo* *Instituto da Conservação da Natureza e das Florestas (ICNF)*
Semi-structured interview	7/7/17	Anabela Trindade *Presidente do Comité Nacional MAB* *Instituto da Conservação da Natureza e das Florestas (ICNF)*
Informal conversation	1/10/18	Inês Cosme *Centro de Investigação em Ambiente e Sustentabilidade* *Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa*

Table C2 Original discourses (in Portuguese), organized by respondent. One of the discourses is not included because it was retrieved from an interview conducted in English

ID	Discourse
B3	"há ali uma parte de problemas que estão a ser resolvidos e de outros que é do passivo… ambiental… das atividades industriais que havia ali, principalmente na zona dos Riachos, que tem que estar claramente tratados e resolvidos para poder pôr as pessoas a andar a pé ali… e não tirarem fotografias a um esgoto ou a uma água completamente negra como era ainda há pouco tempo… que não abona. E por isso, nesse sentido, era bom não divulgar aquilo"
B4	"Quando nós falamos numa reunião alargada de turismo, de conservação da natureza, de agricultura, de caça, de pesca, de comércio… com cinquenta e seis ou cinquenta e sete pessoas ao mesmo tempo… muitas delas com objetivos e fins diferentes… às vezes não obtínhamos aquilo que era o contributo válido de todos. E, portanto, o que entendemos foi que o que fazia sentido, além destas reuniões, criar grupos específicos para a agricultura, específicos para a educação, específicos para o turismo, específicos para a conservação… e eles próprios organizarem-se… informal ou formalmente em pequenas reuniões e apresentar propostas" "a minha ideia era fazer um canal… a ideia dele era aquilo ficar mais ou menos na mesma, a máquina fingir que… (…) E depois destes anos todos, nem ele acha que aquilo deve ser só passar lá com a máquina a fingir que se faz algumas coisas, nem eu acho que aquilo deve ser um canal. E, portanto, houve aqui um caminho de aproximação e eu acho que este caminho de aproximação entre o ambiente, a agricultura e as outras atividades foi um caminho importante que se fez desde essa altura, mas concretamente e em grande evidência, desde que este novo modelo de gestão foi implementado."

Table C2 (continuation)

ID	Discourse
B6	"(…) somos a primeira parte de uma cadeia muito longa que é diluída a responsabilidade até chegar ao consumidor final. (…) Até alguém comer o milho que eu produzo já passou por cinquenta indústrias portanto, dilui-se completamente a origem do meu produto. Tanto faz vir daqui, como da Ucrânia. (…) Vai ser transformado e depois uma galinha é que vai comer aquilo e depois é um porco e... depois vais fazer uma febra e ela vai embalada e vai aparecer no Continente ali da Golegã, mas nunca mais ninguém sabe que isto foi daqui da produção. É a tal falta de rastreabilidade, que não... o mercado ainda não o exige. Estamos longe disso ainda e isso, talvez, seja uma das coisas que não faz o tal ciclo virtuoso de investimento e de retorno desse investimento"
B7	"(...) há um mecenas que quer dar dinheiro, mas dá dinheiro para quem? Para quê? Quem é que vai gerir esse dinheiro? Há aqui um rosto para gerir o dinheiro? Há aqui uma entidade chamada não sei quantos, com o número de contribuinte não sei quantos, a quem se dá o dinheiro? (…) devia haver aqui uma entidade jurídica constituída que possa servir de… pronto, de justificação para as pessoas poderem dar dinheiro. Isto é como antigamente o Henry Kissinger nos Estados Unidos, porque faziam-lhe uma célebre pergunta e dizia assim "Mas eu para falar com a Europa falo com quem?" aqui é um bocadinho assim, não é? Se eu quiser dar dinheiro para a Reserva dou dinheiro a quem?"
B8	"A UNESCO, para os geoparques, tem um caderno de encargos brutal. E depois tem indicadores de gestão que vêm confirmar. E se não cumprires aqueles indicadorzinhos todos, tens cartão amarelo e depois tens x tempo para reparar e… percebes? (…) as reservas da biosfera sempre foram… são uma medalhazinha, são um galardão. E nunca definiram nem obrigações nem estruturas associadas. Portanto, se por um lado a UNESCO não dá apoio financeiro, nem grande apoio técnico e material para a execução, depois exige na mesma medida. (…) Não há um modelo de órgão de gestão. Não há um modelo de estrutura associado. E isso, no fundo, acaba por ser um handicap para o sucesso do processo."
B10	"(…) visto que aqui não há indústria, que seja a partir daí que venhamos a ter uma forma de rentabilizar o comércio e tudo, com essas visitas turísticas e esses passeios na Reserva, no Parque Natural e que depois é alargado à Reserva da Biosfera, e onde haja contemplação. (…) mas o que vier a acontecer dentro destas zonas, seja tudo feito em harmonia com o que existe, sem estragar, tanto a nível ambiental como a nível arquitetónico"
J1	"Nós estamos a intervir numa aldeia com mais de mil habitantes e, portanto, a comunidade que constrói este projeto é uma comunidade não intencional. As pessoas não sabem que estão a participar num projeto de construção de uma ecoaldeia… Assemelha-se muito mais a um projeto de intervenção ambiental... numa comunidade, numa aldeia, portanto o nosso objetivo é aumentar o desempenho, melhorar o desempenho ambiental da aldeia, é o principal objetivo." "(...) há uma decisão a fazer, há uma decisão que precisa de várias pessoas a decidir, faz-se telefonemas ou envia-se um e-mail. Passadas vinte e quatro horas não há resposta, decidimos sozinhos, quer dizer… é um modelo de decisão muito parecido com o de uma empresa, nesse aspeto. (...) nós somos uma equipa muito vasta, com muita coisa… às vezes a informação é muito difícil de passar, é muito difícil pormos todas as pessoas a comunicar, portanto temos que ter esse pragmatismo."

Table C2 (continuation)

ID	Discourse
M2	"(…) o papel da cooperativa em si especificamente é da ligação entre atividades económicas, ou necessidades económicas, e o estado. Como é que as pessoas podem formalmente fazer certas atividades que normalmente não fazem formalmente porque os custos que isso implica não justificam pequenos negócios (…). E então o primeiro lado desta ferramenta é que permite, pela partilha da estrutura de custos, contabilista (…) permite que todos os seus associados depois façam a faturação dos seus produtos. (…) Segunda ferramenta, permite a coordenação, ou facilita eventualmente, de ferramentas ou de coisas coletivas, do género uma loja. (…) A cooperativa não é a nossa cooperação, isso não é um fim em si mesmo, mas responde a coisas concretas de necessidades práticas da vida"
M5	"É interessante ouvir as outras opiniões e aprende-se sempre muito. (…) Eu nunca tive estudos, os meus estudos foram sempre a aprender no campo. E é interessante agente aprender com pessoas que estudaram não é? (...) Há muitas coisas e dicas que nos ensinam que nós não sabemos. Outras ensinamos nós que estamos habituados a trabalhar a terra."
M10	"A ideia que eu tenho da Minga é que continua a ser uma coisa muito fechada. (…) Continua a ser um projeto de pessoal de fora, pouco pessoal de Montemor. As ideias são boas. Mas quando tu te apresentas à comunidade, que é uma comunidade pequena, com um determinado aspeto e um determinado comportamento social não é fácil. (…) tipo de hábitos de consumo, de comidas, pronto. E pronto depois não é fácil cativar também as pessoas de fora porque... não é? Começa por dar uma ideia que aquilo é... pronto é uma coisa talvez pouco séria."

Table C3 Goals of the initiatives according to different dimensions of sustainability. PBNR – Paul do Boquilobo Nature Reserve

Dimension/ Initiative	Paul do Boquilobo Biosphere Reserve	Janas	Minga
Environment	Protect the natural values in the PBNR; Promote good environmental practices in farming	Improve the environmental performance of existing economic activities in Janas; Create zones exclusively dedicated to Nature	Develop projects that use fewer natural resources and have less impact, respecting and restoring the environment
Economy	Increase economic activities compatible with the conservation of biodiversity through ecotourism and certification	Develop new rural business driven by ecological practices; Produce food using practices from organic farming	Facilitate practical needs of everyday life regarding agriculture, housing, services and commercialization of non-agriculture products; Stimulate local consumption and production to substitute current practices in Montemor-o-Novo; Link economic activities with the state
Social	-	Fix population in Janas	Products should be available to everyone (prices low, not focused on profits); Create the tools for people to live more autonomous lives within legality; Promote collaboration and solidarity
Cultural	Protection of the architectural heritage and immaterial values	-	-
Other	Promote scientific research and environmental education; Demonstrate that intensive agriculture can co-exist with biodiversity conservation	Empower adults to become more autonomous and have more sustainable habits of consumption and production; Create a pilot village where it is demonstrated how societies can develop in a sustainable way	-

Table C4 Outcomes of each initiative retrieved from the discourses and organized according to the framework of Ferreira *et al.* (2018). Factors that are relevant at national or international scales are identified in brackets with "national" and/or "international". PBNR – Paul do Boquilobo Nature Reserve

Initiative/ Subcategories	Paul do Boquilobo Biosphere Reserve	Janas Ecovillage	Minga Multisector Cooperative
Economic benefits	-	- 6 persons employed; - Supports the creation of new business – there are 60 beekeepers that did their training at the Ecovillage (national); - Contributes to the local economy by buying local products and services and also by bringing students and tourists that consume in local stores and coffee shops.	- 1 person employed and other people have part-times jobs; - About 8 people receive their wages via Minga; - Many people created and are running business via Minga; - Many people are selling products via Minga (e.g. cookies, pottery, honey); - Small increase of the farming activity in the region; - Contribution to the common god (taxes) (national).
Social benefits	- Decrease of conflicts between farmers and conservationists and better communication between their organizations.	-	- By receiving their wage via Minga, people are in less uncertain social conditions and entitled to have social support from the state; - Integrates people from disadvantaged social groups (e.g. disable people); - Helps the integration of people that arrive to Montemor-o-Novo; - Creates practices of conversation and cooperation and unites people.
Empowerment	-	-	- A feeling of freedom.
Health benefits	-	-	- Tranquillity.
Learning	- The interaction between farmers and conservationists led to changes in attitudes and behaviours from both parties (social learning).	- The focus in developing more environmental-friendly lifestyles and economic activities results in the acquisition of learning that is task-oriented (transformative instrumental learning) and learning-by-doing (experiential learning). Despite the potential for learning is very high there are few opportunities to real learning and most of the participants are taught how to perform a task.	- People are changing their consumption and production habits, the way of working and there are new governance mechanisms in place, such as the collective organization of farming (social learning); - People are experimenting how to produce things in more ecological ways, e.g. in Jorge's farm and in Âmbar (experiential learning); - People learn ways of improving existing activities in the "ajudadas" and talks at "Espaço Integral" (transformative instrumental learning); - More open mind (transformative communicative learning).

Table C4 (continuation)

Initiative/ Subcategories	Paul do Boquilobo Biosphere Reserve	Janas Ecovillage	Minga Multisector Cooperative
Cultural benefits	- More visitors to the PBNR (national/international).	- Cultural exchange between people with different roles and nationalities (tourists, volunteers, students, etc.)	- Contributes to the "cultural broth" of the city; - Contributes to the preservation of traditions, e.g. by selling a traditional bread at the store.
Environmental benefits	-	- Regeneration of the soil, more plants and trees in the farm.	- Increase of the use of regenerative and less pollutant practices in agriculture; - Many projects in Minga are developed according to ecological practices, using biologic and local goods that have less environmental impacts, or contributing directly to a better environment, e.g. installing solar energy panels; - The consumption of local products decreases the emissions associated with the transport.
Economic impacts	-	- People in the farm live from their work, there are no wages and therefore no payments of Social Security to the government (national).	-
Social impacts	-	- People feel devalued and stay a short period in their job or volunteer program.	-
Inequality	-	-	-
Health impacts	-	- Health problems, frustration, stress.	-
Cultural impacts	-	-	- There is a cultural difference between the habits of working and recreation of the community and many of Minga's members.
Environmental impacts	- Cut of trees in the PBNR.	-	-

Figures

Interview protocol

"Understanding strategies for managing social-ecological systems at a regional scale"

1. Relationship with the initiative

1.1. Can you tell me how do you got involved with *[name of the initiative]* ?

1.2. Can you describe what is your role in *[name of the initiative]* ? Which are your functions?

2. Ends

2.1. What are the mission and goals of the *[name of the initiative]* ?

2.2. Do you identify yourself with the mission of the *[name of the initiative]* ? Is there any aspect of the mission/goals with which you do not identify yourself? Which one? How could it be reformulated?

3. Processes

3.1. Decision-making

3.1.1. How are decisions made in the *[name of the initiative] ?* Do you go to the meetings? Can you describe a typical meeting?

3.1.2. Do you think that the mechanism to make decisions is adequate? Why? Can you describe a situation of conflict and how do you manage to resolve it? What could be improved in the mechanism of decision-making?

3.1.3. Who is excluded from the decision-making? How are the meetings set? Do you believe people feel free to talk in the meetings? Why? Are there any mechanisms to promote the participation of everyone?

3.2. Instruments

3.2.1. Which activities are particularly important for the *[name of the initiative]* achieve its goals?

3.2.2. Which other activities would be important to develop? Why?

(continue on the next page)

4. Outcomes

4.1. How the *[name of the initiative]* have contributed to the different pillars of sustainable development (cultural, social, economic and environmental)? Are there other important results? And less positive outcomes?

4.2. Who is benefiting with the *[name of the initiative]* and who is not benefiting, or is having the impacts of its implementation?

5. Factors for success

5.1. What factors (internal and external) facilitate the development of the *[name of the initiative]* ?

5.2. Who are the allies/supporters of the *[name of the initiative]* ?

5.3. Which are the main barriers (internal and external) to the success of the *[name of the initiative]* ?

5.4. Who do not help the *[name of the initiative]* for lack of action or active opposition?

5.5. Which are the main factors that explain the success of the *[name of the initiative]* ?

6. Closing

6.1. How do you imagine the *[name of the initiative]* in 10 years? What have the *[name of the initiative]* achieved?

6.2. Which are the main lessons that you learned during your participation in the *[name of the initiative]* ? What advices would you give to someone starting a similar initiative?

7. About the respondent

7.1. First and last name:
7.2. Born in:
7.3. Nationality:
7.3. Actual city of residence:
7.4. Age:
7.5. Job:
7.6. School level and area of studies:
7.7. Gender:
7.8. Email:
7.9. Who else can I interview in order to better understand the *[name of the initiative]* ?

Thank you for your collaboration!

2

Figure C1 Interview protocol

a)

(continue on the next page)

b)

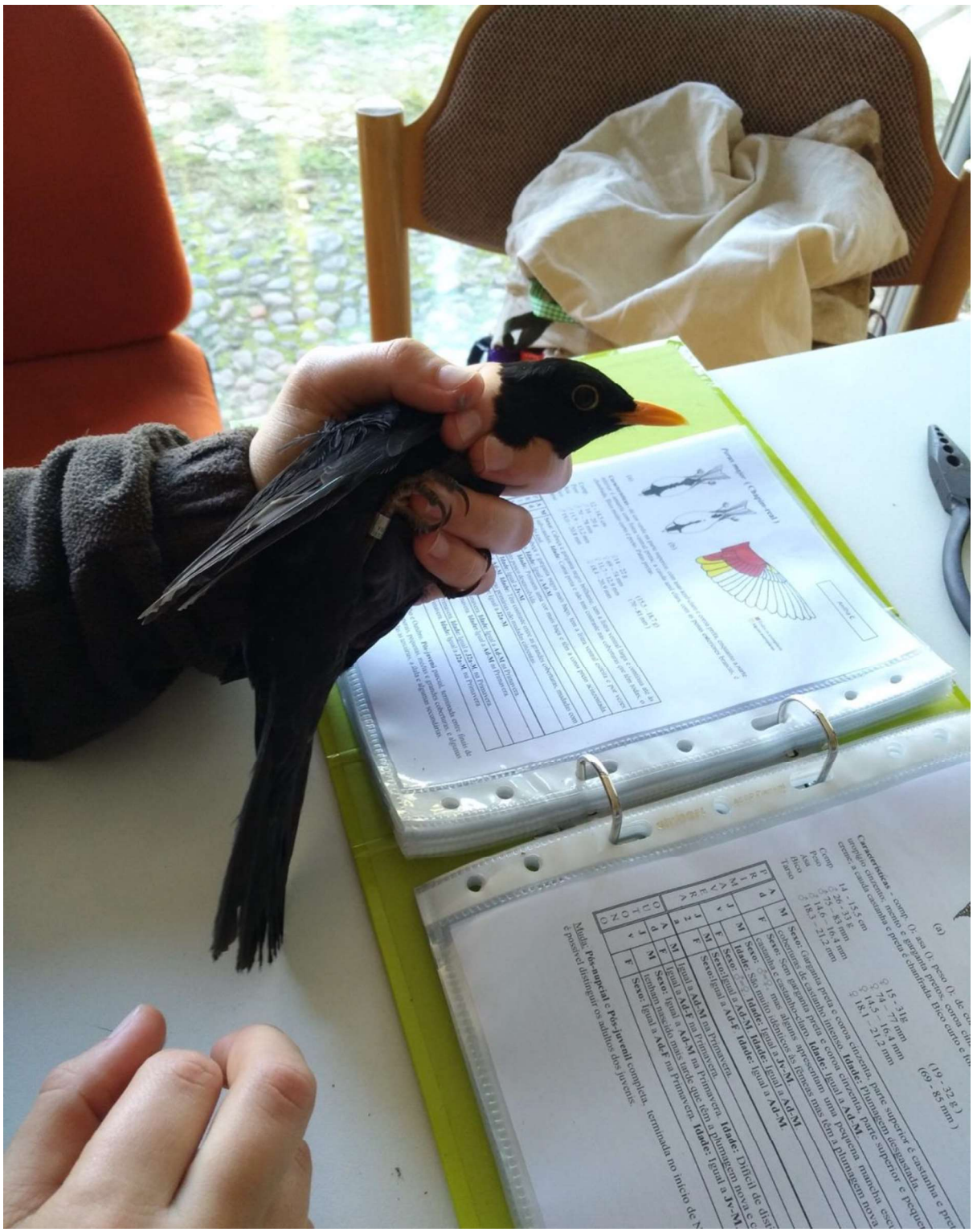

Figure C2 Activities observed in the Paul do Boquilobo Biosphere Reserve: a) a pond installed in the adjacent areas of fields where intensive agriculture irrigated by pivot takes place (in the back), an activity developed for the "Milho Amarelo" project (www.milhoamarelo.pt); b) an Eurasian Blackbird (*Turdus merula* L.) captured during a bird ringing session in the Paul do Boquilobo Nature Reserve. Photos: AFFerreira

a)

(continue on the next page)

b)

Figure C3 The two main spaces of the Janas Ecovillage: a) the Quinta do Luzio farm, where it can be seen many of the satellite wood houses; b) the ALDEA restaurant and grocery store. Photos: AFFerreira

a)

(continue on the next page)

b)

Figure C4 Different elements of the governance of Minga: a) a project of production of biologic cosmetics (Âmbar) is being developed by two cooperants; b) a participatory meeting with farmers to plan the agricultural production for the next year. Photos: AFFerreira

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