The Perceptions of Social-Ecological Changes in Tarituba, a Coastal Village in Southeastern Brazil

by

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ABSTRACT

Research in natural resources management (NRM) is, in its broadest sense, the study of the outcomes of the relationships between human beings and their environment. The purpose of this PhD thesis was to investigate individuals' perceptions of their social-ecological relationships and possible changes in these relationships in a coastal village called Tarituba, in Paraty, Rio de Janeiro, Brazil. During 161 days of participant observation, informal interviews were conducted from September 2010 to October 2011. The outcome of this qualitative investigation was used to analyze current methods, assumptions and concepts in three areas of the literature in NRM: ecosystem services, drivers of change, and participatory scenario planning, because they have recommended the inclusion of stakeholders' perception in their frameworks. This lead to three main findings, namely: (1) Individuals in Tarituba are active agents seeking provisions within their environments and not passive receivers of benefits and goods from nature, as tacitly assumed within much ecosystem services literature; (2) The analysis of research participants' verbal reports about changes in social and ecological domains revealed five intermediate categories, which were used to specify the allocation of perceived causes of changes into the categories of drivers of change from the literature; (3) The analysis of participatory scenario planning literature revealed that there is a need of an operational approach to perception in those studies, and the qualitative analysis of verbal reports could be a tool towards this operationalization. Despite the growing trend of considering stakeholders' perceptions in these areas of literature, the term perception has not been properly defined, which, along with methodological shortcomings identified, lead its use in exchange for terms like opinion and knowledge. The framework used in this study provided tools that may contribute to filling this gap in current NRM research and practice, as it may be adapted and refined in future research.

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Glossary of acronyms

EBM	Ecosystem-Based Management
ESEC	*Estação Ecológica de Tamoios* – Tamoios Ecological Station
FAO	Food and Agriculture Organization
IBGE	*Instituto Brasileiro de Geografia e Estatística* – Brazilian Institute for Geography and Statistics
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
MA	Millennium Ecosystem Assessment
MSY	Maximum Sustainable Yield
NGO	Non-governmental organization
NRM	Natural Resources Management
WWF	World Wide Fund for Nature

CHAPTER 1. INTRODUCTION

1.1. Background and assumptions

Research in Natural Resources Management (NRM) is, in its broadest sense, the study of the outcomes of the relationships between human beings and their environment, specifically the searching for processes that may optimize these outcomes. Thus, human beings are intrinsic components of the research in NRM. Given the human component, NRM research requires the identification of the meanings of what people tell about their human-environment relationships in order to reach an understanding from the verbal reports. A way of identifying the meanings of what people say is by studying people's perceptions of their environment. This PhD thesis focuses on people's perceptions of their human-environment relationships in a coastal village, Tarituba, located in Paraty, a municipality on southeastern Brazil.

Tarituba came into my knowledge when I participated in a research project about artisanal fishery in the Ilha Grande Bay - southern coast of Rio the Janeiro state. In that study, our research team visited 34 coastal villages and interviewed over 400 artisanal fishers about the current status of small-scale fisheries, the fishing areas, fish species they catch, and some of the challenges fishers face while conducting their activities. The main results of that study were reported in a book (Begossi *et al.*, 2010). The contact I developed with the dwellers of these coastal communities fostered my interest in the ways individuals perceive their environments.

During the interviews I conducted in 2009, many fishers reported detailed knowledge about names, food habits, habitat, and migratory patterns of their target species. Fishers also reported a diversity of fishing techniques used to catch them. At the same time, dwellers reported concerns about the environmental protected areas, created to "preserve" biodiversity in the area.

Some people reported issues about potentially predatory fishing techniques. Other people still were concerned about national development projects, such as the off-shore oil exploitation, and the construction of a new unit of the nuclear power plant in Angra dos Reis (neighboring city). The diversity of topics in those conversations and the diversity of emphasis over various aspects in the same topic convinced me that, in Tarituba, I would have the opportunity to study the basic processes I was interested in - namely, individuals' perceptions of their environment, in the context of NRM.

Given my natural sciences' background (Biology undergrad, and masters in Ecology), I realized that I would need to strengthen my interdisciplinary skills, especially those related to social studies, in order to conduct research on human-environment relationships. During the process of elaboration of my research project, I became aware of some of the research areas and methods used in NRM. Coursework and readings provided me with the essential literature to start a research project. My interest in perception of social-ecological relationships (and their changes) and in methods for accessing these processes were stimulated during my PhD studies. During that time, I discovered that perception processes could only be reached by using qualitative methods, because they demand the search for the meanings of what people say (Patton, 2002; Creswell, 2009) or do.

Considering my interest in perception processes, and the broad literature in NRM, I begin this study with three main assumptions. First, *research in Natural Resources Management would benefit from approaches that provide coherent explanatory models about the relationships humans beings have with their environment*. Researchers in many disciplines have devoted their efforts developing explanatory models about human-environment relationships. Some of these studies have fostered scientific debate and created new areas of research in NRM. Examples of

that are studies about the use of common pool resources by Hardin (1968) and the rise of Commons research (D. Feeny *et al.,* 1990; E Ostrom *et al.,* 1999), or the studies about traditional (indigenous or local) ecological knowledge and the recognition of traditional models of management of resources (Begossi, 1995; Johannes, 2002; Berkes, 2008).

Second, *human-environment relationships are diverse and the meanings people give to their environment define what a natural resource is*. In order to study the management of natural resources in a given locality, the basic information is to understand which components of the environment are perceived as natural resources by research participants. Research in human ecology has shown that humans relate to their environment in a diversity of ways, and in some instances, the cultural meanings people give to components of their environment differ from those of the "western" researcher. An example is in Berkes (2008), citing the work of Hunn (1993): dog means *Cannis familiaris*; but depending on the culture, dog can also mean "sled-puller", "men's best friend", or "dinner".

Third, *a qualitative approach is suitable to identifying research participants' perceptions about natural resources, their management, and possible changes in human-environment relationships*. According to Patton (2002), perceptions cannot be reached but through a qualitative approach. Using other methods, such as pure quantitative approach, researchers would not have access to this kind of information. In my research, I attempted to contribute to the research in NRM by developing a framework that considers stakeholders' perceptions in order to identify human-environment relationships and their possible changes. My focus on perceptions derives both from my personal interests and curiosity about the discrepancies between what people "say" and what they actually "do" (interest raised during the different studies and interviews I have conducted - Oliveira *et al.*, 2010; de Oliveira and Begossi, 2011;

Oliveira, Barreto and Begossi, 2012), and from authors that have pointed to the importance of considering the perceptions of stakeholders in NRM research and policy-making.

1.2. Perception and Natural Resources Management

The literature on NRM has stressed the importance of considering the perception of resource users in order to reach desirable outcomes towards sustainability of natural resources. There are different approaches to this perspective: some researchers focus on the importance of local (or traditional) ecological knowledge (Berkes, Colding and Folke, 2000); others focus on the importance of local rules and institutions (E Ostrom *et al.*, 1999); others, still focus on participation of local stakeholders, by incorporating their views, knowledge and perceptions into planning and decision-making (Gelcich *et al.*, 2009; Zagarola, Anderson and Veteto, 2014; Fernández-Llamazares *et al.*, 2016). Overall, most of these studies consider that the perceptions of local resource users are critical for the success of designed natural resources management regimes (Fernández-Llamazares *et al.*, 2016). In that regard, there are different arrangements of NRM which recommend the participation of different stakeholders (including users of local resources), such as co-management (Berkes, 2009a), adaptive co-management (Armitage *et al.*, 2008), and community-based management (Berkes, 1995; Berkes and Heneley, 1997). Although the overall claim that resource users' perceptions are essential for the success of NRM, few studies have empirically assessed this claim (but see Fernández-Llamazares *et al.*, 2016).

According to the Cambridge's Dictionary of Philosophy, perception is defined as "*the extraction and use of information about one's own environment (exteroperception) and about one's own body (interoception)*" ("perception." The Cambridge Dictionary of Philosophy, 2nd

ed. 1999). Still, an essential distinction regarding the study of perception is the difference between the perception of objects and perception of facts. While the later is dependent on our knowledge, system of beliefs, and cognitive systems (memoir, concepts, etc.), the former does not directly depend on these systems. Different academic approaches have been used to study perception, and hence to define it. I do not intend to provide here a comprehensive review on this subject, which would be out of the scope of this dissertation. However, by means of positioning how perception is defined in this thesis, I would like to describe how some disciplines have framed the study of perception.

Based on Ingold (2000), for both Social Anthropology (following the studies of Emile Durkheim) and Cultural Anthropology (following authors such as Franz Boas and Clifford Geertz) perception occurs as a two-step process: the first is the reception of meaningless sense data by the receiver, and second is the organization of this data according to collectively held, culturally acquired, and enduring representations. According to these disciplines, the principles that guide the organization of what is experienced (representations) can be found "*in the publicly accessible space of social discourse, and not in the interiority of the mind*" (Ingold, 2000:160). Using a different perspective, cognitive anthropologists claim that perception happens when individuals' sensory experiences match stable conceptual schemata (mental models). According to this school of thought, "*much if not all of the order that people claim to perceive in the world - and especially the social world - is imposed by the mind rather than given in experience*" (Ingold, 2000:161). Therefore, for these approaches, the individual perceives the "representations" which are either socially defined (as for Social Anthropology and Cultural Anthropology) or mental images or models located in the mind, and not the "environment" itself.

Another school of thought, called Theory of Practice, disagrees with the assumption that perceptions are determined by internal representations or models of the mind. Based on authors such as Bourdieu, and the concept of *habitus* (Bourdieu, 1990), this school puts the experience at the centre of the perception process. According to this school, perceptions are determined by experience - instantiated in the activity itself, which means that individuals do not make sense of their experiences by using pre-determined mental models, rather, the *habitus* subsists in the course of the activity. One conceptual feature resulting from this perspective is that the perceiving organism is no longer seen as "*a passive recipient of stimuli but as an active agent who purposively seeks out information that would specify the meaningful properties of his or her environment*" (Ingold, 2000:165). In line with Bourdieu's Theory of Practice, James Gibson's Ecological Psychology places the movement of the perceiving organism at the center of the concept of perception. According to Gibson (1979), perception is obtained directly from the environment as the organism experiences it, and not mediated by inner representations or mental models. Ecological Psychology as well as the Theory of Practice ultimately seek to overcome the Cartesian dualism body vs mind, which is implicit in the representational (Cognitive) approach to perception (Costall, 1984; Ingold, 2000).

Given my interest in human-environment relationships I draw more upon Ingold's work of perception as opposed to other more cognitive oriented frameworks. In Ingold's perspective an environment is the web of social and ecological relationships within which an individual is embedded. Perception of an environment grows out of the experience of an individual within a particular environment. Individuals learn to perceive relevant information of their environment during daily activities oriented to the fulfilment of their objectives. In other words, as the individual directly experiences the world, his or her perception is attuned, and a representation is

reached. As the purpose of this thesis is to study how individuals perceive their human-environment relationships and changes in these relationships, it is necessary to analyze the verbal reports of individuals, as these are the most readily available raw material that can be used to this end. However, the individuals' verbal reports do not directly express their perceptions, rather a process of decoding such reports is necessary to reach the meanings of what people say, and therefore, their perceptions.

Although this is by no means a thorough description of the philosophical theories devoted to the study of perception, this brief definition and distinction provide the basic idea of what is meant by perception in this study. This study will focus on the extraction and use of information about one's own environment (exteroperception), and on the perception of facts (meaningful relationships individuals have with their surroundings, and possible changes in these relationships), as these are the most relevant components of perception for the purpose of my study.

1.3. Philosophical worldview

The interdisciplinary nature of the research in natural resources management has attracted the attention of many scholars in different disciplines. Ecology, economy, geography, history and anthropology are examples of some academic backgrounds of scholars who have developed research in natural resources management. This interdisciplinary nature creates a challenge for researchers, which is to find a common body of concepts that have the same definition in different disciplines. However, in the current literature it is not rare to find studies that do not clearly define the concepts used, and even studies which use concepts as common sense (see

section 1.6), which may lead to confusion and hinder the operationalization of concepts in different research contexts. This is a major issue in current natural resources management research.

Despite philosophical advances, the worldview "humans separated from nature" is still widespread in current natural resources management research. One example of this worldview is the proposal of technical solutions for fisheries management that has prevailed in the area since the decade of 1970. Several authors have documented the failure of such linear, cause-effect, government-centralized, single species/sector approaches to solve natural resources management problems (e.g.: Berkes, 2007; Robert C. Francis *et al.*, 2007; Ruddle and Hickey, 2008). According to Capra (2012), this worldview is an issue in most scientific thinking of the XX century; thus, it is not restricted to NRM research.

The most influential philosopher who systematized the dualistic worldview was René Descartes, whose mechanistic, cause-effect approaches to understand and intervene in the world prevailed since the Renaissance. Descartes' worldview can be traced back to Leucippus and Democritus' atomic theory and Plato's body and soul dichotomy (Murphy, 1964). Descartes wrote in his book "Passions of the soul" that the movements of our body-parts come from the body and the thoughts come from the soul. He believed that the organ responsible for "transmitting" the thoughts from the soul to the body was the pineal gland. Thus, the basic assumption that humans are separated from nature is a reflex of the dualistic, body vs. soul Cartesian worldview. Although the Newtonian-Cartesian worldview allowed technology to flourish, and the Industrial Revolution to happen, there are many phenomena for which this worldview is not sufficient. One of such instances is the study of individuals' perceptions.

In this study, I align my philosophical approach with authors who have found ways to overcome the dualistic body-soul worldview. In other words, my philosophical approach aligns with those of Aristotle, for whom the movement (the dynamics) is the central idea. Also, I assume that concepts are abstractions that have to be continuously verified in order to attest to their capacity to represent a phenomenon. As I show in Chapters 2 and 3, some of the concepts and categories used in current natural resources management research are insufficient to represent individuals' perceptions because they have been applied as "concrete" entities. This is especially intriguing when there are philosophers who went as far as to demonstrate that concepts originate from equating what is unequal (Nietzsche, 2007), and therefore, are abstractions which cannot be treated as concrete entities.

The study of perception processes in many fields of knowledge has stated the central role of the perceiver. In a field called environmental psychology, Gibson (1978) has studied the visual perception and pointed to the importance of the moving observer in the formation of visual perception. Konrad Lorenz (1995), in the field of Ethology, stated that our perceptions are ultimately formed from the information given by our sensory organs and neural apparatus. Thus, Lorenz (1995) also highlights the importance of the neural and sensorial dynamics of the individual in perception. Lastly, as stated by Thomas Hobbes in his Treatise on Human Nature: "*2. (...) there is nothing without us (really) which we call an image or color. 3. That the said image or color is but an apposition unto us of the motion, agitation, or alteration, which the object worketh in the brain or spirits, or some external substance of the head. 4. That, as in vision, so also in conceptions that arise from the other senses, the subject of their inherence is not the object, but the sentient*" (Hallam, 1863:102-103). The central role of subjacent

mechanisms of perception highlight the importance of *analyzing* what people say in order to access their perceptions.

The concept of salience, as used in the field of ethnobiology and ethnotaxonomy may also contribute to highlight the importance of analysing what people say in order to access perceptions. Hunn (1999) stated that the salience of an organism may be influenced by ecological aspects (the likelihood of meaningful encounters between the human being and a given animal species), and by the size of the animal, which Hunn calls the size effect. The likelihood of an animal being named, or classified, depends upon the salience of that animal to a given person. Oliveira, Barreto and Begossi (2012) have demonstrated the importance of the ecological abundance of snappers (Lutjanidae) in the names used by fishers to classify this group of fish. In conclusion, my argument is that this philosophical approach that states the central role of the perceiver, and the dynamics of perception processes can contribute to the current NRM research.

1.4. The choice of focal literature areas

Natural Resources Management and perception are both vast areas of research in several disciplines. In order to satisfy my interest, and, at the same time, have a focal point of analysis, I searched for a framework that could enable the study of human-environment relationships in the context of NRM. The Millennium Ecosystem Assessment (MA, 2005a) is a global document, which involved the work of approximately 1,360 researchers, from 95 countries. According to the MA (2005a:V), "*people are integral parts of ecosystems and [...] a dynamic interaction exists between them and the other parts of ecosystems*". The influence of this document

(Carpenter et al., 2009), and its focus on human-environment relationships in the context of NRM justified my decision to use the MA framework as a starting point to seek for areas of literature that could be used in my research.

The Millennium Ecosystem Assessment's framework (Figure 1.1) proposes three main interlinked concepts, ecosystem services, drivers of change and human well-being. Additionally, the MA framework proposes a tool that can be used to understand present and future conditions of social-ecological systems, called scenario planning. These operational concepts and tools are used to answer questions such as: "*what are the current condition and trends of ecosystems, ecosystem services, and human well-being? - what are plausible future changes in ecosystem and their ecosystem services and the consequent changes in human well-being?*" (MA, 2005a:VIII). Therefore, I decided to focus on three research themes: ecosystem services, drivers of change, and scenario planning, as they fit my interest in studying changes in social-ecological systems. By focusing on these three areas, I could review their assumptions, methods, and more specifically, how this current thread of NRM research is addressing stakeholders' perceptions of their human-environment relationships.

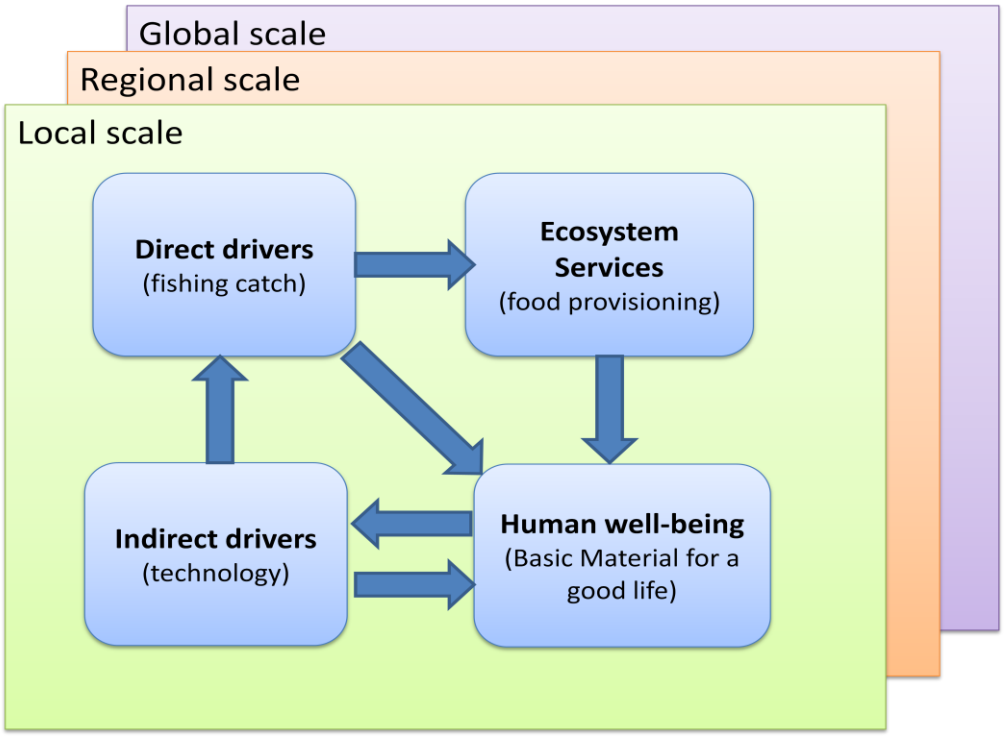

Figure 1.1 - Schematic representation of the Millennium Ecosystem Assessment framework. Interrelationships among indirect drivers, direct drivers, ecosystem services, and human well-being. Blue arrows represent drivers of change. (Adapted from Carpenter *et al.* 2006).

Since the turn of the century, there has been a growing number of publications within the three selected areas of the literature (ecosystem services, drivers of change, and scenario planning) that use the term "perception" in the context of NRM (see Figure 1.2). The increasing trend of using the concept "perception" within these three areas of literature supported my decision of reviewing these three topics as research areas to study the perception of human-environment relationships in current NRM approaches.

1.5. Purpose and objectives

The *purpose* of this study was to investigate stakeholders' perceptions about their social-ecological relationships and possible changes in these relationships in a coastal village called

Tarituba, in southeast Brazil. The outcome of this investigation was used to analyze methods, assumptions and concepts in current NRM research. *Three specific objectives* followed this purpose, as listed below:

a) To assess the extent to which the concept and categories of ecosystem services are able to accommodate the range of perceived human-environment relationships, and their dynamic changes;

b) To assess the precision of the concept and categories of drivers of change to accommodate individuals' perceptions about social-ecological changes;

c) To assess the applicability of the participatory scenario planning approach to consider stakeholders' perceptions of natural resources management.

1.6. Literature review

NRM research has developed a large body of literature, and consequently, of approaches to study, implement, and assess management designs that could enhance the outcomes of the relationships human beings have with their environment, towards the normative paradigm of sustainable use of natural resources. Among the prominent approaches, the ecosystem-based approach was coined as an alternative for single species/sector approach, which has failed in many instances (Berkes, 2007; Ruddle and Hickey, 2008). As stated earlier, one of the most influential frameworks in the recent NRM literature, based on the ecosystem-based approach is the Millennium Ecosystem Assessment (MA, 2005). This literature review focused on three main research areas that compose the MA's framework: ecosystem services, drivers of change and scenario planning. In order to reflect the current trends of NRM literature, I selected publications

from year 2000 to 2017. Whenever it was necessary (in order to access relevant references mentioned in the literature), additional published research from the area was consulted, and its relevance explained.

With regards to ecosystem services and drivers of change, the selection of publications was conducted using ScienceDirect and Scopus databases. For *ecosystem services*, keywords used were "ecosystem service", "natural resources management", and "perception" For *drivers of change*, keywords were "drivers", "change", "natural resources management", and "perception". The search was conducted in August 2017. In total, 129 publications on ecosystem services, 135 publications on drivers of change were identified. Regarding *scenario planning*, the purpose was to investigate how this methodological tool has been used in participatory exercises, and how stakeholders' perceptions have been incorporated into this approach. Thus, keywords used were "participatory scenario planning", "perception", and "natural resources management". As a relatively newer approach (publications containing these three keywords were only found after 2007), and due to the fact that the ScienceDirect and Scopus databases returned few publications, I also conducted the search on GoogleScholar (using the same parameters) for this subject. The database search was conducted in September 2017, and 62 publications were found. The review conducted for each main area is described on the next subsections. Figure 1.2 describes the number of publications per year that resulted from the databases search.

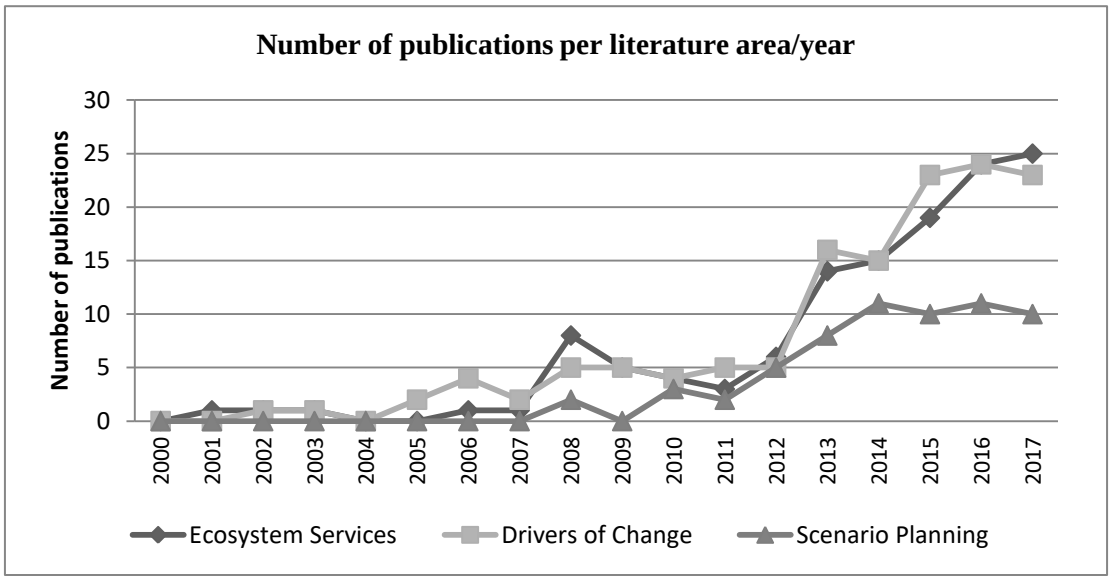

Figure 1.2 - Number of publications retrieved from the database search in each of the research areas selected for the literature review (ecosystem services, drivers of change, participatory scenario planning) per year.

1.6.1. Ecosystem services

1.6.1.1. The concept and categories of ecosystem services

The ecosystem services' concept was coined as such for the first time by Ehrlich and Ehrlich in 1981. However, before the formal use of the term *ecosystem services*, several other terms were used to refer to the human-nature interactions in the context of natural resources management. Terms like environmental services, nature's services, public service function of the global environment, were present in the literature that investigated the relationships between the functions of ecosystems and the societal values derived from them in the late 1970's (Gómez-Baggethun *et al.*, 2010; Hermelingmeier, 2014). According to one of the most influential publications on the topic, the book "*Nature's services: societal dependence on natural ecosystems*" (Daily, 1997), the concept ecosystem services was created to increase the awareness about the value of ecosystem processes and the consequences of human interventions on them.

According to Gómez-Baggethun and colleagues (2010), during the late 1990's with the publication of Daily (1997) and the monetary estimation of global the world's ecosystem services by Costanza *et al.* (1998), the concept of ecosystem services became mainstream, and paved its way into the research agenda. However, it was only after the Millennium Ecosystem Assessment (MA, 2003b) that ecosystem services' research grew exponentially (Fisher, Turner and Morling, 2009). Whereas at its origins, the concept had a pedagogic rationale (Gómez-Baggethun *et al.*, 2010:1213), after the publication of Costanza and colleagues (1998), a growing number of publications focusing on cost-benefit analysis, and a search for the values of ecosystem services emerged. The most prominent economically-centered approaches to ecosystem services are the so-called payment for ecosystem services schemes (Wunder, 2007).

Although a vast literature on valuation of ecosystem services can be found, including some criticisms regarding its inherent commodification of nature (Turnhout *et al.*, 2013) and its shortcomings regarding the valuation of some cultural and aesthetics aspects of the human-environment relationships (Chan, Satterfield and Goldstein, 2012; de Oliveira and Berkes, 2014), this was not the focus of this review. In the present review, I focused on the definitions of current ecosystem services' concepts and categories as are used in the NRM literature, with a special attention to how stakeholders' perceptions are identified within these frameworks. In doing so, I begin with the concepts and categories of three major documents that use ecosystem services as a core concept, which are the Millennium Ecosystem Assessment (MA, 2005), The Economics of Ecosystems & Biodiversity (TEEB, 2010), and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES - Díaz *et al.*, 2015). These documents were selected as representative for this purpose because they involve the work of several scholars,

from different disciplines, and from different countries, in addition to having a strong focus on integrating the ecosystem services' concept within the policy agenda.

In the Millennium Ecosystem Assessment, "*ecosystem services are the benefits people obtain from ecosystems*" (MA, 2005:V). According to this framework, there are four categories of ecosystem services: provisioning, regulating, cultural, and supporting services. Provisioning services are natural resources and raw materials used directly to supply human needs, such as food, water, medicinal plants, fuel, and timber. Regulating services include ecological processes such as water filtering, erosion control, climate regulation, and flooding attenuation. Cultural services enhance emotional, psychological, and cognitive well-being, and include recreational, aesthetic, scientific/educational, and spiritual benefits. Finally, supporting services are the structures and functions essential to the delivery of ecosystem services, such as photosynthesis, nutrient cycling, and soil formation.

According to TEEB, ecosystem services are "*the direct and indirect contributions of ecosystems to human well-being*" (TEEB, 2010:33). The categories of ecosystem services of TEEB are very similar to those of the MA, and they are: provisioning services (e.g. food, raw materials, fresh water, medicinal resources), regulating services (e.g. local climate and air quality regulation, waste-water treatment, pollination, biological control), habitat or supporting services (e.g. habitats for species, maintenance of genetic diversity), and cultural services ("*the non-material benefits people obtain from contact with ecosystems*" - TEEB, 2010:33).

Finally, the IPBES framework uses the broader concept "nature's benefits for people", as it considers that "*[e]cosystem goods and services - including provisioning, regulating and cultural services - all fall in this category*" (Díaz *et al.*, 2015:6). Although the IPBES framework uses the concept "nature's benefits for people", the fact that the concept of ecosystem services is

embraced by this category justifies its inclusion as a current framework on ecosystem services in the context of this review of the literature.

It is worth noting that these three current definitions of ecosystem services resemble some of the definitions of previous literature, such as "*important benefits to humanity*" (Ehrlich and Ehrlich, 1981:preface), "*ecological and socio-economic benefits of environmental functions to human society*" (de Groot, 1987:105), "*the conditions and processes through which natural ecosystems [...] sustain and fulfill human life*" (Daily, 1997:3), and "*flows of value to human societies as a result of the state and quantity of natural capital*" (Costanza *et al.*, 1997:253).

According to Hermelingmeier (2014), three perspectives can be drawn from the analysis of the foundational concepts of ecosystem services. The first is a *Pragmatic Conservationist* perspective, which is intended to raise awareness of the dependency of human societies upon ecosystems. This perspective, represented by Ehrlich and Ehrlich (1981) and Daily (1997), is based on an utilitarian view of nature, and intentionally places the concept of ecosystem services in the interface between ecology and economy, conveying a "familiar" language to make a broader audience aware of the value of ecosystems. The second perspective, *Instrumental Economic*, is represented by Costanza *et al.* (1997) and TEEB (2010), and "*interprets the ES concept as a tool for monetary valuation and economic decision-making*" (Hermelingmeier, 2014:18). Finally, the *Broad Societal* perspective is represented by the MA (2003b) and de Groot (1987), and is based on a mostly descriptive and metaphoric notion of the concept of ecosystem services, as a tool for collaboration between disciplines, as well as science-society communication.

Another common aspect of the concept of ecosystem services , is the use of the term "benefits" within MA's, TEEB's and IPBES's conceptual frameworks. Two important underlining

assumptions can be inferred from the use of the term benefits in those frameworks: first, an utilitarian view of nature, in which nature "serves" humanity with services and goods; and second, that resource users are passive receivers of the "benefits" given by nature, thereby overlooking the agency of individuals in perceiving and acting to obtain what they need. These assumptions have been noted in recent studies (Turnhout *et al.*, 2013; de Oliveira and Berkes, 2014; Spangenberg *et al.*, 2014; L.-E. Ruoso *et al.*, 2015). The rationale of these assumptions and the implication of them for the study of natural resources management will be expanded in the next subsection, when I draw attention to the role of individuals' perceptions of ecosystem services.

1.6.1.2. The perception of ecosystem services in NRM literature

The literature on ecosystem-based management ("Ecosystem Approach" - UNEP-CBD, 2000) has stated that the participation of different stakeholders is essential for the success of resources management (Crowder *et al.*, 2008; Olsson, Folke and Hughes, 2008; Gelcich *et al.*, 2009; Pitcher *et al.*, 2009). Accordingly, one of the principles of ecosystem-based management, as stated in the Convention on Biological Diversity[1], principle 11, recommends that "the ecosystem approach should consider all forms of relevant information, including scientific and

[1] The 12 principles for EBM according to the Convention on Biological Diversity (http://www.cbd.int/ecosystem/) are: 1- The objectives of management of land, water and living resources are a matter of societal choices; 2- Management should be decentralized to the lowest appropriate level; 3- Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems; 4- Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context; 5- Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach; 6- Ecosystem must be managed within the limits of their functioning; 7- The ecosystem approach should be undertaken at the appropriate spatial and temporal scales; 8- Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term; 9- Management must recognize the change is inevitable; 10- The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity; 11- The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices; 12- The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

indigenous and local knowledge, innovations and practices". Therefore, participation of the local population is regarded as a critical component towards the implementation of ecosystem approaches to NRM. As such, how resource users, and other stakeholders, perceive ecosystem services and their categories needs to be investigated in order to inform management decisions.

According to the review I conducted on the recent (published between 2000 and 2017) literature selected from publications that contained the keywords "ecosystem services", "perception", and "natural resources management", there has been a growing number of studies intertwining these terms (see Figure 1.2). I reviewed these publications in order to describe: 1) how perception has been defined, and which aspects of perception have been investigated; 2) the conceptual ES frameworks that have been used; and 3) the methods used to identify stakeholders' perceptions of ecosystem services. A table containing the complete list of reviewed publications and the analysis of each of the publications regarding these three aspects can be found at the end of Chapter 2 - Table 2.3. It is important to mention that the literature search may not reveal all the publications on the subject, given the fact that some terms referring to ecosystem services have also been used, such as "environmental services", "nature's services". However, the term ecosystem services was chosen as representative of the subject area, and avoided the selection of unrelated literature, such as research on medical environment (Fisher, Turner and Morling, 2009).

Out of 129 research items retrieved from the databases' search, two were not considered in the analysis, as one was a glossary entry, and another was a conference presentation abstract with no details on concepts and methods used. Out of the 127 publications considered in the review, 111 regard the perception of stakeholders as an important component of natural resources management approaches (see Table 2.3). In 92 of these publications, individuals'

perceptions were reported as a result in the research; however, only 5 publications defined what was meant by "perception" in the research context.

Among the studies that I considered that defined perception, although they did not provide a literal definition of the concept, they included some reflection about the theories used to approach perception. For example, van Riper *et al.* (2012) were interested in the social values of ecosystem services, and therefore, approached individuals' perceptions by investigating stakeholders' values and preferences regarding specific locations of the studied site. These authors also mentioned that they grounded their research "*within the meta-theory of "transactionalism" that emerged in the field of environmental psychology*" (van Riper et al., 2012:165). Similarly, Baker *et al* (2015) ground their study on the field of environmental psychology, and stated that "*the meaning of the [open] field is derived from the viewpoint of the actor and not through the field*" (p.327), thereby highlighting the centrality of the perceiving individual in "transforming" his or her surroundings. Van Hecken, Bastiaensen and Vásquez (2012), on the other hand, approached individuals' perceptions according to their "willingness to pay" (WTP) for specific ecosystem services. These authors discussed inconsistencies in individuals choices explaining that perceptions are informed by "*cultural repertoire of the local institutional environment*" (p.173), therefore, it could be inferred that their approach resembles that of the representational theories of perception (see section 1.2). As shown by these examples, even though these studies did not report a "literal" definition of perception (probably because this was not the main objective of the study), their conceptual framework could be identified.

However, I could not identify the definition or the conceptual framework in most of the studies reviewed. This finding was striking, as it suggests that most of the publications reviewed are using the term "perception" either as commonsense, or in exchange for terms like

"knowledge", or "opinion". The interchangeability of the terms "perception" and "knowledge" in this literature has also been pointed by Fernández-Llamazares *et al.* (2016). One explicit evidence of the interchangeability of the terms "perception" and "opinion" was found in Kalaba (2016), where the author explain that *"[e]xpert interviews were conducted to elucidate expert opinions and insights on policy implementation*" (Kalaba, 2016:41), and later on the author states that *"[f]indings of this research on policy actor's perceptions of barriers to policy implementation*" (Kalaba, 2016:43). Given that perception is vast field of study, encompassing different disciplines, from philosophy to psychology, and the complexity of this subject, the lack of a shared definition of perception in the current NRM research indicates a substantive challenge for its operationalization.

With regards to the ecosystem services' concepts, out of the 127 studies reviewed, 40 (approximately 31%) used a ES definition or cited the framework used. Similar to the finding regarding the term perception, it could be inferred that most of the reviewed studies are using the term ecosystem services as if it was commonsense. However, some authors have already pointed to the vagueness of the concept (Nahlik *et al.*, 2012), and to operational difficulties given a lack of consensus on what ecosystem services mean (Hermelingmeier, 2014). The proportion of publications that cited the concept or framework used was higher among the 51 publications in which ES was the main focus of the research (33 out of 51 defined ecosystem services - approximately 65%). Still, 35% of the publications in which ES was the main focus of the research did not provide a definition or cited the framework used, which was also striking.

Among the 38 studies in which ecosystem services was the main focus of the research *and* that cited at least one framework used, most of them used the Millennium Ecosystem Assessment (MA 2005) framework (79%). The other definitions cited were Daily (1997 - 18%),

Costanza *et al.* (1997 - 16%), TEEB (2010 - 11%), de Groot *et al* (2002; 2010 - 8%), Fisher and Turner (2008 - 3%), WLE (2014 - 3%), and UK National Ecosystem Assessment (2011 - 3%) - the sum of the percentages presented surpasses 100% because some papers cited more than one framework. Therefore, the review showed a prevalence of the Millennium Ecosystem Assessment's concept and categories among the studies that focus on ecosystem services and perception in the context of NRM.

With regards to the methodological approaches, I analyzed the 45 publications in which ES was the main focus of the research *and* used empirical data (literature reviews, opinion and analysis research were not considered). Out of the 45 publications, 23 (51%) used mixed (quantitative and qualitative) approaches, 14 (31%) used a pure quantitative approach, and 8 (18%) used only a qualitative approach. Among the qualitative approaches used, common data collection procedures were interviews (e.g. Sagie *et al.*, 2013; de Oliveira and Berkes, 2014), focus group interviews (e.g. Asah *et al.*, 2014), and territorial mapping (e.g. Ruoso *et al.*, 2015). Among the pure quantitative approaches, common data collection procedures included questionnaire surveys (e.g. Lagbas and Dl. Habito, 2016), contingent valuation (e.g. Castro *et al.*, 2011; Pinto *et al.*, 2016), and a combination of surveys and GIS mapping techniques (e.g. Grilli *et al.*, 2017; van Riper *et al.*, 2012). Mixed (qualitative and quantitative) approaches often included a set of the previously mentioned quantitative and qualitative data collection procedures. It is important to notice that, for some authors, perception can only be reached using qualitative methods (Patton, 2002).

Although current NRM literature has increased its attention to stakeholders' perceptions of ecosystem services, few studies have assessed *if* ecosystem services are perceived by stakeholders, and, if so, how are they perceived, and extent to which the concepts and categories

of ecosystem services were able to accommodate individuals' perceptions of their human-environment relationships (see Asah *et al.*, 2014; de Oliveira and Berkes, 2014) . Frequently, stakeholders are asked to state their preferences over a set of predefined categories of ecosystem services, and, as a conclusion, authors state that stakeholders perceive one type of ecosystem service over another. These results, as they have been presented, imply that stakeholders actually *perceive* ecosystem services, however, this very assumption was not assessed by researchers. It can be hypothesised that, when this assumption is not verified, and authors conclude that individuals *perceive* ecosystem services, there might be an on-going process of creating "facts" from "words" (Bourdieu, 2011).

There are some examples in the reviewed literature that exemplify the abovementioned claim that researchers may not be verifying *if* individuals perceive ecosystem services, and instead, only collecting people's *opinions* over a set of pre-defined ES categories. For example, García-Nieto *et al.* (2013) reported that *"[e]ach respondent selected the four most demanded ecosystem services from a panel using pictures of potential services provided. [...] The use of panels with pictures and an example of each service in the study area has been previously used in the ecosystem service literature to facilitate respondents' comprehension of ecosystem services"* (García-Nieto *et al.*, 2013:129). Castro *et. al* (2016) reported that: "*This study included eight key ecosystem services in three classes [...]These services were included in a panel with photographs and a brief description that was shown to respondents*" (Castro *et al.*, 2016:3). Zagarola, Anderson and Veteto (2014) explained that, "*[f]or the ES portion of the survey (section 4), the total list of services was based on the MA (2005) typology*" (Zagarola, Anderson and Veteto, 2014:771). In the same lines, Raymond *et al.* (2009) described that: *"[i]n parts 2 and 3 of the interview process, participants were asked to describe their values using the Millennium*

Ecosystem Assessment (2005) natural capital and ecosystem services typology to guide the conversation" (Raymond *et al.*, 2009:1304).

Similarly to presenting research participants with a pre-defined set of ES categories, some studies reported that they explained, beforehand, the concept of ES prior to data collection. For example, Sagie *et al.* (2013) reported that: "*[i]n the interviews with experts, we defined the term "ecosystem services" for them, and then proceeded to ask them directly about the ecosystem services of their area*" (Sagie *et al.*, 2013:41). Owuor *et al.* (2017) described, in their methods section, that "*[p]articipants were taken through an introductory session in which they refreshed their familiarity with the ecosystem types in Mida Creek, defined what ES is and discussed the ES classification using the Millennium Ecosystem Assessment (M.E.A) framework*" (Owuor et al., 2017:13). This is not the complete list of examples found in the literature review, but they are meant to illustrate how the reported "perception" of ecosystem services may, in some instances, be the result of a methodological artifact - the measurement of the effect of the measuring instruments on research participants. According to Bourdieu (2011:224), "*this is what happens whenever the researcher impose on interviewees an issue that is not related to them*". This is a methodological shortcoming faced by current NRM research on ecosystem services.

In summary, the analysis of the current literature that intertwines the terms "ecosystem services", "perception", and "natural resources management" revealed that: 1) the Millennium Ecosystem Approach (MA, 2005) is the most used conceptual framework - however, part of the reviewed literature did not define ES; 2) despite the agreement that stakeholder's perceptions are important for NRM research, few studies define what they mean by perception in their research; 3) there are some methodological issues regarding the research of perception of ecosystem

services, namely, few studies addressed *if* stakeholders perceive ecosystem services, and most studies report participants' opinions over a set of pre-defined categories. These findings were taken into consideration when I addressed the first objective of this thesis - Chapter 2.

1.6.2. Drivers of change

The endeavor of understanding the causes of change in integrated social-ecological systems is a challenge for the field of natural resources management. Three main theoretical approaches have been used to understand the dynamics of changes in social-ecological systems: complex adaptive systems (Levin, 2006, 1998), resilience (Gunderson and Holling, 2002; Holling, 1973), and punctuated equilibrium (Olsson, Folke and Hughes, 2008; Hagerman, Dowlatabadi and Satterfield, 2010). The commonality among those approaches is that they consider that dynamism is inherent to complex systems. They move away from the idea of simple systems, characterized by a single equilibrium point, linear relationships, stability, and certainty. In addition, all those approaches focus on the factors that cause changes in social-ecological systems (and the interactions among them), at different scales of time and space.

Causes of change in social-ecological systems have been named *drivers of change* in NRM research. The study of drivers of social-ecological change in NRM research has become common since the publication of the Millennium Ecosystem Assessment in 2003 (MA, 2003c). The incorporation of the concept of drivers of change in recent international, policy-oriented NRM approaches, such as the IPBES (Díaz *et al.*, 2015), also stresses its importance in current research. Additionally, there is a growing trend of using participatory tools to understand drivers at local level, based on the perceptions of stakeholders (Mbow *et al.*, 2008; Udayakumara *et al.*,

2010; Cerdán *et al.*, 2012; Leo X.C. Dutra *et al.*, 2015; Pirard, Petit and Baral, 2017). Despite the importance of this growing field of literature, there is little discussion about the concepts, taxonomies, and characteristics of drivers of change. Especially, there is a lack of studies evaluating how stakeholders' perceptions of social-ecological changes have been identified using this approach. The objective of this literature review is to identify the main frameworks, concepts and categories of drivers of change used in current NRM literature, focusing on studies that have considered stakeholders' perceptions.

1.6.2.1. Frameworks of drivers of change in the reviewed literature

Among the 135 publications retrieved from the Scopus and ScienceDirect databases' search for publications linking "drivers of change" and "perception" in the context of NRM, three main theoretical frameworks could be identified. The most common theoretical framework was the Millennium Ecosystem Assessment, which was cited in 44 research items[2]. The Millennium Ecosystem Assessment is one of the most important global studies considering the interrelationships among drivers, ecosystem services, and human well-being. The framework devised by the MA analyzes how direct and indirect drivers, ecosystem services, and human well-being interact and cause changes in each other at different scales of time and space. The prevalence of the Millennium Ecosystem Assessment could also be assessed by the fact that

[2] Publications that cited the Millennium Ecosystem Assessment Framework: Ekins *et al.*, 2003; Mbow *et al.*, 2008; Buitrago, Guada and Doyle, 2008; Crowder *et al.*, 2008; Remoundou *et al.*, 2009; Bryan *et al.*, 2010; Castro *et al.*, 2011; Thomas *et al.*, 2012; Van Hecken, Bastiaensen and Vásquez, 2012; van Riper *et al.*, 2012; Cerdán *et al.*, 2012; Frank *et al.*, 2013; Fürst *et al.*, 2013; García-Nieto *et al.*, 2013; Lopes and Videira, 2013; Namaalwa *et al.*, 2013; Partidario and Gomes, 2013; Yang *et al.*, 2013; Asah *et al.*, 2014; de Oliveira and Berkes, 2014; Lund, Banta and Bunting, 2014; Turner *et al.*, 2014; Baker *et al.*, 2015; Díaz *et al.*, 2015; Khakzad, Pieters and Van Balen, 2015; Krause *et al.*, 2015; Caro-Borrero *et al.*, 2015; De Vreese *et al.*, 2016; García-Martín *et al.*, 2016; Lagbas and Dl. Habito, 2016; Pandeya *et al.*, 2016; Caballero-Serrano *et al.*, 2016; Villegas-Palacio *et al.*, 2016; Walther *et al.*, 2016; Chen *et al.*, 2016; Farhad, Gual and Ruiz-Ballesteros, 2017; Gabay and Alam, 2017; Martínez-Sastre *et al.*, 2017; Nava Fuentes, Arenas Granados and Martins, 2017; Owuor *et al.*, 2017; Perni and Martínez-Paz, 2017; Queiroz *et al.*, 2017; Rojas-Downing *et al.*, 2017; Rozas-Vásquez *et al.*, 2017.

among the 135 publications reviewed, 104 mentioned the term "ecosystem services", which is a core component of this framework.

The second most commonly cited framework in the reviewed literature was the IPCC (Intergovernmental Panel on Climate Change), which was cited in 20 research items[3]. According to the IPCC (2014), there are *immediate drivers* of greenhouse gases emissions, such as population, gross domestic product and gross national expenditure per capita, energy intensity of production and expenditure, and greenhouse gases-emission intensity. In addition to immediate drivers, IPCC defines *underlying drivers* as "*the processes, mechanisms, and characteristics of society that influence emissions through the factors, such as fossil fuels endowment and availability, consumption patterns, structural and technological changes, and behavioural choices*" (IPCC, 2014:356). IPCC is concerned about drivers of global climate change, and its goal is to assess the science related to climate change.

Finally, another framework identified in the reviewed literature is the IPBES (Diaz *et al.*, 2015). IPBES framework was cited in eight research items from 2012 to 2017[4]. IPBES defines direct drivers as those that affect nature directly. Direct drivers are subcategorized as natural direct drivers ("*those that are not the result of human activities and whose occurrence is beyond human control*"), and anthropogenic direct drivers ("*those that are the result of human decisions and actions, namely, of institutions and governance systems and other indirect drivers*") (Diaz *et*

[3] Publications that cited the IPCC framework: Remoundou *et al.*, 2009; Ramachandran Nair *et al.*, 2010; Bond, 2012; Thomas *et al.*, 2012; Pasquini, Cowling and Ziervogel, 2013; Villamor *et al.*, 2014; Gray *et al.*, 2014; Atela *et al.*, 2015; Ruiz-Mallén *et al.*, 2015; Díaz *et al.*, 2015; Dutra *et al.*, 2015; Torresan *et al.*, 2016; Villamor and van Noordwijk, 2016; Nagoli and Chiwona-Karltun, 2017; Rojas-Downing *et al.*, 2017; Denjean *et al.*, 2017; Douxchamps *et al.*, 2017; Gabay and Alam, 2017; Grilli *et al.*, 2017; Grygoruk and Rannow, 2017.

[4] Research items that cited the IPBES conceptual framework: Thomas *et al.*, 2012; García-Nieto *et al.*, 2013; Díaz *et al.*, 2015; Pandeya *et al.*, 2016; Villegas-Palacio *et al.*, 2016; Walther *et al.*, 2016; Denjean *et al.*, 2017; Rozas-Vásquez *et al.*, 2017.

al., 2015:7). Indirect drivers, on the other hand, are defined as those that "*in the vast majority of cases [...] do not affect nature directly, but rather through their effects on direct anthropogenic drivers*" (Diaz *et al.*, 2015:7). The drivers' concepts and categories of IPBES (direct and indirect) are similar to those of the Millennium Ecosystem Assessment.

1.6.2.2.Concepts and categories of drivers of change

Drivers of change have been characterized according to: 1) their nature, whether natural (non-human-induced) or anthropogenic (human-induced); 2) their impact on the ecosystem, whether direct or indirect; and 3) the scale of time and space, whether endogenous or exogenous in relation to the system being analyzed.

Non-human induced factors, such as climate variations, volcanic activities, and photosynthesis can significantly alter the state of any given ecosystem. These non-human events have been called natural, environmental, or biophysical drivers of change (Taylor *et al.*, 2008; Perry *et al.*, 2010). On the other hand, human actions such as fishing, hunting, mining, breathing, bombing, have also been pointed as the causes of extensive changes in ecosystem processes, with profound consequences for biological diversity (Chapin *et al.*, 2000). Those events have been called anthropogenic, socio-economic, or human-induced drivers (Gerald C Nelson *et al.*, 2006; B. S. Halpern *et al.*, 2008; Kronen *et al.*, 2010). One comment that can be made about the distinction between natural and anthropogenic direct drivers (despite their given definitions) is that the choice of these names may cause some confusion, since human activities are also natural, environmental, and biophysical (i.e. humans are inherent components of ecosystems). It can be argued that these categories may reinforce the idea that humans are separated from the natural systems - thereby suggesting that anthropogenic actions are not natural.

With regards to their impacts on the ecosystem, drivers have been classified as direct and indirect. Direct drivers unequivocally influence ecosystem processes (Gerald C Nelson *et al.*, 2006). For example, fishing has been pointed as a main direct driver that causes change in marine ecosystems (B. S. Halpern *et al.*, 2008; Crowder *et al.*, 2008), and land-cover change as an important direct driver changing terrestrial ecosystems (Gerald C Nelson *et al.*, 2006; Reyers *et al.*, 2009). Other examples of direct drivers include: climate change (Rojas-Downing *et al.*, 2017), pollution, evolution, volcanic eruptions, and tsunamis, to name just a few. On the other hand, indirect drivers act more diffusely, generally altering one or more direct drivers (MA, 2005b; Diaz *et al*., 2015). Examples of indirect drivers are demographic shifts, economy, socio-politics (such as the actions of NGOs, protected areas created by the government), culture and religion (for example sacred groves, and food taboos), and science and technology (for example, advances in fishing devices and genetically modified organisms).

Finally, regarding scales of time and space, drivers have been classified as endogenous and exogenous. Endogenous drivers originate inside a defined boundary of time and space, whereas exogenous drivers are generated outside that boundary (MA 2003a). This distinction has a direct implication for management; endogenous drivers may be controlled by a given decision-maker, whereas exogenous drivers are not (MA 2003a). Still according to the MA (2003a), the sub-national, national, and international structures provide a natural hierarchy of endogeneity for drivers. Decisions made at higher hierarchical levels are exogenous drivers in relation to lower hierarchical levels. For example, at national level, technology development is an endogenous driver, while development in basic science is exogenous. Or at the local community level, it is possible to control the amount of fish caught, but it is not possible to control the regional market value of that fish. Moreover, endogeneity and exogeneity are influenced by the temporal scale.

For example, in Brazil, a mayor's term of office is four years (extendible to eight years, if re-elected). Processes occurring at a time frame longer than that may not be controlled by a given mayor's decisions.

These three sets of distinctions of drivers of change found in the literature poses a challenge for researchers, given the fact that those classifications are not mutually excluding. For example, fishing can be at the same time an anthropogenic, direct, and endogenous (and even exegenous, depending on the scale of observation). Although a taxonomy is necessary for categorization, when one reviews the literature on drivers of change, one may find it confusing. This confusion relies on the fact that "*if a set of categories is complete, then each entity in the world will belong to a category and no entity will belong to more than one category"* ("category", The Cambridge Dictionary of Philosophy, 2nd Ed. 1999: 123). When I reviewed the literature on drivers of change, I found a set of categories in which one entity (for example, fishing) could belong to more than one category. This finding stresses the necessity of specifying the inclusion of an item in the categories from the literature.

When the objective of the research is to identify drivers based on stakeholders' perceptions, then the specification of where to assign stakeholders' verbal reports in the categories of literature becomes even more important. The lack of studies assessing how stakeholders' perceptions have been identified in current drivers' research, and the non-excluding characteristic of categories of drivers of change identified in the literature, opens up a research avenue. In this regard, Chapter 3 explores this avenue, based on the second objective of this thesis, which is to assess the extent to which the concepts and categories of drivers of change are able to accommodate the range of perceptions of stakeholders about social-ecological changes in Tarituba.

1.6.3. Participatory scenario planning

NRM research has accompanied a scientific shift in which the prevailing view of an "orderly and well-behaved" world has been replaced by one that currently sees the world as "complex and uncertain" (Kinzig *et al.*, 2006). This shift has lead to the conceptualization of social-ecological systems as complex adaptive systems (Olsson, Folke and Berkes, 2004; Berkes, 2006). In this context, conceptual frameworks and research tools had to be designed to take into consideration the inherent non-linear relationships, scale dependency, cascading and threshold effects, regime shifts, multiple possible outcomes and limited predictability of social-ecological systems (Folke, 2006; Kinzig *et al.*, 2006; Walker *et al.*, 2006).

One approach that allows the consideration of the inherent complexities of social-ecological systems is scenario planning. Scenario planning ("development", or "analysis" - Reed *et al.*, 2013) was originally conceived as a military exercise, and its use as a strategic planning tool in business has been reported since the decade of 1970 (van der Heijden 2005; Shwartz 1996). The use of scenario planning in NRM has gained momentum since the turn of the century (Reed *et al.*, 2012), although its application to environmental issues can be traced back to the beginning of the 1970's (Alcamo, 2008). The use and recommendation of scenarios approach in international, policy-oriented research frameworks, such as the Millennium Ecosystem Assessment (MA 2005) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES - Díaz *et al.*, 2015) may have contributed to pave the way of scenario planning into NRM research and practice agendas.

Simply put, scenarios are defined as alternative descriptions of the future (Brummel and McGillivray 2008). A more complete, widely used definition is found on the IPCC's Special

Report on Emission Scenarios: scenarios are plausible descriptions about how the future may unfold, based on a coherent and internally consistent set of assumptions about key relationships and driving forces (Raskin *et al.*, 2005; IPCC, 2010). Scenario planning is the process of building and analyzing such scenarios (Peterson, 2007). Three basic types of scenario planning exercises are found in the literature: predictive, exploratory, and normative, as they address respectively, "what will happen?", "what can happen?", and "how can a specific target be reached?" (Börjeson *et al.*, 2006:725). Accordingly, different methods are used to develop such scenarios, including, quantitative, qualitative or mixed-methods approaches (Alcamo, 2008). Participation of stakeholders in scenario planning varies, but a trend of including the views and perceptions of those belonging to the social-ecological system under analysis has evolved in NRM research under the term "participatory scenario planning" (Pahl-Wostl, 2008; Reed *et al.*, 2013).

The reasons for involving stakeholders in scenario planning exercises have been widely discussed in the literature, and it follows the trend of increasing stakeholders' participation in decision-making regarding the use and management of natural resources (Pahl-Wostl, 2008). A pragmatic rationale sustains that the participation of stakeholders is recommended to enhance the plausibility of the scenarios themselves, since stakeholders possess fine-grained information regarding the structure of the system, main uncertainties, relationships and variables to be considered (Enfors *et al.*, 2008; Bohensky, Butler and Mitchell, 2011; Reed *et al.*, 2013). Pahl-Wostl (2008) also stated that the involvement of stakeholders in the process may increase the probability that the scenarios will actually be used. Another rationale supports the participation of stakeholders as it will ultimately empower local communities via co-production of knowledge, exercise of democracy, consensus-reaching, and construction of a shared vision of the future

(Enfors *et al.*, 2008; Palomo and Montes, 2011; Plieninger, Bieling, *et al.*, 2013; Reed *et al.*, 2013). Finally, there is also a claim in the literature that scenario planning exercises may foster social learning processes (Oteros-Rozas *et al.*, 2015; Brown *et al.*, 2016).

It is also worth mentioning that the literature on participatory scenario planning in the context of NRM overlaps with the literature on ecosystem services and drivers of change. Out of 62 research items reviewed (see section 1.4), in 40 (65%) authors used the term "ecosystem services", and in 41 (66%) researchers used the term "drivers", in the sense of drivers of change. The fact that participatory scenario planning is considered a practical tool to foster participatory management of natural resources, and deals with the concepts of ecosystem services and drivers of change, which are also topics of this research, justifies a deeper analysis of how this approach has been applied in current NRM literature.

1.6.3.1. Stakeholders' perceptions in participatory scenario planning

The combined use of the terms "perception" and "participatory scenario planning" in NRM literature is a recent phenomenon - a literature database search using these keywords (see section 1.4) retrieved publications from 2008 on. Although I recognize that the used keywords ("participatory scenario planning") may have restricted the search of all publications linking "perception" and "scenario planning", it still seems valid to say that this association is fairly recent, and has grown since 2008 (see Figure 1.2). Given that the study of perception is a vast field, with varying definitions and approaches, it seems valid to review how this term has been used in participatory scenario planning literature, especially how stakeholders' perceptions are identified in such exercises.

Sixty-two research items combining "perception" and "participatory scenario planning" in NRM context were retrieved from Scopus, ScienceDirect and Google Scholar databases (see section 1.4). The literature selected from the databases contained: research articles that described the application of participatory scenario planning, literature reviews of participatory scenario planning exercises, and other non-related research, in which the keyword "participatory scenario planning" was in the titles of references. Five publications were excluded from the review because they were grey literature (thesis), and did not address directly the topic scenario planning. All 57 remaining publications were reviewed according to its overall approach to perception (whether perception was defined or not, and whether it was reported as results or not).

Out of the 57 reviewed publications, 30 (53%) described individuals' perception as part of their results, however, none provided definition or specific framework on how perception was approached. Among the 27 publications (Table 4.3) that actually described the application of the scenario planning approach[5], 19 (70%) reported stakeholders' perceptions as part of their results, but did not provide a definition or explanation on which aspects of perception were being considered. This lack of definition may indicate that the concept perception has been used as

[5] Because the database search retrieved research items that contained the keywords anywhere in the main text (including references), the number of selected items (57) was higher than the number of publications that actually described the application of the scenario planning approach (27). Most frequently, the keywords "participatory scenario planning" were found in the references sections of the items which did not describe the actual application of scenario planning, as the approach was just mentioned. For further consultation, these are the 30 research items that were retrieved, but did not describe the application of a scenario planning exercise: Pahl-Wostl, 2008; Mitchell *et al*., 2010; Nelson, 2010; Daniel *et al*., 2012; Maliondo, Mpeta and Olson, 2012; Enfors, 2013; Palomo *et al*., 2013; Onaindia *et al*., 2013; Engle *et al*., 2014; Hetemäki, 2014; Milcu *et al*., 2014; Moreno *et al*., 2014; Nkoka, Veldwisch and Bolding, 2014; Vacik *et al*., 2014; Wise *et al*., 2014; Zorrilla-Miras *et al*., 2014; Kanwar and Thummarukudy, 2014; Nahuelhual *et al*., 2014; Sibanda, 2015; van der Zouwen *et al*., 2015; Graham *et al*., 2015; Leitch *et al*., 2015; Mcleod *et al*., 2015; von Bormann and Gulati, 2016; Mascarenhas *et al*., 2016; Burkhard and Maes, 2017; Cord *et al*., 2017; Vogler, Macey and Sigouin, 2017; de Kraker, 2017; Delgado-Serrano *et al*., 2017.

commonsense in the participatory scenario planning literature, and therefore this is a topic that deserves further investigation.

The aim of considering stakeholders' perception in participatory scenario planning exercises varied among the studies reviewed. Some studies reported that scenario planning exercises could foster a change in stakeholders' perceptions (Pert *et al.*, 2010; Quinlan, 2012; Schauppenlehner-Kloyber and Penker, 2015; Brown *et al.*, 2016), such as helping stakeholders in finding a common problem perception (Düspohl and Döll, 2016). Other studies considered stakeholders' perceptions as key for knowledge integration, co-production of knowledge, and learning (Harvey *et al.*, 2013; Reed *et al.*, 2013; Brown *et al.*, 2016; de Bruin, Kok and Hoogstra-Klein, 2017). Still, other studies considered stakeholders' perceptions as a critical component to enhance the plausibility of scenarios based on local perspectives (Oteros-Rozas *et al.*, 2015; Hertzog *et al.*, 2017; Johnson and Karlberg, 2017). Further development and examples of this variation can be found in Chapter 4.

The review of the recent literature on participatory scenario planning revealed that this approach has gained momentum in NRM research. This literature overlaps with the other two concepts explored in this thesis: ecosystem services and drivers of change. Finally, there is apparently a trend in including stakeholders' perceptions into this approach, however, there was an overall lack of definition on what authors mean by "perception". I believe that these findings support the last objective of my study, which is to investigate the applicability of the participatory scenario planning approach to consider stakeholders' perceptions of natural resources management. The result of this investigation is reported in Chapter 4.

1.7. Study site and methods

1.7.1. Study site

My PhD's field research was conducted in Paraty, one of the two municipalities that compose a region called Ilha Grande Bay, at the South of Rio de Janeiro state, Southeastern coast of Brazil (Figure 1.3). This region is located inside the remnants of the Atlantic Forest, a biome that extends along most of the Brazilian coast (see Figure 1.4). Within this area (however not restricted to it) live the *Caiçara* people[6], a mixed-heritage cultural group, descendent from Brazilian native groups, European colonizers, and African slaves (Begossi, 1998; Diegues, 2008). The aim of this subsection is to present a background about the Atlantic Forest in the study site and the Caiçara people. In particular, I review the history of changes in this social-ecological system with a special focus on major past changes described in the literature.

Scales of time and space are important elements when one is trying to understand changes in social-ecological systems. Therefore, for precision, some standardization regarding geographic area and corresponding spatial scale is necessary. In my research, community scale was used to refer to the village of Tarituba; local scale was used to refer to the Ilha Grande Bay; regional scale was used to refer to Brazil; and global scale was used to refer to supra national phenomena. With regards to temporal scales, I used the construction of the highway (BR-101) as a time reference because research participants referred to events before and after the construction of the highway, which occurred in 1970. In order to address some of the past important events that occurred at local scale, I reviewed the literature about the economic cycles of the Ilha Grande Bay, the transformations of the Atlantic Forest in the area, and changes in cultural aspects of the Caiçara people.

[6] Although other social groups live in this area, such as *Guarani* (an aboriginal group) and *Quilombolas* (people of settlements created by refugee slaves inside the forest), my research focused on Caiçara.

For my review, I explored some of the literature on Atlantic Forest, Caiçara people, and the history of Ilha Grande Bay. In the first subsection I describe the Atlantic Forest, one of the world's biodiversity hotspots for conservation (Myers *et al.*, 2000; Metzger, 2009). In the second subsection, I describe the Caiçara people and their interactions with the Atlantic Forest. Lastly, I investigate the main changes described about the past of the Ilha Grande Bay and the potential drivers responsible for such changes, according to the literature.

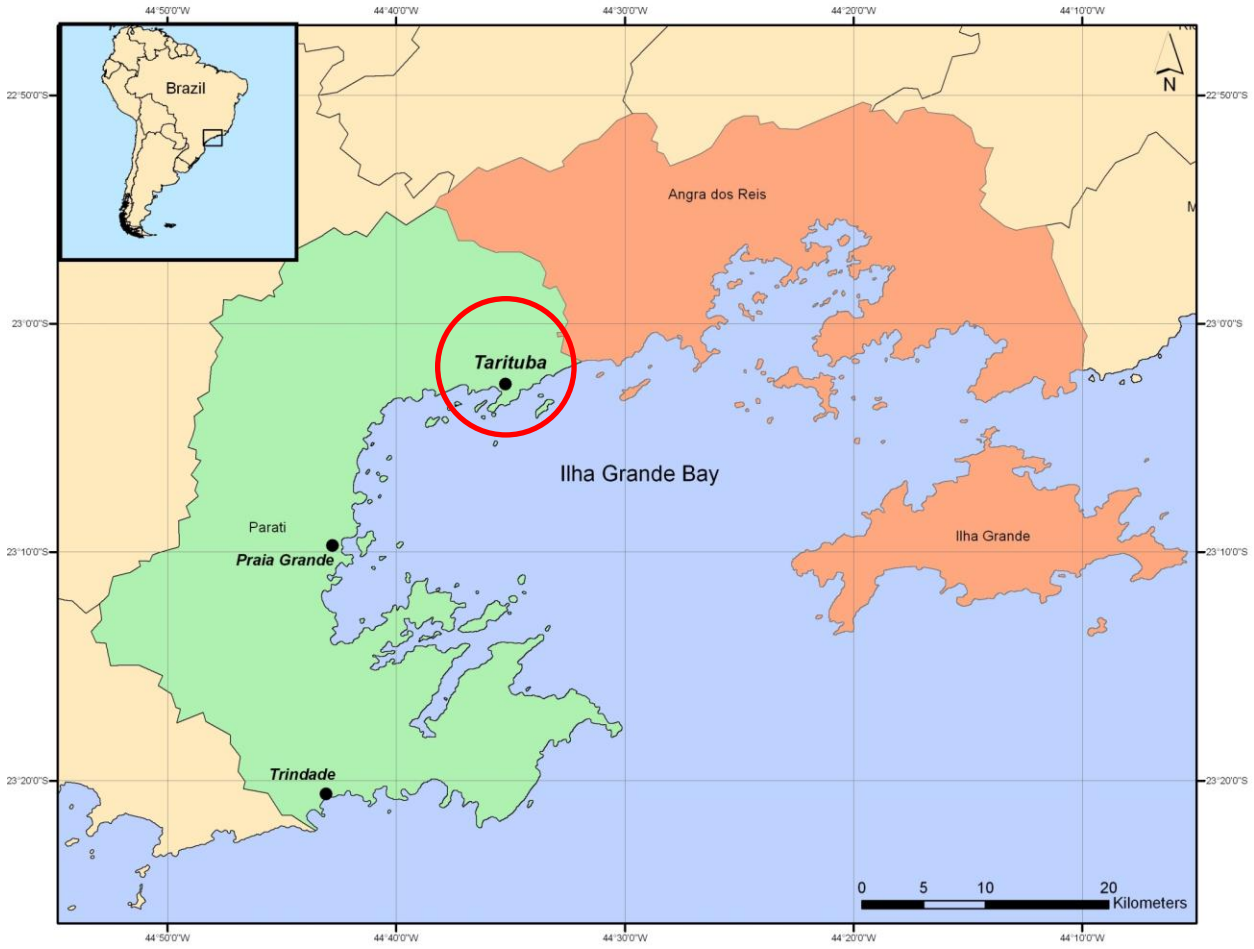

Figure 1.3 - Map of the study area. Paraty (green) and Angra dos Reis (orange, including the Ilha Grande island) compose the Ilha Grande Bay. The red circle indicates where Tarituba is located.

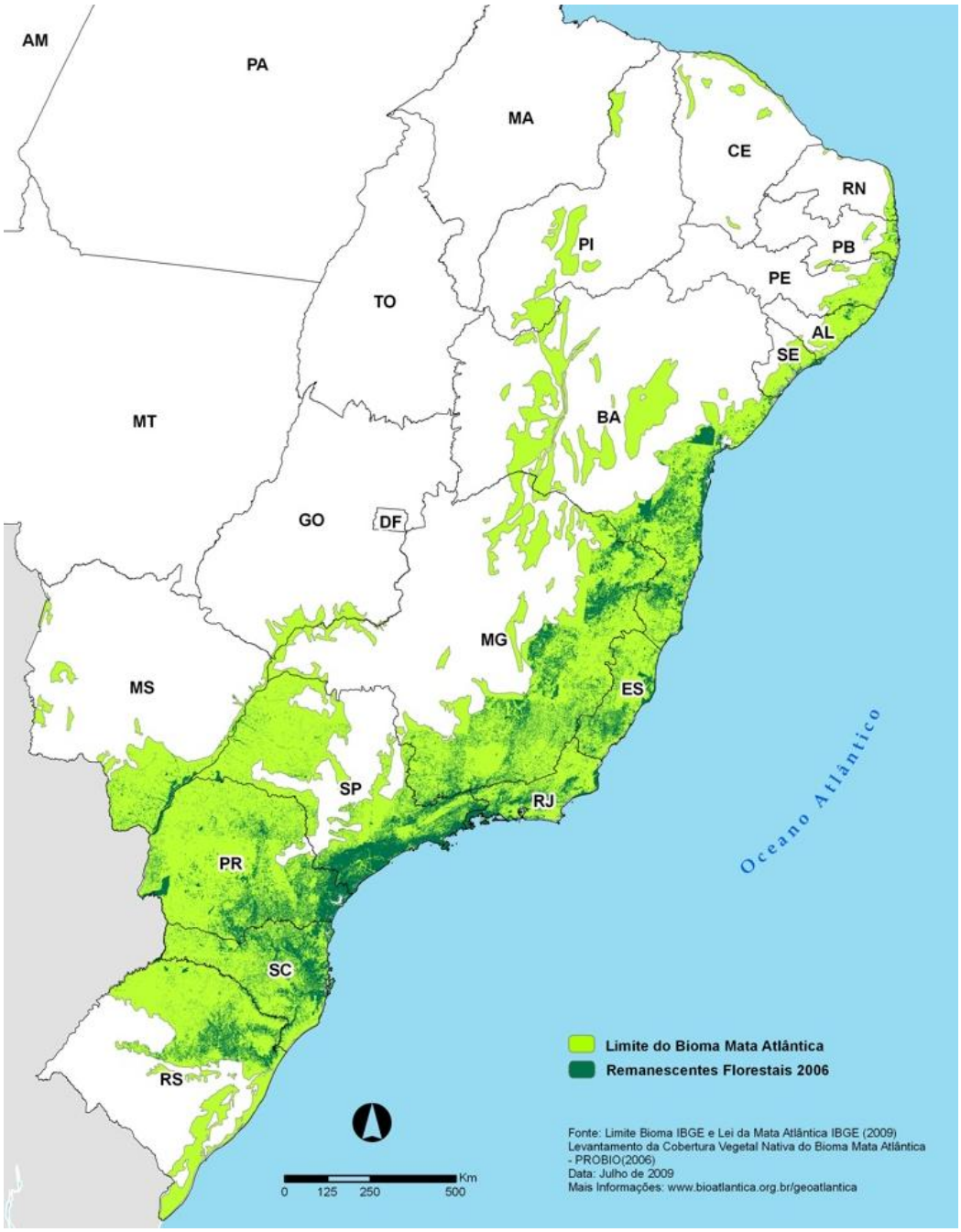

Figure 1.4 - Map of the remnants of the Atlantic Forest in Brazil. In light green is represented the area occupied by the Atlantic Forest biome, and in dark green is represented the area that remains as forest in 2006. Source: ONG IBIO - Instituto Bioatlântica. Authorization to reproduce this map can be found at: http://www.bioatlantica.org.br/creditos.asp (retrieved Jun 2010).

1.7.1.1. The Brazilian Atlantic Forest

When European colonizers arrived in South America around the year of 1500, they found an exuberant forest on the east side of the continent. At that time, the Atlantic Forest covered approximately 1,480,000 km2 (17.4% of the Brazilian territory - Metzger, 2009), and encompassed a variety of topographic and climatic conditions, ranging from 3^{o}S to 30^{o}S along the Atlantic coast, and from the sea level up to 2700m, which also included portions of Paraguay and Argentina (Ribeiro *et al.*, 2009). This heterogeneity in habitats is responsible for species diversity and endemism higher than most Amazonian forests (Morellato and Haddad, 2009). For example, 8,000 of the over 20,000 plant species and 567 of 1,361 vertebrate species identified are endemic (Myers, 2000). However, it is estimated that only 7 to 12% of the area of the original forest cover still remain (Figure 1.4) (Ribeiro *et al.*, 2009; Morellato and Haddad, 2009). Because of Atlantic Forest's high number of endemic species and extraordinary rate of habitat loss, it is considered one of the 25 world's hotspots for biodiversity conservation (Myers, 2000).

Currently, remnants of the Atlantic Forest are fragmented in over 245,000 areas, most of them (83.4%) smaller than 50 ha (Ribeiro *et al.*, 2009). The largest fragments of the Atlantic Forest in Brazil are located on the mountain slopes of *Serra do Mar*, along the coast of the states of São Paulo and Rio de Janeiro (Ribeiro *et al.*, 2009). Interestingly, this region is the most populous portion of Brazil (approximately 41.9% of the population living in 10.8% of the territory, according to 2009 census - http://www.ibge.gov.br/home/, retrieved May 2013), which includes two of the largest urban centres of Latin America, São Paulo and Rio de Janeiro.

Along with the terrestrial variety of landscapes, a diversity of coastal and marine ecosystems is found along the Brazilian Atlantic coast. These ecosystems include coral reefs (mainly in the Northeast region), mangroves, coastal lagoons, barrier islands, restingas, dunes, one upwelling area in Cabo Frio (Rio de Janeiro state), sandy beaches, and rocky coasts

(Diegues, 1999). This diversity of habitats is also reflected in a high diversity of living organisms. For example, an inventory of marine organisms, financed by the Ministry of Environment in Brazil (*Ministério do Meio Ambiente*), identified only in the Ilha Grande Bay, 905 species within 7 groups studied[7] (Creed, Pires and Figueiredo, 2007).

The history of human exploration, occupation, and land use are the main factors behind the habitat fragmentation observed in the Atlantic Forest. At the beginning of the colonization in the XVI century, the *Pau-Brasil* tree (*Caesalpinia echinata*) was the first and main species explored at large scale to be used as red dye in Europe (Metzger, 2009). Later, the decimation of the forest continued for timber, firewood, charcoal, agriculture, mining, cattle ranching, and urban development (Morellato and Haddad, 2009).

The arrival of European colonizers accelerated exponentially the Atlantic Forest fragmentation. Likewise, the arrival of Europeans marked the beginning of the decimation of Atlantic Forest's native inhabitants, which caused the extinction of a great part of the cultural diversity that once existed. It is estimated that by the time of the arrival of Europeans, 1 to 10 million people inhabited Brazilian territory, and more than 1,300 dialects were spoken by different groups. Today, the best estimate of the total population of "índios" in Brazil is 460,000 (FUNAI - http://www.funai.gov.br/funai.htm; retrieved Jun 2010). However, the mixing of native South-Americans, Europeans, and later on African peoples (who were brought to Brazil to work as slaves) originated a distinct cultural group along the coast of Paraná, São Paulo, and Rio de Janeiro states, the Caiçara. The next topic will provide more details about this mixed-heritage group and its co-evolution with the Southeastern Atlantic Forest.

[7] The inventory identified: 111 species of Macroalgae, 26 species of Cnidaria, 378 species of Mollusca, 113 species of Polychaeta, 60 species of Crustacea, 27 species of Echinodermata, and 190 species of fish from both sandy beaches and coral reefs (Creed, Pires and Figueiredo, 2007).

1.7.1.2. Caiçaras and the Atlantic Forest

The Atlantic Forest has co-evolved with human groups. Specifically to the study area, there are archaeological evidences showing that the Ilha Grande was occupied by a group of hunter-gatherers more than 3,000 years ago (Tenorio, 2006). By the time of the European arrival, several societies lived in the Atlantic Forest, traditionally grouped in two main cultural trunks, Tupi and Guarani. Many of those groups were exterminated, some escaped, and others were assimilated by the incipient Brazilian society (FUNAI - http://www.funai.gov.br/funai.htm; retrieved Jun 2010). The *Tupinamba* was the group who inhabited the area where Caiçara people live today (Begossi, Hanazaki and Tamashiro, 2002).

Caiçaras inhabit the Atlantic Forest along the coast of South and Southeastern regions of Brazil, more specifically in the coast of the Paraná, São Paulo, and Rio de Janeiro states (Diegues, 2008; Begossi, 1998). Their livelihood consists of small-scale fisheries, small-scale agriculture, and a growing participation in tourist-related activities and extraction of non-timber forest products (Begossi, 1998; Hanazaki *et al.*, 2007; Diegues, 2008). In short, Caiçara way of life and being results from (and co-evolves with) the occupation of the geographic area *between the sea and the land* (paraphrasing the title of Hanazaki *et al.*, 2007). Likewise the imposition of the terms "traditional", "indigenous", and "native", the designation "Caiçara" was created by outsiders to refer to this group of people (Adams, 2000). However, today, people from these communities call themselves Caiçaras.

The study of Caiçara's use of natural resources reveals important elements of the evolution of the Atlantic Forest. With regards to plant use, Caiçaras manage a wide variety of species for a variety of purposes, such as house construction, handcrafts, medicine, food, and canoe construction (Hanazaki *et al.*, 2007; Begossi *et al.*, 2002). A study that we conducted in

2009 in the region of Ilha Grande Bay, showed that artisanal fishers gather 110 ethnospecies of plants are from the forest, and cultivate other 73 ethnospecies in either home gardens or small-scale agriculture plots (Begossi *et al.*, 2010). Begossi and colleagues (2002), investigated Caiçara's plant use in different locations of the Southeastern coast, and found that of 227 species used, 44% were introduced and 38% were native (the other 18% consisted of invasive species with no defined category). These results show that Caiçara's mixed-heritage cultural practices (in this example cultivation of introduced species) have been changing the landscape and the structure of the forest, which has probably responded to those disturbances, co-evolving.

Another example of the co-evolution of Caiçara culture and the Atlantic Forest comes from the study of the Caiçara's swidden agriculture and cassava (*Manihot esculenta* Crantz) varieties. A legacy from the native Amerindian population and adopted by Caiçara communities, cassava varieties have been managed traditionally since their domestication 7,000 years ago (a full description can be found in: Peroni, Kageyama and Begossi, 2007). The most common form of cassava cultivation is the slash-and-burn of patches in the forest, which are cultivated for 1-2 years (generally by a family) and then left to fallow for some years (Peroni and Hanazaki, 2002). Emperaire and Peroni (2007) identified 53 to 58 genetically different varieties of cassava managed by Caiçara people. Restrictive environmental laws, among other factors (see next subsection), have contributed to Caiçaras' abandonment of their swidden agriculture, which may cause the loss of genetic variety of cassava, and also of other species cultivated within the agricultural plots, such as rice (Peroni and Hanazaki, 2002). In addition, the heterogeneity created in the landscape by the swidden/fallow cycles in patches could also be contributing to the resilience of the forest (Holling, 1973). In sum, the abandonment of this kind of agriculture may reduce the resilience of both Atlantic Forest and the Caiçara culture.

Marine resources also play an important role for Caiçara livelihoods. Fish is the main source of animal protein consumed by most Caiçara communities, especially those communities to some extent isolated from urban centres (e.g. Hanazaki and Begossi, 2000; MacCord and Begossi, 2006). However, MacCord and Begossi (2006) identified dietary shifts in one Caiçara community in which importance of fish seems to be diminishing, while importance of beef is increasing. In the region of Ilha Grande Bay, small-scale fisheries are important sources of subsistence for several communities (Begossi *et al*., 2010). Among the 73 marine ethnospecies used by artisanal fishers in that region, the most consumed are mackerel (*Scomberomorus cavalla*), croaker (*Micropogonias furnieri/Umbrina coroides*), grouper (*Epinephelus marginatus*), weakfish (*Cynoscion* spp.), and bluefish (*Pomatomus saltatrix*). And the most important species for market purposes are mackerel, snook (*Centropomus* spp.), shrimp (various species), croaker, and grouper. Interestingly, one ethnospecies (peixe porco, *Monachantidae*) is also used as a medicine (Begossi *et al.*, 2010).

1.7.1.3. Ilha Grande bay

In my research, I focused a small portion of the Atlantic Forest biome, the Ilha Grande Bay ($22^{o}50' - 23^{o}20'$S, $44^{o}00' - 44^{o}45'$W; Creed *et al.*, 2007), which is located between two of the largest urban centres in Brazil: approximately 260 km from Rio de Janeiro and 310 km from São Paulo. Paraty and Angra dos Reis are the two municipalities that compound Ilha Grande Bay (Table 1.1 resumes population and territorial data of the two municipalities). Several small Caiçara communities live in the different "praias" (beaches), or villages, neighbourhoods both in the main land and in some of the 197 islands of the bay. Following Köpper-Geiger international classification, the climate is considered Cwa, with dry winter and hot summer (Peel, Finlayson

and McMahon, 2007). The annual average temperature is around 24^{o}C (www.litoralcostaverde.com.br; retrieved Jun 2010), and annual average precipitation is approximately 2,150 mm (Oliveira *et al.*, 2007).

Table 1.1 - Population and territorial area of Ilha Grande Bay, and data separated by municipalities of Paraty and Angra dos Reis.

	Paraty	**Angra dos Reis**	**Ilha Grande Bay**
Population in 2009	35,730	168,664	**204,394**
Territorial area (km^2)	928	800	**1,728**

Source: IBGE (http://www.ibge.gov.br/, retrieved May 2014)

Similarly to other areas of Atlantic Forest, Ilha Grande Bay has faced changes since the arrival of European colonizers. The economic cycles in this region may have contributed to the shaping of this social-ecological system. During the XVI century, the beginning of the colonization, the main product explored in the Atlantic Forest was the "pau-brasil" (Brazilwood). From Brazilwood's core was extracted a red pigment, ideal to dye fabric, which was traded in Europe by the Portuguese. During this economic cycle, some of the pre-Columbian societies were turned into slaves to work on the extraction of Brazilwood. The Brazilwood exploration cycle was followed by the sugarcane and coffee cycles.

According to Teixeira (2006), sugarcane agriculture started in the Ilha Grande Bay at the beginning of the XVIII century and lasted until the first half of the XIX century. The importance of Ilha Grande Bay for this economic cycle can be exemplified by the more than 250 sugarcane processing plants that have existed in Paraty (http://www.paraty.com.br/historia.asp; retrieved Jun 2010). As a legacy of this period, Paraty is still known for producing good "*aguardente*" (a liquor produced from sugarcane). Coffee agriculture, on the other hand, started a little later, in the second half of XVIII century, and declined around 1890. During this period, the landscape of the Ilha Grande Bay changed from a forest to predominantly rural with several farms along the

lowlands. However, the mountain slopes of the *Serra do Mar* continued predominantly unexplored, mostly because of its declivity (Adams, 2000).

During the XVIII century, at the same time that Ilha Grande Bay was integrated into European trading by the ocean, it was integrated with the interior of the country. The *Caminho do Ouro* (Golden Pathway), a trail linking Paraty and the gold mining fields in Minas Gerais, was the main pathway used to transport gold and export it to Europe (http://www.paraty.com.br/historia.asp). This cycle was interrupted at the end of the XVIII century, when a new path was opened linking the gold mining fields directly to Rio de Janeiro, because of constant pirate attacks in Paraty. Therefore, the integration with the European market during the first centuries followed by colonization was the main driver causing changes in this social-ecological system.

The XIX century was marked by the importance of Ilha Grande Bay as a landing point for Africans brought to work as slaves in the sugarcane and coffee farms (Teixeira, 2006). Slave traffic was a highly profitable business at that time. However, by the end of the XIX century, coffee production begun to decline, marking the end of the farming cycles. This decline was driven by various factors, such as the abolishment of slavery in 1888, the difficulty of material outflow along the coast, and the consequent out-migration of farmers to inland areas, where they found an even richer soil to produce coffee (Teixeira, 2006; Adams, 2000). According to Adams (2000), this process of depopulation of the coast favoured the formation of small population nuclei. During this period, cassava flour and *aguardente*, were the most important local products (Adams, 2000). Until that time, fishery was not explored commercially, only for local consumption purposes (Teixeira, 2006; Adams, 2000).

Technological changes during the first half of the XX century facilitated the development of fisheries as a form of economic production in the Ilha Grande Bay. During the period of 1920-1930, the introduction of motor boats and fish corrals (brought by the Japanese immigrants) turned fisheries into a more efficient form of economic production (Diegues, 2008; Teixeira, 2006; Adams, 2000). Those technological changes in fisheries seem to have contributed to the abandonment of farming and the intensification of fisheries as the subsistence model (Adams 2000). Adams (2000) consider the introduction of motor boats as a major driver of change in the social identity of the Caiçara people, in which many of the former farmer-fishers (or fisher-farmers) started to spend most of their time only in fisheries.

This change towards an intensification of fisheries and partial abandonment of agricultural plots during the decades of 1930-1960 triggered the first steps of forest regeneration over the previous agricultural fields (Diegues and Nogara, 1994). During the decade of 1960, the national government started to subsidize the development of industrial fisheries along the coast. However, according to Teixeira (2006), the expansion of the industrial fisheries at the Ilha Grande Bay only developed after the construction of the *Rio-Santos* highway (BR-101) in 1970, which allowed the fish harvest to flow to the main urban centers. During the 1970-80 decade, the focus of the national government was on tourism development along the coast of Rio de Janeiro and São Paulo, which resulted in the construction of the Rio-Santos highway. Many authors point to the construction of the BR-101 as the main driver of accelerated urbanization and the beginning of land speculation in this region (Diegues, 1995; Adams, 2000; Teixeira, 2006).

Since the construction of the Rio-Santos, Ilha Grande Bay has become a main touristic destination. At the same time the growing conservationist discourse resulted in the implementation of several protected areas (PA) in this area. In 2014, 11 PAs overlapped with the

boundaries of the Ilha Grande Bay (Table 1.2). These protected areas are governed at municipal to federal scales with varied degrees of restriction for resource use and occupation. The increasing awareness about environmental protection by the government, which resulted in the creation of several PAs (without the proper participation of local communities; Oliveira, 2010), is another factor causing changes in this social-ecological system (Diegues and Nogara, 1994). The creation of protected areas restricted agricultural practices, which allowed the regeneration of the forest. At the same time, the creation of the Protected Areas along with subsides for fisheries pushed Caiçara people to a growing dependence on fisheries as subsistence model.

Table 1.2 - Protected areas overlapping with the boundaries of the Ilha Grande Bay.

Name of Protected Area	**Type**		**Law number/year**	**Government level**
	Type (Brazilian terminology)	***IUCN Category***		
Parque Nacional Serra da Bocaina	National Park	II	Federal Decree - nº 68.172/1971	Federal
Parque Estadual Marinho do Aventureiro	State Park	II	State Decree - nº 15.983/1990	State
Parque Estadual da Ilha Grande	State Park	II	State Decree - nº 15.273/1971	State
Estação Ecológica de Tamoios	Ecological Station	IV	Federal Decree - nº 98.864/1990	Federal
Reserva Ecológica da Juatinga	Ecological Reserve	Ia	State Decree - nº 17.981/1992	State
Reserva Biológica da Ilha Grande	Biological Reserve	Ia	State Decree - nº 9.728/1987	State
Reserva Biológica da Praia do Sul	Biological Reserve	Ia	State Decree - nº 4.972/1981	State
Reserva Particular do Patrimônio Natural O Saquinho do Itapirapuã	Private Reserve	V		Private
APA do Cairuçu	Area of Environmental Protection	V	Federal Decree Nº 89.242/1983	Federal
APA da Baia de Paraty e Saco do Mamanguá	Area of Environmental Protection	V	Municipal Law - nº 685/1984	Municipal
APA dos Tamoios	Area of Environmental Protection	V	State Decree - nº 9.452/1986	State

Sources: www.ibama.gov.br (retrieved June 2010); http://www.inea.rj.gov.br/legislacao/conteudo.asp (retrieved June 2010); Diegues, 2008.

The construction of the BR-101 along with other large construction projects, such as the shipyard *Verolme*, the nuclear power-plant Angra I, the oil port of Ilha Grande (named as *TEBIG*), and the port of Angra dos Reis, have caused several changes mainly for the mangroves and restinga forest in the Ilha Grande Bay. Along with the land-cover change, industrial and domestic pollution have also been causing ecosystem changes. For example, the imposition of male characteristics in female individuals (imposex) has been found in three species of neogastropods within the Ilha Grande Bay (Pessoa *et al.*, 2009). Imposex is caused by TBT (tributyltin), a chemical compound used in paints designed to protect boats from corrosion.

Tourism expansion may also have contributed to livelihood changes faced by Caiçaras. At the same time that land speculation created incentives for Caiçaras to sell their lands and move to the larger cities (generally to the poorest areas of those cities), tourism created new opportunities of income for those who remained in the area, such as renting their house for tourists, housekeepers, construction, and restaurants. Although those jobs were created, most of them are enterprises carried on by wealthy people or companies that come from other parts of Brazil, or from other parts of the world. In addition, land speculation has caused Caiçaras to "move up on the mountain", because houses and "*ranchos de pesca*" (tents used to store fishing boats and equipments) located by the shoreline are bought by outsiders and adapted to small hostels (or "pousadas") (Nayak, Oliveira and Berkes, 2014). Idrobo, Davidson-Hunt and Seixas (2016) proposed that even the term Caiçara has been shaped according to different political discourses (and interests as those from the tourism sector or environmental agencies), which end up occluding the discourses of Caiçaras themselves.

In Table 1.3, I summarize the main social-ecological transformations in Ilha Grande Bay, as described in the literature I reviewed. I also summarize the potential drivers of such

transformations. One can notice that the majority of the causes of changes described in the literature are external causes. For example: the international trade of brazilwood, sugar, and coffee; the national policies for fisheries and tourism development; and the creation of protected areas for environmental conservation.

Table 1. 3 - Major changes and drivers of changes in the social-ecological system of Ilha Grande Bay, according to the literature reviewed.

Period	Major changes	Possible drivers
XVI –XVII centuries	- Landscape change: Brazilwood extraction; - Native inhabitants are killed, turned into slaves, and mixed with the incipient Brazilian society.	- Arrival of colonizers; - Trade of Brazilwood with Europe.
1701-1750	- Forest to farm - Beginning of sugarcane agriculture in the Ilha Grande Bay	- Trade with Europe.
1751-1800	- Forest to farm - Beginning of coffee agriculture in Ilha Grande Bay	- Coffee market in Brazil and Europe.
1801-1850	- Arrival of Africans	- Traffic of slaves to work in both local farms and in the gold mining in Minas Gerais.
1851-1900	- Decline of coffee agriculture (1890); - Out-migration of farmers.	- Difficulty for production outflow; - Abolishment of slavery.
1901-1920	- Initial steps of forest regeneration and formation of small nuclei based on subsistence species (cassava and sugarcane);	- Economic stagnation.
1921-1940	- Increasing role of fisheries over agriculture – land cover change	- Introduction of motor boats and *cercos* (pound nets or set nets) by Japanese immigrants.
1941-1960	- Increased abandonment of agriculture	- Increasing opportunities to work in industrial fisheries in other regions.
1961-1970	1967 – development of industrial fisheries in the Ilha Grande Bay.	- Government subsidies to industrial fisheries.
1971-1980	- Landscape change – construction of Hotels and "pousadas", and industries; - out-migration of local people to the periphery urban centres; - Destruction of mangroves;	- Government incentives for tourism development, including the construction of the road "Rio-Santos" linking the cities of Rio de Janeiro and Santos along the coast; - Creation of the protected areas.
1981-1990	- Decline of fish stocks and conflicts between artisanal and industrial fishers.	- Intensification of fisheries by industrial fleets coming from other regions to fish inside the Ilha Grande Bay.
1991-2000	-Terrestrial landscape predominantly forested and marine stocks with signs of depletion; - Intensification of tourism in Ilha Grande.	- Dismantlement of the maximum security prison Candido Mendes (1994).
2001-2010	- Conflicts between local communities and environmental agencies.	- Intensification of enforcement in protected areas; - Fish stocks decline.

1.7.1.4. *Tarituba*

During my fieldwork, I chose a village to study individuals' perceptions of changes at the community and individual scales. Tarituba was chosen because of previous work conducted in the area (Begossi *et al.*, 2010), which identified that Tarituba differed from other Parati's villages because of its relatively higher average income from fisheries, and for its conflicts with protected areas, especially with the ESEC Tamoios (Oliveira *et al*., 2010). Tarituba is a village located at 32 km from Paraty city on highway BR-101 towards Angra dos Reis. According to local sources, around 800 to 1000 people live in Tarituba. Hanazaki and colleagues (2013) surveyed the livelihood activities in Tarituba and other villages in the municipality of Paraty, and found a diversity of activities based on local resources, tourism, and private sector. Frequently, individual households tended to show a diversity of livelihood activities.

As part of the development of a nuclear power plant in Angra dos Reis (about 15 km from Tarituba), the federal government created in 1990 the "Estação Ecológica de Tamoios" (Ecological Station of Tamoios), a very restrictive protected area encompassing 29 geographical landmarks (including islands, islets, and rocky formations), and their surroundings (1km) – a total area of 8,699.7 ha. This category of protected area, according to Brazilian law, does not allow any kind of use or extraction of resources within its boundaries (it corresponds to IUCN Ia category). Access is allowed only for scientific purposes. In the cove where Tarituba is located, there is an island called "*Ilha Comprida*" (Lengthy Island), which is one of the protected areas of ESEC Tamoios. This island used to be a traditional fishing territory for fishers in Tarituba (Begossi *et al.*, 2010), and after the implementation of the protected area, access is forbidden.

This is one example of the conflicts that exist between community members and the environmental enforcement agencies in the area.

Despite the prohibitions imposed by the environmental laws, many activities related to natural resources use are practiced in Tarituba. Along with subsistence activities, cultural activities are also evident in Tarituba. Groups of music and dance, local artists, folklore and religious events are announced in the festival calendar of the community, and local food and recipes are served in homes and restaurants., all of which suggest a culturally alive village. The ubiquity of these cultural events also drew my attention, and I devoted a generous amount of effort gathering information about such events in order to understand their relationships with changes in the social-ecological system. Most of these findings are discussed in Chapter 2.

1.7.2. Methods

1.7.2.1. Background and theoretical framework

Individuals' perceptions and the process of documenting what people perceive as changes, causes of changes and future opportunities are of paramount importance to the field of NRM. In order to access perceptions, researchers have recommended the qualitative approach (Patton, 2002; Creswell, 2009; Stake, 2010). The interdisciplinary nature of the research in Natural Resources Management allowed me to look for approaches, data collection instruments and analysis' methods suitable to study such processes. In this study, the main sources of data are verbal reports from research participants. Therefore, this research deals with personal dimensions which are not measurable. As a result, in this qualitative analysis, I do not intend to formulate laws or generalizations; rather, my focus is on the understanding of people's reports when talking about changes in social and ecological domains. In order to do that, I did not focus on

numeric precision, which is the goal of quantitative approach; instead, I kept methodological rigour to understand phenomena which are not quantifiable, such as feelings, opinions and beliefs about the research themes (Martins and Bicudo, 1989).

Qualitative research relies primarily on human perceptions and understandings (Stake 2010). In qualitative research, "*the researcher collects open-ended, emerging data with the primary intent of developing themes from the data*" (Creswell 2003:18). Some of the special characteristics of a qualitative study, as described by Stake (2010), are: it is interpretive - it keys on the meanings of human affairs as seen from different views; it is experiential, field oriented and empirical; it is situational; and it is personalistic - it is empathetic, working to understand individual perceptions. It seeks uniqueness more than commonalities. It honours diversity. Since the 1990's there has been a steady growing number of publications that use qualitative approaches (Carrera-Fernández, Guàrdia-Olmos and Peró-Cebollero, 2014), which have contributed to the assessment, refinement, and improvement of qualitative data collection and analysis procedures.

In my research, I did not intend to make generalizations about the relationships people have with their environment in Tarituba. Likewise, I did not try to confirm if the verbal reports I collected described an "actual" event in the real world. My intention was to study individuals' perceptions about changes, as well as causes of such changes, in social-ecological systems. In that sense, the present study differs from most of the literature I reviewed on ecosystem services, drivers of change and scenario planning (see section 1.6). While most of the reviewed literature aims at identifying concrete entities (for example, *the* ecosystem services, *the* main drivers of change in a given location, *the* uncertainties that could shape the future of a region), my focus of study is the *perception* of social-ecological relationships and changes in those relationships. For

the purpose of this study, a given verbal report of a research participant (for example, "there was more fish in the past") is not judged against empirical studies. My object of analysis is the verbal report as it is presented, which is subsequently analyzed to disclose that individual's perception as gained from his or her experience of his or her environment. Describing the narrative method in a qualitative approach, Connelly and Clandinin (1990:7) wrote: "*Like other qualitative methods, narrative relies on criteria, other than validity, reliability, and generalizability. The language and criteria for narrative inquiry are under development*". Thus, my study may contribute to the development of qualitative, narrative approaches and methods in NRM research.

The main theoretical basis I used to guide my methodological approach can be found in the book "The Government of Self and Others" (Foucault, 2010), in the lecture of January 5th, 1983 (first hour), where M. Foucault describes his method of research[8]. In order to reach an understanding about research participants' perceptions of changes in social-ecological systems, I start with a process of interview. With the interview, I collect *what is known* (verbal reports) about my research topics of interest (values and relationships people have with their

[8] "These three elements—forms of a possible knowledge, normative frameworks of behavior, and potential modes of existence for possible subjects—these three things, or rather their joint articulation, can be called, I think, "focal point of experience." Anyway, this was the perspective in which, a long time ago, I tried to analyze something like madness, which, for me, was not to be taken as an unchanging object throughout history on which systems of representation with variable representational functions and values have been brought to bear. Nor, for me, was this history a way of studying attitudes towards madness that may have existed down the centuries or at a given point in time. Rather, it involved trying to study madness as experience within our culture, and grasping madness, first of all, as a point from which a series of more or less heterogeneous forms of knowledge were formed whose forms of development had to be analyzed: madness as the matrix of bodies of knowledge which may be of a strictly medical nature, but which may also be psychiatric, psychological, sociological, and so on. Second, to the extent that madness is a form of knowledge, it was also a set of norms, both norms against which madness could be picked out as a phenomenon of deviance within society, and, at the same time, norms of behavior for normal individuals, for doctors, psychiatric personnel, and so on in relation to this phenomenon of madness. Finally, third, this perspective involved studying madness insofar as this experience of madness defined the constitution of a certain mode of being of the normal subject, as opposed to and in relation to the mad subject. It was these three aspects, these three dimensions of the experience of madness (form of knowledge, matrix of forms of behavior, constitution of the subject's modes of being) that I more or less successfully and effectively tried to link together." Foucault (2010:3).

environments, changes in natural resources use and social organization, and the drivers of those changes). At that step of the research, the data collection instrument used was the informal interview, which will be described in detail later. Second, I analyze the reports I collected. In order to accomplish this step, I used the analysis of verbal reports in order *to reveal the matrix that structures the diversity of discourses found*. Finally, I checked if the matrix found was able to accommodate all data collected in the interview process, a task I called *validation of what is known*.

A similar approach was presented by Martins, Boemer and Ferras (1990). According to these authors, the qualitative approach consists of three steps: the first one is reading the whole description of the studied phenomenon (in my research, all the verbal reports), without looking for any interpretation, specific elements or attributes, in order to reach a general understanding of the material; the second step is the coding process, which consists of re-reading the whole material focusing on the phenomenon that is under investigation, and apprehend the units of meaning; the third step is the classification of the units of meaning, which synthesize the themes of the descriptions in categories.

In a seminar lecture in 1989, Prof. Amadeu Giorgi also described a similar method of qualitative research (Bicudo, 1990), in four steps: the first step consists of reading the descriptions about a given phenomenon in order to identify the totality of the theme; the second step is to break the theme into units of meaning – a similar step to the coding described by Martins (1983); the third step is to describe the implicit meaning of the units identified; and the fourth step is to synthesize the units of meanings into categories.

The necessity of analyzing what is said in order to reach an understanding of perception relies on the fact that there is a difference between stimuli and perception. As demonstrated by

Kuhn (1974), a given stimulus, for example a number of combined different wavelengths can be perceived as a single color. Likewise, a single stimulus (a figure) can evoke different sensations depending on the recipient, for example one recipient perceives a duck, while another perceives a swan. Therefore, the verbal report (stimulus) does not necessarily represent a perception, because a perception is dependent on a vast amount of neural processing in order to happen. That means that the expression of a perception is mediated by learning processes (e.g. color names), and does not rely entirely on innate responses (Kuhn, 1974). The answer given during an interview shows what the individual has learned to express his/her perception, and not the perception itself.

1.7.2.2. Selection of participants and the interview process

Fieldwork was conducted from September 2010 to October 2011 in monthly trips to the study area. In total, I spent 161 days living in Tarituba (Table 1.4). Selection of interviewees is an important step of the interview process. Therefore, I would like to describe this selection in detail, as it started the first time I arrived in the village. During my first visit to the village of Tarituba, I had the company of one biologist colleague (V. Nora) who was working there, collecting data about the fishing landings and fish biology. This colleague introduced me to some of the fishers who were participating in his research. So, the first individuals I contacted in the village were fishers. Due to my previous experiences in field studies at coastal villages in Brazil (Oliveira, 2010; de Oliveira and Begossi, 2011; Oliveira, Barreto and Begossi, 2012), I knew that in those villages there are occupations other than fishers. According to Michelat (1981), in qualitative research it is paramount to choose the most diverse group of individuals to interview. Therefore, my goal was to contact (and later interview) the most diverse individuals from the village, and this diversity I measured by their occupations.

Table 1. 4 - Number of days living in Tarituba according to the month/year.

Month/Year	Days of the month	Number of days
September/2010	5th to 8th	4
November/2010	3rd to 19th	12
December/2010	7th to 12th	7
January/2011	5th to 22nd	18
February/2011	11th to 25th	15
March/2011	15th to 28th	14
April/2011	12th to 20th/29th to 30th	10
May/2011	1st to 2nd/16th to 31st	18
June/2011	11th to 25th	15
July/2011	1st to 7th/20th to 31st	18
August/2011	11th to 25th	15
September/2011	14th to 22nd	9
October/2011	14th to 19th	6
Total of days living in Tarituba		**161**

An important aspect of these initial approaches to potential research participants was introducing myself, explaining the reason of my presence there, and the general purpose of my study. During these approaches I respected the research participants' availability and willingness to engage in a conversation, as well as I behaved the least intrusively as possible. Of course the very fact of being a researcher in the village has its own intrusiveness, which should be considered. As a consequence, there were individuals who avoided contact with me, others that told me they did not want to participate in the research, but most people I contacted gave me their consent to be part of the research. Along with the willingness to participate in the research, there were some cultural issues that prevented me from interviewing some individuals, such as the fact that it was not considered appropriate to approach women when they were away from their partners. Additionally, I obtained consent from the president of the Community Association, and one letter explaining the objectives of the research was handed out to potential research participants (see copy in Appendix 1). In total, 38 participants were included in the data collection procedure.

Table 1.5 describes participants per occupation I included in the sample. Occupations included individuals whose livelihoods depend directly on local resources, such as fishers (including different fishing techniques, such as small-scale shrimp trawling, spear fishing, gillnet fishing, hook and line fishing), fish market or fish processing workers, and tourism entrepreneurs (owners of bars, restaurants, *pousadas*, souvenir stores, and boat tour operations); and individuals that live in Tarituba, but do not depend directly on local resources for livelihoods, such as an NGO member, public service staff, teachers, workers in the tourism sector in Paraty city or in Angra dos Reis (neighboring municipality), and industry workers, either seasonal or year-round. Industries that hire people from Tarituba include the nuclear power plant (Central Nuclear Almirante Álvaro Alberto), and the shipyard Estaleiro Verolme (which makes boats, ships, and oil exploration platforms construction/repair), both located in the neighbor municipality, Angra dos Reis.

Table 1.5 - Occupations, activities, age class and gender of the 38 research participants.

Participant	Occupation	Description of main activities	Age class	Gender
1	President of local NGO	President of local environmental NGO / aquaculture entrepreneur	51-60	M
2	Fish market owner	Fish market owner	51-60	M
3	Cultural curator	Organizes the group of local musicians and dancers	51-60	M
4	Community leader	President of community association	41-50	M
5	Municipal councillor	Municipal councillor of Paraty	41-50	M
6	Restaurant owner	Cook and sell meals, appetizers and drinks, mostly to tourists.	41-50	M
7	Free lancer	Day/wage free lancer	41-50	M
8	Small-scale fisher	shrimp trawling / vice-president fishing organization	41-50	M
9	Small-scale fisher	Hook and line fishing	61-70	F
10	*Pousada* (bed and breakfast) owner	Owns a souvenir store and a bed and breakfast	21-30	F
11	Small-scale fisher	Gillnet fishing	51-60	M
12	Restaurant owner	Cook and sell meals, appetizers and drinks, mostly to tourists	31-40	F
13	Small-scale fisher	Shrimp trawling	31-40	M
14	Ice-cream shop owner	Sells ice-cream	51-60	F
15	Environmental agency (ESEC Tamoios) staff	Manager of protected area	31-40	M
16	Public service staff	Environmental agent of municipality	21-30	M
17	Small-scale fisher	Gillnet fishing	51-60	M
18	*Pousada* (bed and breakfast) owner	Owns a souvenir store and a bed and breakfast	51-60	F
19	Small-scale fisher	Gillnet fishing	41-50	M
20	Small-scale fisher	Shrimp trawling	21-30	M
21	Public service staff	Firefighter	31-40	M
22	Tourist	Owns a house in the village	41-50	M
23	Community leader	Former president of community association	31-40	M
24	Sports fishing guide	Runs a boat tour operation	41-50	M
25	*Pousada* (bed and breakfast) employee	Works in a *pousada* (bed and breakfast) during touristic season	41-50	M
26	Small-scale fisher	Spear fishing	31-40	M
27	Free lancer	Day/wage free lancer	41-50	M
28	*Pousada* (bed and breakfast) owner	Owns a souvenir store and a bed and breakfast	21-30	F
29	Teacher	Teaches at the elementary school	31-40	F
30	Public service staff	Post office attendant	21-30	F
31	Engineer	Works for the nuclear power plant	21-30	M
32	Industry worker	Works for a phone and cable tv company	21-30	M
33	Small-scale fisher	Spear fishing	41-50	M
34	Restaurant employee	Works as waitress during the tourism season	21-30	F
35	Fish market employee	Fish market employee	61-70	M
36	Small-scale fisher	Retired	71-80	M
37	Small-scale fisher	Spear fishing	61-70	M
38	Small-scale fisher	*Parati* (mullet) fishing	41-50	M

Along with occupations of village dwellers, I also included individuals whose occupations were related to the village's natural resources management, such as municipal politicians, community leaders from other villages, and environmental agency staff. Along with individual interviews, I participated in public meetings related to natural resources management, scientific meetings, and a variety of cultural activities, such as community festivals, religious events, and recreational activities, in Tarituba and around the municipality. These observations were also registered and used as supplementary material for the analysis.

The overall approach for data collection was participant observation. Participant observation is considered a core strategic method in cultural anthropology (Bernard, 2011). Its use is recommended to build rapport, which helps to reduce the refractory effect that is naturally produced when conducting research with humans. Participant observation is considered a strategic method because it helps to create the necessary rapport to conduct other data collection procedures, such as informal/unstructured interviews and direct observation, and prompt research participants about activities that could not be observed otherwise. Participant observation puts the researcher in the position of collecting meaningful information (Bernard, 2011), which is paramount for qualitative research (Michelat, 1981).

Notwithstanding, participant observation has the potential to produce deception during the research process (Bernard, 2011). In the context of my field research, I prevented deception by being clear since the first contact with research participants, both verbally and in a written document (see Appendix 1), that I was a researcher and that I would be collecting data about their lives. I also respected those individuals who did not want to take part in the research process. Avoiding deception naturally creates a shortcoming for the generality of the results obtained (meaning that those individuals who were not included in the research process could

have different perceptions from those that agreed to participate), which should be considered by the reader of this thesis.

Interviews are used to collect data about a phenomenon that is difficult or even impossible to observe directly, such as opinions, beliefs, and ideas (Dunn 2005). During an interview, there is a direct exchange of verbal information between interviewer and interviewee (Dunn 2005). There are different styles of interviews with respect to the degree of structure (or the amount of control - Bernard, 2011) imposed by the researcher (Berg, 2004), ranging from informal interviews (where there is a focus on listening to what research participants tell, with no or little probing) to completely structured questionnaires (in which the topics, the wording, and the order of questions, are defined by the researcher), as they suit different research objectives (Newing *et al.*, 2010). Given my research objectives, the type of interview chosen was the informal interview.

Informal interviews lack a structure or control of the researcher over the interviewees (Bernard, 2011; Newing *et al.*, 2010). As described by Bernard (2011:211), in informal interviews, "*[t]he researcher just tries to remember conversations heard during the course of a day in the field. This requires constant jotting and daily sessions in which you sit at a computer, typing away, unburdening your memory, and developing field notes*". Although informal interviews lack a structure, Newing (*et al.*, 2010) considers part of the informal interview process, "*encouraging [people] to say more when they mention something that is particularly relevant to your research*" (p.99). Therefore, informal interviews provided me with the necessary tool to gather verbal reports about the key topics of interest in my research (values and relationships people have with their environment; changes in natural resources use and social organization; and drivers of those changes), as they emerged during the interview process.

Given that the purpose of my study was to understand how people perceive changes in their social-ecological system and the causes of those changes, the first step was to learn what, in Tarituba, was important for research participants. Therefore I could not ask about characteristics I considered (personally or academically) important, which hindered me from using a set of pre-defined questions about types of social-ecological relationships, key social-ecological changes, and the drivers of those changes. According to Michelat (1981), non-directive interviews confer research participants a degree of freedom (of course relative given the presence of the researcher) that facilitates the emergence of information from deeper levels than those that emerge from a questionnaire (structured interviews). This profound socio-affective information that emerges from non-structured interviews is the type of information necessary to access individual's perceptions.

During my fieldwork, I experienced a diversity of events, situations, and conversations with research participants. A qualitative field research is a full time job, and the simple action of doing groceries at the local market can lead to data collection, given that I could meet a research participant and start a conversation. As a consequence, the number as well as the length of informal interviews varied among research participants. Some participants I interviewed more than once (for example, with one of the participants, I had 17 interview instances during my fieldwork), while other participants I interviewed only once. The length of interviews also varied from as short as five minutes to as long as one hour. I understand this diversity as a reflex of the very nature of the relationships I developed with research participants. Also, I was always aware that although my research process was very important for me, life and activities of research participants had to be respected, far beyond the constraints of my schedule. I registered 107 interview instances, a total of 2290 minutes (average 21 min per interview instance). Interviews

were registered in Portuguese (native language of both researcher and participants) as soon as they finished, and no audio-recordings were used. Along with the interviews, daily field activities were registered as field notes, which were used as a complementary source for data analysis.

1.7.2.3. Data analysis: revealing the matrix that structures what is known

During my fieldwork, I kept a daily written report of my activities and interviews. This report was written every night. However, whenever an interview instance happened, I would go back to the room I was renting to register that information as soon as possible. So, by the end of fieldwork, I had a written document containing both interviews' transcripts and field notes. Therefore the first step for data analysis was to separate transcripts regarding participants' interviews from the ones regarding field notes. By the end of this process, I had 38 documents, each containing interview transcripts of each participant. Along with the interview transcripts per participant, I compiled a document in which I included all my field notes - my observations, perceptions and thoughts. This separation was important to discriminate my own feelings, interests and observations from those of research participants, which is recommended in participant observation to reach an objective understanding of the observed phenomena (Bernard, 2011). After this separation, I started an exhaustive reading of these documents. Reading and re-reading these documents is part of a qualitative analysis's process called impregnation (Michelat 1981).

During the readings of the interview material, whenever I found a passage regarding my research themes, I marked that passage with a keyword in parenthesis. In this *coding* process, I took into consideration my three topics of investigation: reported human-environment

relationships (e.g. occupations, activities), reported changes, and drivers of those changes. For example, when I read a passage like: "*Over the last 30 to 40 years the forest of that slope has been recovering. That is why there are more birds coming to eat the bananas I put for them in my yard*" (Participant 3), I would put in parenthesis "change", "forest recover" and "more birds". The keywords informed me that there was a report about perceived changes and perceived drivers of change. In other passages, like: "*many people now work on tourism*" (Participant 4), I would code it as "change" and "tourism". Or when Participant 32 said that "*back in the past, snook used to come closer to the shore, where they were harpooned*", I would use the codes "harpoon fisheries" (relationship - fishing technique) and "change". This process of coding was conducted throughout all the interviews and field notes.

Along with the coding for reported changes and social-ecological relationships, whenever a passage referred to future aspirations, I would code that passage as "future", as it could be used on Chapter 4 about scenario planning. For example, when talking about the possibility of further urban development in Tarituba, Participant 33 said that "*it should stay as it is, this quietness*". Similarly, Participant 23 said that "*people want to preserve a quiet style of life*". These quotes were coded as "future".

As I mentioned earlier, my purpose was not to confirm or disconfirm if the reported changes or their drivers had actually happened in the "real world". Therefore, I did not look for empirical evidence to support statements like the ones described in the previous paragraph. Rather, my interest was in collecting the most diverse range of verbal reports about the themes I was researching, because my purpose was to investigate individuals' perceptions. The diversity of registered verbal reports about human-environment relationships, perceived changes, and perceived causes of changes compelled me to find tools that could help me to analyze this

diversity. The analysis of data collected in the interview process had the objective to reveal an underlying matrix that structures the diversity of verbal reports. The need to go beyond what is said in order to understand a phenomenon involving human beings is paramount in qualitative research (Tunes and Simão, 1998)

Given the interdisciplinary nature of the research in natural resources management, I founded my investigation on well-established methods of analysis of verbal reports. The main method I used is described in Tunes and Simão (1998), under the title "*Sobre a análise do relato verbal*". This method was used because it is based on a qualitative approach, and provides the tools to access individuals' perceptions. In order to identify the implicit perceptions from the verbal reports, I used the method of analysis described by Michelat (1981).

Succinctly, the tools presented by Tunes and Simão (1998) and Michelat (1981) consist of finding the *units of meaning* from the pool of collected verbal reports. For example, in Chapter 3, I analyze research participants' perceptions of causes of social-ecological changes. When I asked participants to talk more about what has caused the reported lack of fish, a common verbal report was: "shrimp trawling". The analysis of verbal reports consists of breaking this reported cause in its basic components. In this case, the "cause of change" reported (shrimp trawling activity) is, first of all, a fishing technique (therefore it contains a "behavioural" nature); also it is an economic activity (contains an "economic" nature), that happens in a "political" and "sociological" context, influenced by "administrative" reasons. These fundamental units of meaning (behavioural, economic, political, sociological, administrative) were the output of the analysis of verbal reports, since they could be used to specify the diversity of reports about causes of change.

1.7.2.4. Validation of data: checking the soundness of the analysis' output

The analysis of verbal reports provided material to understand research participants' perceptions of relationships they have with their environment, changes in social and ecological domains, and drivers of such changes. I presented the results of this analysis separately in Chapters 2 and 3. The description of the diversity of the research participants' perceptions of human-environment relationships and their changes are described in Chapter 2, as it addresses the first objective of the thesis: "to assess the extent to which the concept and categories of ecosystem services are able to accommodate the range of perceived human-environment relationships and their dynamic changes". The mere description of perceived human-environment relationships and their changes would not be an analysis per-se, and as such, would not be considered an analysis chapter. Therefore, I presented the description of these perceptions in comparison to an area of current NRM literature that aims to investigate and categorize such relationships, namely the ecosystem services' literature. To accomplish this task, I tested the capacity of the categories of ecosystem services (provisioning, cultural, regulating, and supporting services - MA, 2005a) to accommodate the material I collected.

In order to verify the soundness of the output obtained through the analysis of verbal reports, one needs to contrast all the reports obtained about one theme (for example, "causes of lack of fish", as presented in the previous subsection) with the fundamental units of meaning – the intermediate categories. This verification was conducted in Chapter 3. In order to do that, I listed, from the material I registered, all the verbal reports about causes of social and ecological changes from all research participants.

The procedures described under selection of participants and interview process, analysis of the verbal reports and validation of data were conducted for both Chapters 2 and 3. These

were the main data collection and analysis procedures upon which the results are based. In Chapter 4, I assessed if the analysis of verbal reports (especially for the identification of drivers of change according to individuals' perceptions) could be a contribution to another area in current NRM literature, participatory scenario planning.

1.7.2.5. Ethical considerations

All research involving human subjects must be approved by the University of Manitoba Research Ethics Board (http://umanitoba.ca/research/ors/ethics/human_ethics_index.html, retrieved in March 2010). The approval of the Research Ethics Board was obtained (protocol number #J2010:100 – Appendix 2). My research respected the right of free and informed consent of research participants. Oral consent was obtained from participants and no deception was involved.

CHAPTER 2. ECOSYSTEM SERVICES FROM LOCAL PEOPLE'S PERCEPTIONS[9]

2.1. Introduction

Different frameworks have been developed to study ecosystem services (e.g. MA, 2005; TEEB, 2010; Díaz *et al.*, 2015). Nevertheless, based on the literature review in Chapter 1, researchers have rarely identified ecosystem services based on research participants' perceptions about their relationship with their surroundings. Most of the studies referring to the perception of ecosystem services describe the opinion of research participants over a set of pre-defined list of ecosystem services (e.g. Raymond *et al.*, 2009; García-Nieto *et al.*, 2013; Zagarola, Anderson and Veteto, 2014; Castro *et al.*, 2016), and have not investigated *if* research participants perceive ecosystem services as defined by the literature (but see (Asah *et al.*, 2014 for exception). In spite of that, such studies are often recommended to inform natural resources management decisions (e.g. MA, 2005; Díaz *et al.*, 2015). So, the purpose of this chapter is to evaluate the capacity of the concept and categories of ecosystem services to accommodate the range of relationships people have with their environment in a coastal village (Tarituba, Municipality of Paraty, southeastern coast of Brazil), and to understand changes in these relationships.

The concept of ecosystem services has been used to integrate two areas related to natural resources management, ecology and economy (Daily, 1997; Costanza *et al.*, 1998; Farber *et al.*, 2006; Boyd and Banzhaf, 2007). One of the main references on this topic, "Nature's services: societal dependence on natural ecosystems" (Daily, 1997), was written with the pedagogic purpose of increasing public awareness about the value of ecosystem processes and the consequences of human interventions on them (Gómez-Baggethun *et al.*, 2010). Ecosystem

[9] A version of this Chapter has been published as a journal paper (Oliveira, L.E.C. and Berkes, F. 2014. What Value São Pedro's Procession? Ecosystem Services From People's Perceptions. *Ecological Economics* 107:114-121).

services were defined by Daily (1997) and by Costanza and colleagues (1997) as the full range of benefits that humans obtain directly or indirectly from ecosystem processes.

The annual average value of all the services provided by global ecosystems to human beings was estimated by Costanza *et al.* (1997) at US 33 trillion although the authors believe that this value is an underestimate. Since this publication, and especially after the publication of the Millennium Ecosystem Assessment (MA, 2003b), various ecological economists have attempted to quantify the combined values of ecosystem services (Boyd and Banzhaf, 2007; Barbier *et al.*, 2008; Reyers *et al.*, 2009).

Although the field of ecological economics has increased public awareness about the importance of ecosystem processes for the economy (such as the pollination of crops by honeybees), there are some limitations on monetary valuation approach. On the one hand, the economic modeling approach may overlook intrinsic values related to human well-being (such as spiritual, aesthetic, and recreational values) because such values do not fit the economic models usually employed to value ecosystem services. For this reason, some recent studies have called attention to the fact that intrinsic values of ecosystems have often been overlooked in the ecosystem services literature (Chan, Satterfield and Goldstein, 2012). On the other hand, the identification of the ecosystem services for a given location is mostly based on scientific (western) understanding of ecosystem functions and processes. Only a few studies have identified ecosystem services based on local peoples' perceptions (e.g.: Rodríguez, Pascual and Niemeyer, 2006; Berbés-Blázquez, 2012).

Kumar and Kumar (2008) pointed out the assumption that underlies the monetary valuation of ecosystem services: the attempt to measure the specific utility of a given ecosystem service for one individual, and then to combine the monetary values for all the individuals of a

society. However, "*the utility that an individual derives from a given ecosystem service depends on that individual's preferences*" (Kumar and Kumar, 2008:810). Therefore, the focus on monetary valuation approach to ecosystem services overlooks individual preferences and changes in values.

Another problem is the view of ecosystem services as "benefits", which creates an assumption that human beings are passive receivers of products and services from ecosystems. This assumption has been questioned in the literature of environmental change, and some authors have used the concept of agency (capacity of individuals to make their own free choices, and to act independently) in order "*to overcome the view of people as powerless victims of environmental change*" (Brown and Westaway 2011: 323). Therefore, along with the limitations of monetary valuation, the practice of ecosystem services may also be overlooking human actions, and perceptions of individuals about their relationships with the environment (Spangenberg *et al.*, 2014).

Based on the argument above, this chapter aims to explore the concepts and categories of ecosystem services, based on individuals' perceptions living within a coastal village in Brazil. The specific objectives are (1) to identify types of perceived relationships people have with their environment, and; (2) to assess the extent to which the concept and categories of ecosystem services in the current literature are able to accommodate the range of these relationships, and their dynamic changes. I conducted this assessment by trying to fill the categories described in MA (2005a) with the data derived from research participants' perceptions. The choice of the Millennium Ecosystem Assessment as the reference framework to assess concepts and categories rely on the fact that most of the literature which has addressed the perception of ecosystem

services uses the Millennium Ecosystem Assessment as their reference framework (see Chapter 1).

2.2. Methods

Fieldwork was conducted from September 2010 to October 2011. During this period, I spent 161 days (in monthly trips) living in Tarituba (Table 1.4). In order to identify individuals' perceptions about their relationship with the environment, I used a qualitative approach (Stake, 2010; Creswell, 2009; Tunes and Simão, 1998) in which participant observation was the overall data collection strategy (Bernard, 2011), and informal interviews were the main data collection procedures. Research participants were selected based on purposive sampling (Tongco, 2007; Bernard, 2011) to include the broadest range of occupations that could be found in the village. Along with the diversity of occupations (detailed in Chapter 1, section 1.7.2.2), I also registered a variety of cultural activities, such as community parties, religious events, and recreational activities. The purpose and objectives of the study were explained to potential research participants to obtain oral consent. In total, 38 participants were included in the data collection procedure.

The qualitative approach was used to gather data about the relationships individuals have with their environments as reported by research participants. The strategy of participant observation was conducted throughout the fieldwork, as it helped to build rapport with community members, and allowed me learn from the experience of taking part in daily activities. The main data collection procedure employed was informal interviews. Informal interviews suited the objectives of this study because they lack structure and control (Bernard, 2011), which allowed me to gather data on topics as reported by research participants. As the fieldwork progressed and research participants became used to my presence in the community, I began

collecting data on the themes I was interested in, which were 1) relationships individuals have with their environments, and 2) changes in those relationships. Interview notes were written up shortly after an interview finished (no audio recordings were used). In total, 107 interviews instances were registered, and they lasted, on average, 21 minutes each. Along with the interviews, daily field activities were registered as field notes, which were used to complement data analysis.

Additional data were collected in documents, including reports, scientific publications (including studies conducted by our research group, Begossi *et al.*, 2010, and Hanazaki *et al.*, 2013), and traditional songs and dances which are relevant for the study of cultural values. Nascimento, Netto and Bulhões (2004) contains the songs in Portuguese; I translated some parts, which are described in the results. As well, I watched videos (movies and a soap opera) filmed in Tarituba and elsewhere in the area of Paraty, as they were recommended by research participants.

During data analysis, interview notes were read and re-read, a process called impregnation (Michelat, 1981), and coded according to the themes that emerged from the analysis of the material (Newing *et al.*, 2010). The types of perceived human-environment relationships that were identified from the interviews were then compared to the Millennium Ecosystem Assessment's (MA, 2005a) categories of ecosystem services: provisioning, regulating, cultural, and supporting. In order to analyze historical changes in use of ecosystem services, I used the beginning of the decade of 1970 as the base of comparison because local people perceive the construction of the highway (BR-101) as a landmark for changes observed in the village. The use of landmarks is recommended to enhance the accuracy of retrospective

reports (Bernard, 2011). Discrepancies between the MA's categories and the types of perceived relationships people have with their environment were noted.

2.3. Study area: Tarituba

Paraty is one of the two municipalities that comprise a region called Ilha Grande Bay on the south of Rio de Janeiro state, southeastern coast of Brazil (Figure 1.1). This region is located inside the remnants of the Atlantic Forest. Although highly fragmented and at 11 - 13% of its original size, the Atlantic Forest is still a biome with high biodiversity and high endemism of species (Metzger, 2009). For this reason, the Atlantic Forest has been considered one of the 25 world's hotspots for biological conservation (Myers *et al.*, 2000). Within this area (but not restricted to it) live the Caiçara people, a mixed-heritage cultural group, descendents from Brazilian native groups, European colonizers, and Africans (Diegues, 2008; Begossi, 1998).

Tarituba is a village located at 32 km from Paraty city on highway BR-101 towards Angra dos Reis (Figure 1.1). According to local sources, around 800 to 1000 people live in Tarituba. Hanazaki and colleagues (2013) surveyed the livelihood activities in Tarituba and other villages in the municipality of Paraty, and found a diversity of activities based on local resources, on tourism sector, and on the private sector. Frequently, the same household shows a diversity of livelihood activities.

In Tarituba, I identified that livelihood activities based on local resources included fishing, working on the fish market, and working on fish processing (there is a local fish market called *Peixaria Lara*). Livelihood activities based on tourism included ownership of bars, restaurants, *pousadas* (type of bed and breakfast), souvenir stores, and conducting boat tours for fishing trips, and other employment - either seasonal, year-round, or day wage. Livelihood

activities based on the private sector include employment at the Nuclear Power Plant (*Central Nuclear Almirante Álvaro Alberto*), and the shipyard *Estaleiro Verolme*, both located on the neighbour municipality, Angra dos Reis. See section 1.7.1 for a detailed description of study site and occupations.

2.4. Results

Results are organized according to the corresponding categories of ecosystem services under the Millennium Ecosystem Assessment framework (MA 2005a). Provisioning and cultural services are described in separate subsections. Regulating and supporting services are described under one subsection because regulating services seem to accommodate very few examples of perceived human-environment relationships in Tarituba.

2.4.1. "Provisioning Services"

Provisioning ecosystem services are defined as "*the products people obtain from ecosystems, such as food, fuel, fiber, fresh water, and genetic resources*" (MA, 2005b:29). I will use the example of obtaining food to analyze this concept in relation to (1) the range of perceived relationships of individuals and their environment, and to (2) the changes in these relationships.

In Tarituba, individuals obtain food locally, by fishing, gathering non-timber forest products, collecting seafood, hunting, and cultivating plants. People obtain these food items locally or outside the village, by buying their food from grocery stores, street markets, or supermarkets, also by receiving food as a gift from other persons, as in food sharing situations such as fish sharing on the beach (Table 2.1). Most commonly people will use a combination of these processes to obtain food. Therefore, instead of talking about "benefits" they obtain from the ecosystem, the analysis of the data collected during interviews revealed that people in

Tarituba talk about their “occupations” (and the specific actions of these occupations) as the means to obtain their basic needs. Thus, the term “benefits”, as imbued in the concept of ecosystem services, does not fully capture what people actually do. For example, one research participant, a fisher, said that in order to buy medicine for his mother, he went fishing on a windy day, caught a snook (*Centropomus* spp.) and sold it to a restaurant owner. The social behavior of this fisher, to satisfy a basic need, can be defined as goal-oriented rational action (Weber, 1991). So, individuals actively seek for their provision, and do not wait for benefits or goods from nature. In other words, the concept of ecosystem services assumes that there are "pre-defined, static, benefits" (products or goods) out there in nature, and all that individuals do is to "receive" them. This assumption overlooks the fact that benefits (products or goods) are derived from the environment via goal-oriented rational actions of individuals.

With regards to the changes in human-environment relationships, looking at the means by which individuals obtain their basic needs (occupation) was more fruitful than looking at “benefits humans obtain from nature”, which is rather static. Table 2.1 presents the perceived means to obtain basic needs (occupations and specific activities of these occupations) identified in Tarituba around 1970 and in 2011.

Table 2.1 - Past and current occupations* and specific activities based on provisioning ecosystem services identified in Tarituba, Paraty-RJ, Brazil.

Occupation **(activities)**	**Before 1970**	**2011**
Aquaculture operator	**Absent**	Present
Canoe maker	Present	**Absent**
Farmer (small-scale agriculture)	Present	**Absent**
Gatherer		
Collecting non-timber forest products**	Present	**Absent**
Oyster gathering	Present	**Absent**
Timber for house construction	Present	**Absent**
*Hunter***	Present	**Absent**
Large-scale fisher		
Shark fishing	Present	**Absent**
Trawling (Herring and croaker)	Present	Present
Small-scale fisher		
Beach seining	Present	**Absent**
Cerco de robalo (snook fishing)	**Absent**	Present
Cerco fixo fishing (pond nets)	Present	**Absent**
Covo fishing (fishing traps – groupers)**	Present	Present
Gillnet fishing	Present	Present
Gillnet shrimp fishing (redinha)	Present	Present
Harpoon fishing (Snook)	Present	**Absent**
Hook and line fishing	Present	Present
Lobster fishing	Present	**Absent**
Parati (mullet) fishing	Present	Present
Small-scale shrimp trawling	Present	Present
Spear fishing	Present	Present
Squid fishing	Present	Present
Tourism operator	**Absent**	Present
Managing Pousadas (bed and breakfast)	**Absent**	Present
Managing Restaurants	**Absent**	Present
Managing Camping	**Absent**	Present
Managing boat tours	**Absent**	Present

* Italics refers to occupations; non-italics refers to activities.

**Although the activities of this occupation might still be performed by some individuals, the overall perception is that they are illegal, because of protected areas.

The changes identified in fishing techniques are a good example for understanding the dynamic nature of the relationship individuals have with their environments when obtaining food. At least five of the fishing techniques used before the construction of the highway are not used anymore, for example harpoon fishing and lobster fishing (complete list of techniques in Table 2.1). Nine techniques were used before the highway and are still being used within fishing activities in Tarituba, for example, small-scale trawling, gillnet shrimp fishing, and gillnet fishing (Table 2.1). On the other hand, one technique that was not used before 1970, *cerco de robalo*, has been adopted by some fishers in Tarituba. *Cerco de robalo* consists of finding schools of snook (*Centropomus undecimalis* and *C. paralellus*), encircling them with a net using one or two boats, and diving to spear the fish.

Under the ecosystem services framework, as proposed by the MA (2005b), one would be led to think of “fish” as a “product”, or "benefit", which corresponds to a provisioning service. Therefore, one would see that fish, as a provisioning service, was present in 1970 and it was present in 2011. One might also be able to see that the fish stocks declined or increased in the period. However, one would not see the changes in the social-ecological system as a whole, which is better demonstrated by the changes in fishing techniques (Table 2.1; Figure 2.1).

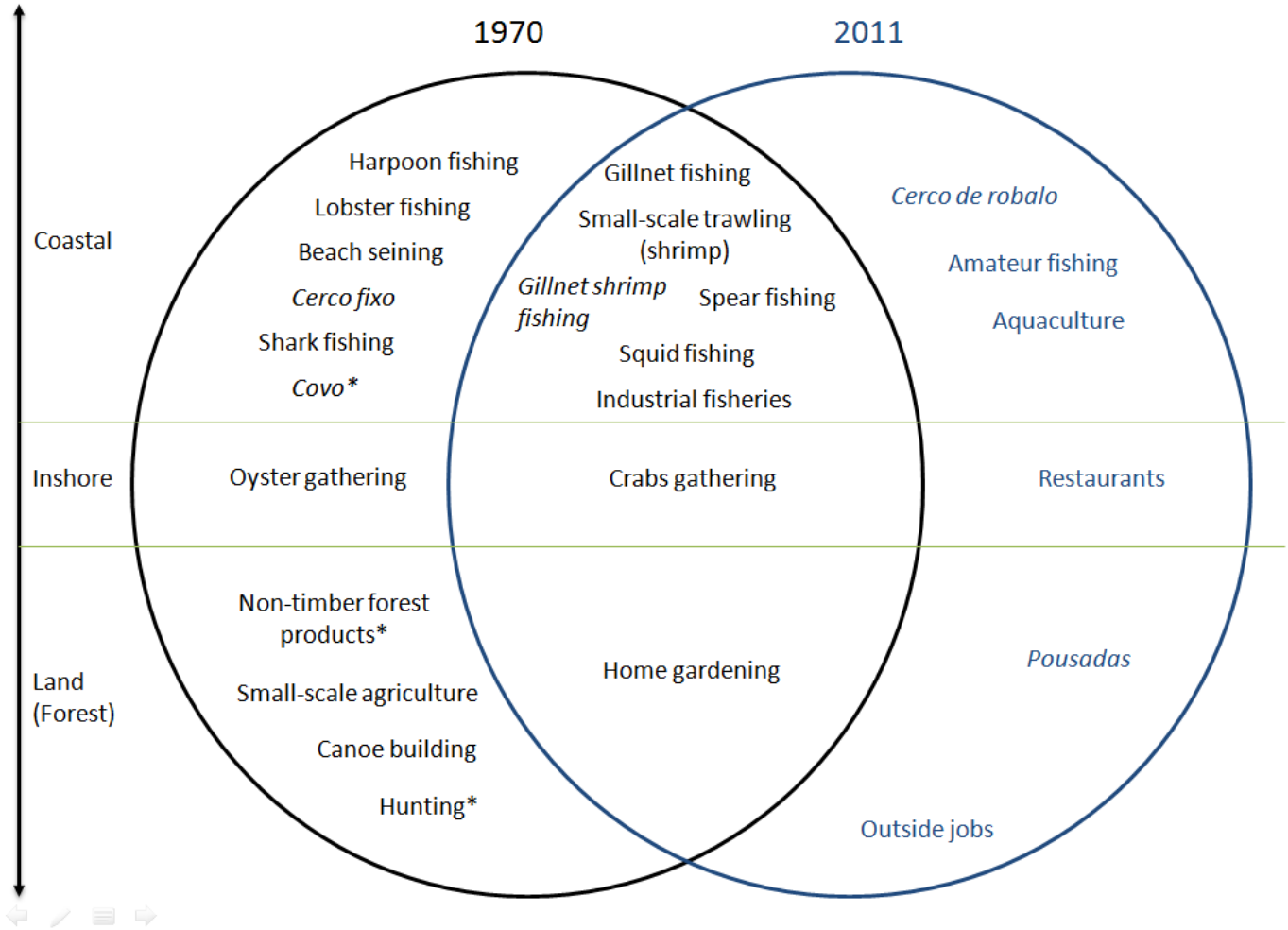

Figure 2.1 - Shifts in provisioning activities and occupations as they were identified on the coast, inshore and on the land (forest). Activities marked with an "*" might be happening currently, but the overall perception is that they are illegal activities.

2.4.2. Cultural Services

Cultural ecosystem services are defined as "*nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences*" (MA, 2005b:29). Similarly to the analysis conducted with provisioning services, here I explore the extent to which the concept of cultural ecosystem services can communicate the range of perceived relationships people have with their environments, and changes in these relationships. The results are given in Table 2.2. Because cultural aspects are usually neglected from the valuation analysis of ecosystem services (Chan, Satterfield and Goldstein, 2012), I describe them in some detail here. Results are explored under the subtopics of recreational activities, aesthetics values, scientific/educational activities, spiritual connections, and social cohesion. These subcategories followed the ones proposed by the MA (2005) framework.

Table 2.2 - Past and current perceived human-environment relationships related to cultural ecosystem services

Perceived relationships related to cultural ecosystem services	**Before 1970**	**2011**
Community celebrations and festivals	Present	Present
Inspiration for traditional songs and dances	Present	Present
Leisure options (beaches, islands, trails, waterfalls, soccer field)	Present	Present
Local Ecological Knowledge	Present	Present
"Mutirão" (joint effort for a specific task)	Present	Present
"Puxada de canoa" (part of the canoe making process)	Present	**Absent**
Religious ceremonies	Present	Present
Sacred places	Present	Present
Scenery for TV and Cinema	**Absent**	Present
Scenic beauty	Present	Present
Science and education	**Absent**	Present
Spiritual connections	Present	Present

With regards to *recreational activities*, before 1970 leisure options in Tarituba were the beaches, islands, trails and waterfalls close to the village, along with common leisure areas in the

village, such as the soccer field and the dancing club. According to research participants, it was common in the past to go for picnics on islands close to Tarituba (*Ilha Comprida, Ilha do Pelado, Ilha de Araraquara*) on the weekends. Also, parties were very common to celebrate good fish catches, harvest periods, *puxada de canoa* (the process of carrying a tree trunk from the forest to make a canoe on the beach), or religious holidays. Finally, a very important leisure activity for community members in Tarituba was the community soccer field, which is still used every Sunday, as reflected in the local song *Cateretê*: "*Sunday afternoon/ Before the sunset/ The youth from Tarituba/ Play soccer happily*" (Nascimento, Netto and Bulhões, 2004:28).

Recreational activities have changed since 1970. For example, some of the leisure activities are now reduced, such as island recreation, because most of the islands used in the past are now part of a protected area, *Estação Ecológica de Tamoios*, created in 1990 by a federal decree (Decree n^{o} 98.846). Because of the restrictive nature of the protected area (corresponds to IUCN Category Ia), only scientific research and environmental education activities are allowed within its boundaries. As a consequence, leisure (as well as fisheries and tourism on these islands) is illegal. Also, the water quality on the beach in Tarituba is perceived as poor because the untreated sewage of the village is released into the water. Therefore, some research participants said that they do not use the beach to swim anymore.

Aesthetic properties of the place have always been valued in Tarituba, according to research participants. The scenic beauty of the place provides inspiration for local artists to write songs and poems. Even before 1970, Tarituba had a group of local musicians and dancers known as *Grupo de Danças Folclóricas de Tarituba*. This group rehearses twice a week at the *Ponto de Cultura*, a cultural centre created for the purpose of maintaining the familiarity about local dances and music for new generations. A common theme in the lyrics is the scenic beauty of

Tarituba. For example in the song *Catereteê*, "*Tarituba, Tarituba/ Little piece of Brazil/ See how beautiful they are/ The green sea and the blue sky*" or in another part, referring to Tarituba, "*Green forest, clear sand/ Blue sky, beautiful moonlight*" (Nascimento *et al*., 2004:28).

The richness of this material can be exemplified by the different styles of music and rhythms performed by the group. Among the different styles and rhythms are *ciranda*, *mancado*, *xiba*, *cateretê*, and *folia de reis*. See Nascimento, Netto and Bulhões (2004) for song styles and dances performed in Tarituba, and the "Essay on Brazilian Music" by Mario de Andrade (Andrade, 1962) for a broader description and analysis of Brazilian rhythms and dances.

After the construction of the highway and the tourism development, the scenic beauty of Tarituba captured the attention of cinema and TV. As a result, at least two movies were filmed in Tarituba, one called "*O Rei dos Milagres*" (The Miracles King), directed by Joel Barcellos in 1971, and another called "Running Out of Luck", a musical with Mick Jagger, which was partially filmed in Tarituba in 1987. Between 1991 and 1992, a soap opera called "*Mulheres de Areia*" (Sand Women) was filmed in the village by the national broadcast channel *Rede Globo*. Advertisements, documentaries, and other TV series also used Tarituba as a scenario. During the time I was in the field, the Discovery Channel was shooting parts of a documentary in the village. After research participants had recommended that I watch scenes of the soap opera, they asked me "*did you see how beautiful Tarituba used to be*?"

Scientific and educational activities have changed since the construction of the highway. Local ecological knowledge used to be the main source of information for the elaboration of local rules over natural resources use. A diverse set of institutions were in place to regulate the use of resources, such as customary fish netting sites as done elsewhere in the region. For example, a woman, research participant, mentioned that "*before the regulations imposed by the*

protected area, we had our own rules, like releasing smaller, juvenile fish. (...) Instead of organizing the fisheries, these new laws just caused a total disorganization of the rules". The scenic beauty of the place, along with the discourse on conservation of the Atlantic Forest, also attracts researchers from different areas, especially biologists, to carry out scientific research.

Spiritual connections identified in Tarituba are mostly related to the religious ceremonies. In fact, most of the celebrations and festivals in Tarituba have a religious background. The predominant religion is Roman Catholic, although there is also an Evangelical Church (*Igreja Universal do Reino de Deus*). For example, in June, every year, there is a set of three celebrations in honor of three Catholic saints: *Santo Antônio*, *São João*, and *São Pedro*.

In Brazil, people believe that *Santo Antônio* can intercede for those who believe in him, in order to make a marriage happen. *São João* (also known as *São João Batista*) is known for having baptised Jesus Christ in the waters of Jordan River. Lastly, *São Pedro*, who was a fisher himself, is considered the patron saint of fishers. During the celebration for *São Pedro*, there is a procession of boats that follow a main boat with the icon of *São Pedro*. The boat procession takes place during the day. Boats navigate close to *Ilha do Pelado, Ilha Comprida* (two of the islands in close to Tarituba) and return to the harbor of Tarituba. At night, a bonfire is lightened and food is shared. According to research participants, the purpose of the celebration is to ask *São Pedro* for a good year of fishing and good weather at sea.

Another important religious festival in Tarituba is the *Festa de Santa Cruz*, which happens every year at the beginning of May. *Festa de Santa Cruz* is a celebration in honour of the Holy Cross, which represents the crucified Jesus Christ, the most important symbol of the Catholic religion. During the *Festa de Santa Cruz*, the aforementioned group presents their music and dances, as a ball. This ball is performed to celebrate good harvests or good fishing

catches, but nowadays it is also performed during parties and other festivals in Paraty, or in other parts of Brazil, such as the "Rock in Rio Festival". Some customary recipes are shared, or dishes sold, during the festival, such as *canjica* (meal made of dried whole-grain corn, milk and sugar), sweet potato, manioc, *quentão* (alcoholic drink made of ginger, honey and *cachaça*, which is a liquor made of sugarcane) and *café de cana* (coffee made with the juice of sugar cane).

Although most of the perceived cultural people-environment relationships in Tarituba are still in place, the *social cohesion* of the village is perceived as having declined during the last 40 years. According to some research participants this decline is related to the reduction of collective labor activities, and to the individualistic way of life that became common with the arrival of "progress". Examples of group activities that are less frequent since 1970 are: 1) *mutirão*, collective work to help relatives or friends to build houses or new agriculture plots; 2) beach seine fishing, a cooperative technique that involved over six individuals and often as many as 20 or 30; and 3) *puxada de canoa*, the process of carrying down a tree trunk (pre-shaped canoe) from the forest to the beach, to be turned into a dugout canoe. Although these examples can illustrate the issue of loss of social cohesion, they are not sufficient to fully document this complex phenomenon.

Cultural aspects identified in Tarituba indicate two properties, also mentioned by Chan, Satterfield and Goldstein (2012): they are incommensurable and intangible. To some extent, the Millennium Ecosystem Assessment (MA 2005b) framework was applicable for the identification of cultural aspects of the relationship between the individual and the environment, but to quantify or measure these relationships in monetary terms seems inappropriate or irrelevant. For example, how meaningful would it be to assign a monetary value for the boat procession in honour of *São Pedro*?

2.4.3. Regulating and supporting services

Regulating services are defined as "*the benefits people obtain from the regulation of ecosystem processes, including air quality maintenance, climate regulation, erosion control, regulation of human diseases, and water purification*" (MA, 2005b:29). This definition of regulating services seems to accommodate very few examples of perceived human-environment relationships in Tarituba. People perceive human actions, in this case, as sources of disturbance to the natural regulation, and no participants said that they receive a benefit from regulating services (but I guess that at least some people know the relationship between vegetation and erosion control).

The water consumed in the village comes from streams located up the hill, where there used to be a banana plantation. The water is piped from the streams to a reservoir, and from the reservoir to the houses. No water treatment is provided by the municipality. One research participant conjectured that "*if the cultivation of bananas on the hills had continued, the village would probably have had problems with the water supply*". Therefore, the participant perceives human actions as potential disturbances to regulating services. Furthermore, any kind of intervention is perceived, by this research participant, as a source of disturbance to natural regulation. But the regulation is not perceived as a benefit, rather it is perceived as a natural condition.

According to the definition of MA (2005b:29), "*supporting services are those that are necessary for the production of all other ecosystem services, such as primary production, production of oxygen, and soil formation*". No data collected on the interviews could be accommodated under the definition of supporting services. This definition seems mostly based on the perceptions of ecological economists.

2.5. Discussion

Three main topics guide this discussion. First, I discuss the applicability of the concept of ecosystem services (and categories of the Millennium Ecosystem Assessment) to accommodate the range of perceived human-environment relationships. Second, I evaluate the extent to which these categories and definitions can be used to analyze the changes on the human-environment relationships. Finally, I focus on the assumptions of the monetary valuation of ecosystem services when addressing the complexity of human-environment relationships.

2.5.1. Could the concept of ecosystem services accommodate the range of perceived human-environment relationships?

A broad range of definitions of ecosystem services can be found in the literature, but they all share the same assumption that nature "gives" products and benefits to human beings, who are the mere "receivers" of these goods. To illustrate this analysis, I cite the three most used definitions of ecosystem services in the literature. Daily (1997:3) defined ecosystem services as "*the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life*". The Millennium Ecosystem Assessment, a major international study, defined ecosystem services as "*the benefits people obtain from ecosystems*" (MA 2005b:27). More recently, the IPBES (Intergovernmental Platform on Biodiversity and Ecosystem Services), an independent governmental body, open for all the member countries of the United Nations, with the goal of "*strengthening the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term*

human well-being and sustainable development" (Díaz *et al.*, 2015:3), uses the term "nature's benefits for people", which also reinforces the assumption that nature gives benefits to people.

Some studies published after the MA (2005a) have slightly changed the definition of ecosystem services, but they also seem to consider human beings as mere "receivers" of the goods, services, or products from ecosystems (see Fisher, Turner and Morling, 2009; Chan, Satterfield and Goldstein, 2012; Plieninger, Dijks, *et al.*, 2013). For example, Boyd and Banzhaf (2007:619) presented a definition in which "*final ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being*". In this definition there is more room for considering the actions of individuals, however, the "components of nature" seem very static and independent from the perceptions of people. The limitation of these definitions is that they do not consider the actions of individuals, and the motivation behind these actions, which are guided by the perceptions that individuals have about their surroundings (Bourdieu, 2005).

According to the material collected in Tarituba, I could not accommodate some of the relationships individuals have with their environment under the MA (2005b) categories of ecosystem services. For example, as for provisioning services, I identified that people talk about their occupations and specific actions of these occupations, and not about benefits they receive from nature (Table 2.1). If I had considered just part of the findings, I could have fitted the data under the provisioning services category, but that would have required forcing what is perceived as a social action into a category related to a product. For example, one fisher said that in order to make a large canoe, he would have to look for a tree trunk close to a river, because transportation would be easier. Based on this information, we could think that the tree trunk would fit under provisioning services category, a benefit "received" from nature. However, the description of the process shows that the individual's behavior was a goal-oriented rational

action (Weber, 1991), and he did not “receive” the trunk, rather, the description reveals that he pursued it.

With regard to regulating and supporting services, I could rarely accommodate data identified from research participants’ perceptions. These categories do not seem to represent how people observe and talk about things in Tarituba. Asah *et al.* (2014) studied the perception of ecosystem services, using open-ended questions to allow research participants to "*express the benefits they receive from ecosystems, and how they acquire and use those benefits, in their own words and from their own frames of reference*" (Asah *et al*., 2014:180). Similarly to the results I found, those authors also found that interviewees "*rarely mentioned regulating or supporting services*" (Asah *et al*. 2014:183). On the other hand, Derak and Cortina (2014) found that stakeholders considered provisioning and supporting services more important than cultural and provisioning services. However, as opposed to allowing research participants to express themselves according to their own frames of reference, Derak and Cortina (2014), used a quantitative approach (questionnaires) and asked participants to rank a set of previously selected list of ecosystem services. These conflicting results could be related to the methodological approach and choice of data collection instruments, which should be investigated in future research.

In conclusion, to answer the question raised in this subsection, I believe that so far, the concepts and categories of ecosystem services in the literature cannot accommodate the full range of human-environment relationships. The examples above inform us that a robust model for analyzing human-environment relationships must include the perceptions and actions of individuals. So far, the definitions and categories of ecosystem services have not sufficiently considered subjective aspects of human-environment relationships, such as perceptions and

motivations, neither has fully considered human actions (or agency, as used by Brown and Westaway, 2011), because of the assumption of nature as "giver" and humans as "receivers" of services and benefits. In the same lines, Asah *et al.* (2014), stated that understanding how stakeholders perceive, acquire and use ecosystem services may be more interesting to policy and management than its classification.

2.5.2. Could the concept of ecosystem services be used to understand changes in human-environment relationships?

Based on the results, I identified that the definitions of ecosystem services found in the literature are suitable to "take a snapshot" of *some* (see subsection above) human-environment relationships. In other words, the outcome of the identification process is a picture of a given moment, which is rather static when one aims to represent the intrinsically dynamic human-environment relationships. For provisioning services (or products) in this area, using the concepts from the literature, I would have fish, timber, manioc, and water, for example. I could also attribute a monetary value to these products based on how much individuals earn by selling these products. However, this identification and monetary valuation, using the concepts and categories of ecosystem services of the literature, do not take into consideration the full range of perceptions (and consequently intrinsic values) that individuals have about their human-environment relationships, which are diverse by nature.

When looking at provisioning services, it makes more sense to look at occupations (and specific activities of these occupations) than to look at provisioning "products" or "benefits". This is especially important if one is trying to understand changes in relationships. In order to assess the changes in relationships individuals have with their environment, it is paramount to

understand individual perceptions over the object under analysis. The same fish can mean food for one individual, money for another, and a pleasant activity for another. Following the same logic, a fish can mean food in a given moment of a person's life, money in another moment, and still the result of a leisure activity in another moment. Needless to say that the value an ecological economist gives to the fish will also be very distinct from the value a fisher gives, because these individuals occupy different positions within social space (Bourdieu, 2005).

Individuals have different perceptions depending on the position they occupy within social space. According to Bourdieu (2005), social space can be imagined as two perpendicular axes, one is economic capital, and the other is cultural capital, and individuals will occupy different positions within a social space according to their total capital (cultural plus economic). Therefore, perceptions (and consequently, motivations) of individuals are determined by their position in the social space. The closer they are within social space, more similarly will individuals perceive the world. This is an argument in favor of approaches to ecosystem services that fully consider how individuals perceive their human-environment relationships.

According to Bourdieu (2006), economists may overlook the diversity of utilities, or real uses that different individuals may attribute to the same product, because such values are determined by individual perceptions, which are diverse. As stated above, people may have different perceptions and dispositions for action, depending on the position they occupy in social space. I argue that a framework that aims at understanding changes in human-environment relationships must take into consideration the dynamics of the positions individuals occupy within social space, and the struggles within each field of action. In other words, it is necessary to include people's actions and perceptions in framework frameworks devoted to the study of human-environment relationships.

2.5.3. The shortcomings of the monetary valuation approach

There are two main shortcomings that arise with the monetary valuation of ecosystem services. First, many of the so-called "ecosystem services" cannot be valued in monetary terms, for example, cultural services, which have been frequently pointed out by researchers (Berbés-Blázquez, 2012; Chan *et al.*, 2012; Chan, Satterfield and Goldstein, 2012). Second, the current scientific approach to identify and value ecosystem services has rarely identified individuals' perceptions about what they value as part of their surroundings; instead, most of the recent publications on the perception of ecosystem services report individuals' opinions instead of individuals' perceptions (see literature review on section 1.6). These shortcomings are worrisome because the ecosystem services approach has been widely used in decision-making over management of natural resources, including in the most recent international policy-oriented NRM guidelines, such as the IPBES.

As Turnhout *et al.* (2013) put it, the ecosystem services discourse is symptomatic of the logic that reduces human values and ecosystems into a set of utilitarian values. The tacit outcome of the use of these models of monetary valuation as such, is that the perspectives of the resource users themselves have not been taken into consideration in the decision-making processes. There is a growing number of studies on ecosystem services that have considered cultural services as intangible and incommensurable (e.g. Chan *et al.* 2012; Chan, Satterfield and Goldstein, 2012; Plieninger, Dijks, *et al.*, 2013). The results in the present study supports that literature, since cultural aspects of the human-environment relationships in Tarituba were perceived as intangible and incommensurable.

The framework provided by the MA (2005a), could be used for the identification of some aspects (products) of the environment potentially valuable for people. However, this will not capture the amount and kind of value each person attributes to their environment, which can only be investigated by looking at peoples' perceptions. There has been a growing number of publications that have addressed the valuation of ecosystem services (e.g. Remoundou *et al.*, 2009; Czembrowski, Kronenberg and Czepkiewicz, 2016; Pandeya *et al.*, 2016). Also, various approaches to valuation and ways to integrate non-market values into ecosystem services frameworks have been proposed (Gómez-Baggethun and Ruiz-Pérez, 2011; Chan, Satterfield and Goldstein, 2012). However, despite these efforts, with regards to the study of the perception of ecosystem services in the current natural resources literature, researchers have not reached operational concepts, and consequently, results are seldom comparable (see Chapter 1).

Very few studies have investigated how resource users, or local people, value ecosystem services. Even those studies that meant to investigate local people's perceptions have not questioned *if* the categories and concepts of ecosystem services are actually perceived by resource users as such. For example, both Berbés-Blázquez (2012) and Plieninger *et al.* (2013) aimed at understanding how local people perceive and value ecosystem services. However, before starting their interviews, they explained the ecosystem services framework (from the literature) to their research participants. This approach organizes beforehand the answers of participants, and all data collected will probably fit under the framework that was explained.

2.6. Conclusions

Despite a growing number of publications addressing the perception of ecosystem services by stakeholders, a review of the literature on current NRM research showed that most of the studies lack a operational definition of perception (see Table 2.3), which sometimes is used

in exchange of terms like opinion and knowledge. Additionally, some of the stakeholders' perceptions, as reported in the literature, seem to be derived from a methodological artifact, as researchers organize beforehand the responses that may be obtained - thereby fitting the responses into pre-defined categories derived from the literature. Based on these findings, there is a need of an operational concept of perception (or at least a working definition), as well as the standardization of methods to assess individuals' perceptions of ecosystem services in future research.

In this chapter, I identified that the current concepts and categories of ecosystem services from the main international policy-oriented approaches (MA, 2005; TEEB, 2010; IPBES - Díaz *et al.*, 2015) have an underlining assumption that nature "gives" benefits to individuals, which may result in overlooking the agency of individuals in their relationships with the ecosystem. Additionally, the rather static categorization of nature components may not be sufficient to capture the dynamics of social-environmental changes. The use of a qualitative analysis to understand the relationships individuals in Tarituba have with their environment revealed that their actions (occupations and specific activities) better represent the way people perceive their dynamic social-ecological relationships. Although this was an exploratory study, and based on one case, these results suggest that the qualitative approach was able to capture elements of peoples' perceptions regarding human-nature relationships, and should be refined to contribute to the literature on stakeholders' perceptions of ecosystem services.

With regards to the economic approach to ecosystem services, this study contributes to the well-developed literature that highlights the need of developing better methods and strategies to study how individuals value ecosystem services, especially the so-called cultural ecosystem services (Spangenberg and Settele, 2010; Chan, Satterfield and Goldstein, 2012). The strict

economic approach to attribute a monetary value to the relationships individuals have with their environment may overlook the complex dynamics of these relationships.

To sum up, in order to become realistic, models of identification and valuation of ecosystem services need to incorporate other approaches as well as the conventional ones from ecological economics, and values other than the ones strictly based on economics. Psychological as well as cultural dimensions of ecosystem services should be included in the models. This revision of the ecosystem services approach is needed to make better, more grounded decisions for the management of natural resources.

Table 2.3 - Research items retrieved by the database search on ecosystem services (see description on Chapter 1). Items were analyzed regarding their focus on ecosystem services, methodological approach, and main definition of ecosystem service. Research items were also described according to how they approached the concept of perception: if perceptions of individuals were presented as part of the results, if perception was defined as a concept, and finally if authors considered the perceptions of research participants important.

Reference	Is ES focus of the research? (Y/N)	Methodological approach (Quali; Quant; Mixed)	ES definition(s), if presented	Perception presented as result? (Y/N)	Defines perception? (Y/N)	Considers perception important ?(Y/N)
(Saxena *et al.*, 2002)	No	Quantitative	None	Yes	No	Yes
(Ekins *et al.*, 2003)	Yes	Non applicable	Daily (1997)	No	No	Yes
(Smardon and Faust, 2006)	No	Non applicable	None	No	No	Yes
(Bodin and Wiman, 2007)	No	Non applicable	None	No	No	No
(Matyssek *et al.*, 2008)	No	Non applicable	None	No	No	No
(Buitrago, Guada and Doyle, 2008)	No	Non applicable	None	No	No	Yes
(Mbow *et al.*, 2008)	No	Mixed	None	Yes	No	Yes
(Enfors and Gordon, 2008)	No	Mixed	None	Yes	No	Yes
(Mee, Dublin and Eberhard, 2008)	No	Mixed	None	No	No	Yes
(Vaccaro and Norman, 2008)	No	Qualitative	None	Yes	Yes	Yes
(Levrel and Bouamrane, 2008)	No	Qualitative	MA (2005)	Yes	No	Yes
(Stoate and Jarju, 2008)	No	Mixed	None	Yes	No	Yes
(Remoundou *et al.*, 2009)	Yes	Mixed	MA (2003)	Yes	No	Yes
(Reed *et al.*, 2009)	No	Qualitative	None	Yes	No	Yes
(Renting *et al.*, 2009)	No	Non applicable	None	No	No	No
(Bestelmeyer *et al.*, 2009)	No	Non applicable	None	No	No	No
(Raymond *et al.*, 2009)	Yes	Qualitative	MA (2005)	Yes	No	Yes
(Udayakumara *et al.*, 2010)	No	Mixed	None	Yes	No	Yes
(Bryan *et al.*, 2010)	Yes	Qualitative	MA (2005)	Yes	No	Yes
(Stakhiva and Stewart, 2010)	No	Non applicable	None	No	No	No
(Nair *et al.*, 2010)	No	Non applicable	None	No	No	No
(Castro *et al.*, 2011)	Yes	Mixed	MA (2005)	Yes	No	Yes
(Kull *et al.*, 2011)	No	Quantitative	None	Yes	No	Yes
(Lusiana *et al.*, 2011)	No	Mixed	None	Yes	No	Yes
(Cerdán *et al.*, 2012)	Yes	Qualitative	MA (2005)	Yes	No	Yes

(van Riper *et al.*, 2012)	Yes	Quantitative	Costanza et al (1997), Daily (1997), de Groot et al., 2002)	Yes	Yes	Yes
(Van Hecken, Bastiaensen and Vásquez, 2012)	Yes	Mixed	MA (2005)	yes	Yes	Yes
(Thomas *et al.*, 2012)	No	Quantitative	None	No	No	No
(Frank *et al.*, 2013)	Yes	Mixed	None	Yes	No	Yes
(García-Nieto *et al.*, 2013)	Yes	Mixed	de Groot et al. (2010)	Yes	No	Yes
(Partidario and Gomes, 2013)	Yes	Mixed	MA (2005) TEEB (2010)	Yes	No	Yes
(Namaalwa *et al.*, 2013)	Yes	Mixed	MA (2005) TEEB (2010)	Yes	No	Yes
(Vignola, McDaniels and Scholz, 2013)	No	Quantitative	None	Yes	No	Yes
(Pasquini, Cowling and Ziervogel, 2013)	No	Qualitative	None	Yes	No	Yes
(Clerici and Vogt, 2012)	No	Quantitative	None	No	No	Yes
(Motavalli *et al.*, 2013)	No	Non applicable	MA (2005)	No	No	Yes
(Fürst *et al.*, 2013)	No	Non applicable	MA (2005)	No	No	No
(Yang *et al.*, 2013)	Yes	Mixed	MA (2005)	Yes	No	Yes
(Kirkman, 2013)	No	Quantitative	None	No	No	Yes
(Lopes and Videira, 2013)	Yes	Mixed	Daily (1997); Costanza et al. (1997); MA (2005)	No	No	Yes
(Sagie *et al.*, 2013)	Yes	Qualitative	UK National Ecosystem Assessment (2011); MA (2005)	Yes	No	Yes
(Bouma and Ansink, 2013)	No	Quantitative	None	Yes	No	Yes
(Grace B. Villamor, van Noordwijk, *et al.*, 2014)	No	Non applicable	None	Yes	No	Yes

(de Oliveira and Berkes, 2014)	Yes	Qualitative	Daily (1997); Costanza et al. (1997); MA (2003)	Yes	Yes	Yes
(Derak and Cortina, 2014)	Yes	Quantitative	MA (2005)	Yes	No	Yes
(Khan *et al.*, 2014)	Yes	Quantitative	None	Yes	No	Yes
(Asah *et al.*, 2014)	Yes	Qualitative	MA (2005)	Yes	No	Yes
(Wattana, 2014)	No	Non applicable	None	no	No	No
(Grace B. Villamor, Le, *et al.*, 2014)	Yes	Quantitative	None	Yes	No	Yes
(Secco *et al.*, 2014)	No	Quantitative	None	No	No	Yes
(Turner *et al.*, 2014)	No	Quantitative	None	Yes	No	Yes
(Buta, Holland and Kaplanidou, 2014)	No	Quantitative	None	Yes	No	Yes
(Larkin and Beier, 2014)	No	Quantitative	None	Yes	No	Yes
(Gray *et al.*, 2014)	No	Qualitative	None	Yes	No	Yes
(Cárcamo, Garay-Flühmann and Gaymer, 2014)	No	Quantitative	None	Yes	No	Yes
(Lund, Banta and Bunting, 2014)	No	Mixed	None	Yes	No	Yes
(Votsi *et al.*, 2014)	No		None	No	No	No
(Lindell *et al.*, 2014)	Yes	Mixed	Daily (1997); MA(2005)	Yes	No	Yes
(Zagarola, Anderson and Veteto, 2014)	Yes	Quantitative	MA (2005)	Yes	No	Yes
(Baker *et al.*, 2015)	Yes	Mixed	(Daily, 1997; MA, 2005; TEEB, 2010; WLE, 2014)	Yes	Yes	Yes
(Krause *et al.*, 2015)	No	Non applicable	None	No	No	Yes
(Díaz *et al.*, 2015)	Yes	Mixed	resembles MA (2005)	Yes	No	Yes
(Brimont and Karsenty, 2015)	Yes	Mixed	None	Yes	No	Yes
(Babbar-Sebens *et al.*, 2015)	No	Non applicable	None	No	No	Yes
(Hauck *et al.*, 2015)	No	Non applicable	None	Yes	No	Yes
(Ruiz-Mallén, Corbera, Calvo-Boyero, Reyes-García, *et al.*, 2015)	No	Mixed	None	Yes	No	Yes

(Jim L Wescoat, 2014)	No	Non applicable	None	No	No	Yes
(Hassenforder, Smajgl and Ward, 2015)	No	Mixed	None	Yes	No	Yes
(Abolina and Luzadis, 2014)	No	Mixed	None	Yes	No	Yes
(Atela *et al.*, 2015)	No	Mixed	None	Yes	No	Yes
(Caro-Borrero *et al.*, 2015)	Yes	Mixed	MA (2005)	Yes	No	Yes
(Leo X.C. Dutra *et al.*, 2015)	No	Non applicable	None	No	No	Yes
(Khakzad, Pieters and Van Balen, 2015)	No	Non applicable	None	No	No	Yes
(Leo X C Dutra *et al.*, 2015)	No	Qualitative	None	Yes	No	Yes
(Binot *et al.*, 2015)	No	Qualitative	None	No	No	Yes
(Francesconi *et al.*, 2015)	Yes	Quantitative	None	No	No	Yes
(Moussa *et al.*, 2015)	Yes	Mixed	None	Yes	No	Yes
(L. E. Ruoso *et al.*, 2015)	Yes	Qualitative	Costanza et al (1997); Daily (1997)	Yes	No	Yes
(Caballero-Serrano *et al.*, 2016)	Yes	Quantitative	(de Groot et al. 2002)	Yes	No	Yes
(Czembrowski, Kronenberg and Czepkiewicz, 2016)	Yes	Quantitative	None	Yes	No	Yes
(De Vreese *et al.*, 2016)	Yes	Mixed	None	Yes	No	Yes
(Raymond and Kenter, 2016)	Yes	Mixed	None	Yes	No	Yes
(Pandeya *et al.*, 2016)	Yes		TEEB (2010)	No	No	Yes
(Villegas-Palacio *et al.*, 2016)	Yes	Mixed	None	Yes	No	Yes
(Bianchi *et al.*, 2016)	No	Non applicable	None	No	No	Yes
(Pinto *et al.*, 2016)	Yes	Quantitative	Fisher and Turner (2008)	Yes	No	Yes
(Hugé *et al.*, 2016)	No	Qualitative	None	Yes	No	Yes
(Figueroa *et al.*, 2016)	Yes	Mixed	None	Yes	No	Yes
(Lagbas and Dl. Habito, 2016)	No	Mixed	None	Yes	No	Yes
(García-Martín *et al.*, 2016)	No	Quantitative	None	No	No	Yes
(Kelly, Germain and Mack, 2016)	Yes	Mixed	None	Yes	No	Yes
(Torresan *et al.*, 2016)	No	Quantitative	None	No	No	No
(Ulrich, Malley and Watts, 2016)	No	Mixed	None	Yes	No	Yes
(Qian *et al.*, 2016)	No	Quantitative	None	Yes	No	Yes

(Chen *et al.*, 2016)	No	Mixed	None	Yes	No	Yes
(de Jesus, 2016)	No	Non applicable	None			
(Trillo, Toledo and Colantonio, 2016)	No	Mixed	None	Yes	No	Yes
(Clifton, Gan and Gil, 2016)	No	Quantitative	None	Yes	No	Yes
(Castro *et al.*, 2016)	Yes	Quantitative	MA (2005); Costanza (1997)	Yes	No	Yes
(Levin, Lechner and Brown, 2017)	No	Quantitative	None	Yes	No	Yes
(Sterling *et al.*, 2017)	No	Non applicable	None	Yes	No	Yes
(Grilli *et al.*, 2017)	Yes	Quantitative	None	Yes	No	Yes
(Rojas-Downing *et al.*, 2017)	No	Non applicable	None	No	No	Yes
(Queiroz *et al.*, 2017)	Yes	Mixed	MA (2005)	Yes	No	Yes
(Rozas-Vásquez *et al.*, 2017)	Yes	Mixed	None	Yes	No	Yes
(Denjean *et al.*, 2017)	No	Non applicable	None	Yes	No	Yes
(Gabay and Alam, 2017)	No	Non applicable	MA (2005)	Yes	No	Yes
(Walther *et al.*, 2016)	Yes	Non applicable	MA (2005)	Yes	No	Yes
(Grygoruk and Rannow, 2017)	No	Qualitative	None	Yes	No	Yes
(Nagoli and Chiwona-Karltun, 2017)	No	Mixed	None	Yes	No	No
(Perni and Martínez-Paz, 2017)	Yes	Quantitative	MA (2005)	Yes	No	Yes
(Alarcon *et al.*, 2017)	Yes	Quantitative	None	Yes	No	Yes
(Farhad, Gual and Ruiz-Ballesteros, 2017)	Yes	Qualitative	MA (2005)	Yes	No	Yes
(Górriz-Mifsud, Marini Govigli and Bonet, 2017)	No	Mixed	None	Yes	No	Yes
(Martínez-Sastre *et al.*, 2017)	Yes	Mixed	TEEB (2010)	Yes	No	Yes
(Pirard, Petit and Baral, 2017)	No	Quantitative	None	Yes	No	Yes
(Villamor *et al.*, 2017)	No	Mixed	None	Yes	No	Yes
(Nobre *et al.*, 2017)	No	Mixed	None	Yes	No	Yes
(Nava Fuentes, Arenas Granados and Martins, 2017)	No	Quantitative	None	Yes	No	Yes
(Owuor *et al.*, 2017)	Yes	Mixed	MA (2005)	Yes	No	Yes
(Qian *et al.*, 2017)	No	Quantitative	None	Yes	No	Yes
(Douxchamps *et al.*, 2017)	No	Non applicable	None	No	No	No
(Nguyen, Jacobson and Ross, 2017)	No	Mixed	MA (2005)	Yes	No	Yes

(Vien *et al.*, 2017)	Yes	Mixed	MA (2005)	Yes	No	Yes
(Kamran, Aijaz and Shivakoti, 2017)	No	Qualitative		No	No	No

CHAPTER 3. DRIVERS OF CHANGE AS PERCEIVED IN TARITUBA

This chapter aims at satisfying the second specific objective of this thesis, which is: "to assess the precision of the concept and categories of drivers of change to accommodate research participants' perceptions about social-ecological changes in Tarituba". The approach used in this chapter is based on the second and third steps of the method proposed for this research, as described in sections 1.7.2.3 and 1.7.2.4 of this thesis. The main goal of this chapter was to analyze research participants' verbal reports about causes of change in social and ecological domains, and then to compare the findings of this analysis to the concept and categories of drivers of change from the current NRM literature. Because the main sources of data for this analysis are people's beliefs, feelings, and opinions about changes in social and ecological domains in Taributa, this is a qualitative study. Therefore, my goal is not in making generalizations, nor is my focus comparing what people told me with other sources of empirical evidence. In that sense, this study differs from most of the literature on drivers of change, since my objective is not to identify drivers of change in a given location, and analyze their impact on the social-ecological system. Instead, my study focuses on identifying how individuals describe their perceptions about changes in social and ecological domains, and, based on this identification, to assess the extent to which current concepts and categories are able to accommodate these descriptions. By doing so, I intend to contribute to the current methods and approaches used to study changes in social-ecological systems.

3.1. Introduction

The dynamic relationships human beings have with their surroundings have attracted the attention of researchers in several disciplines. Research in natural resources management has investigated this topic in order to better understand how communities manage their natural

resources. A description on how researchers have studied causes of changes in social-ecological systems can elucidate assumptions and models used to identify the so-called drivers of change. On the next paragraphs I intend to summarize the main theoretical approaches, concepts, categories and examples of what researchers have acknowledged as "drivers of change" in social-ecological systems.

Current natural resources management's literature has focused on the study of drivers of social-ecological changes in order to develop effective management strategies (Carpenter *et al.*, 2006, 2009; Gerald C. Nelson *et al.*, 2006; Millennium Ecosystems Assessement - MA, 2003c). In so doing, researchers have derived concepts and categories of drivers of change from theoretical fields, such as complex adaptive systems (Levin, 1998, 2006), resilience (Holling, 1973; Pimm, 1984; Gunderson and Holling, 2002), and punctuated equilibrium (Speth, 2006). By using these theoretical frameworks, from different disciplines, such as mathematics, physics, and biology, researchers have claimed that social-ecological systems have to be studied as complex systems, using an interdisciplinary approach.

According to these authors, social-ecological systems can be characterized as complex adaptive systems because they share the following properties: hierarchy, in which different patterns emerge at each level of the organizational scale; nonlinearity, in which a change in one variable can lead to different outcomes, depending on the history of changes in the system; and self-organization, in which the system has a propensity to organize itself in dynamic states of equilibrium (or domains; or basins of attraction), until it is pushed to a breaking point (e.g. Levin, 1998). The capacity of the system to maintain itself within a dynamic equilibrium state is called resilience (Gunderson and Holling, 2002). The processes that push the system to a breaking point are called drivers of change.

With these broad concepts derived from different disciplines, researchers have studied different geographic areas, different social-ecological systems, identified drivers of the studied system, and suggested strategies of natural resources management. However, there is a lack of studies that evaluated the extent to which these concepts and the categories of drivers of change can represent specifically what resource users perceive as causes of social-ecological changes. In this chapter, I explore this gap, given that the literature on natural resources management has highlighted the importance of considering resource users' perspectives for implementing effective management plans (Berkes, Colding and Folke, 2000; Huntington, 2000; Olsson and Folke, 2001; Begossi, 2008; Fernández-Llamazares *et al.*, 2016).

Based on a literature review of publications from 2000 to 2017 which contained the keywords "driver", "change", "natural resources management" and "perception", I found that there has been a growing trend of intertwining these concepts since the turn of the century (see section 1.6). Additionally, there are three main conceptual frameworks that have been used in current research devoted to studying drivers of change: the Millennium Ecosystem Assessment framework (MA, 2005), the IPCC (2014), and the IPBES (Díaz *et al.*, 2015). The Millennium Ecosystem Assessment can be regarded as the most influential because it was the most frequently cited, as well as one of the core concepts of this approach (ecosystem services) was mentioned in 104 out of 135 studies reviewed.

According to the Millennium Ecosystem Assessment (MA 2005a), drivers are defined as any natural or human-induced factor that directly or indirectly causes a change in the ecosystem. Alternatively, Hagerman and colleagues (2009) defined drivers as "*key factors and forces (potentially from either or both biophysical and social domains) for which there is empirical evidence to indicate a measurable contribution to a set of observed phenomena*" (Hagerman *et*

al., 2009:2). The Intergovernmental Panel on Climate Change distinguishes two main categories of drivers of greenhouse gases emissions: immediate drivers and underlying drivers (IPCC, 2014). Finally, the IPBES defines driver as "*natural or anthropogenic (human-induced) factor that directly or indirectly causes a change in nature*" (Díaz *et al.*, 2015:13). Following these broad definitions, a taxonomy has been created in order to categorize the drivers of change.

As previously described in Chapter 1, drivers of change in natural resources research have been categorized according to: 1) their nature, whether natural or anthropogenic; 2) their potential impact on the ecosystem, whether direct or indirect; and 3) the section of the system being studied, whether endogenous or exogenous to the cut made by the researcher. These categories are not the extensive list of categories of drivers of change, but they represent the three main frameworks identified in the reviewed literature. Below, I give some examples of phenomena that have been classified under each of these categories.

Researchers have classified a myriad of processes as natural (also called biophysical or environmental; Taylor *et al.*, 2008; Perry *et al.*, 2010) drivers of change, as opposed to anthropogenic, (also called socio-economic drivers). Regarding the former category, examples given by researchers include volcanic activities, natural climate variations, and photosynthesis. As emphasised by the IPBES (Díaz *et al.*, 2015:13), natural drivers "*are not the result of human activities and are beyond human control"*. Considering the latter (anthropogenic), examples given by researchers include: fishing, hunting, mining, bombing, farming, and land-cover change (e.g. Chapin *et al.*, 2000; Gerald C. Nelson *et al.*, 2006; Halpern *et al.*, 2008; Kronen *et al.*, 2010; Perry *et al.*, 2010). In sum, anthropogenic drivers result from human activities. Although the difference between natural and anthropogenic drivers is stated by the frameworks previously mentioned, an underlining assumption of this taxonomy is that anthropogenic drivers are not

natural. In other words, this difference may further reinforce the idea that human actions are not natural, which creates an artificial separation between humans and their environments.

Another set of categories, organized by the Millennium Ecosystem Assessment (MA 2005a), classified drivers of change as direct or indirect. "*A direct driver unequivocally influences ecosystem processes*" (MA 2005a:33), for example, two processes have commonly been called direct drivers of change in coastal ecosystems: fishing and land-cover change (Benjamin S. Halpern *et al.*, 2008; Crowder *et al.*, 2008; Reyers *et al.*, 2009). As opposed to direct, "*an indirect driver operates more diffusely, often by altering one or more direct drivers*" (MA 2005a:33). Examples of processes researchers have classified as indirect drivers include socio-economic factors (Cinner and McClanahan, 2006; Knudsen, Zengin and Koçak, 2010; Kronen *et al.*, 2010), demographic shifts (MA, 2005a), culture and religion (MA, 2005a), and science and technology (Side and Jowitt, 2002). The IPBES' framework also proposes the classification of drivers as direct and indirect (Díaz *et al.*, 2015).

Lastly, drivers of change are classified as endogenous and exogenous (MA, 2005a), according to the decision the researcher makes in bounding the system. The most common examples of exogenous drivers (which are uncontrollable by a local decision-maker; MA 2005a) are climate change (Badjeck *et al.*, 2010; McIlgorm *et al.*, 2010), market forces (e.g. Cinner and McClanahan, 2006), and globalization (Berkes *et al.*, 2006). Among the endogenous drivers, researchers have classified a variety of processes that could be under the influence of a given decision-maker. So these drivers are recommended for intervention purposes (MA 2005a), as opposed to exogenous drivers, which the system can only cope with or adapt to them.

Based on the main frameworks used to identify drivers of change in the context of NRM, I found three sets of categories: natural/anthropogenic; direct/indirect; exogenous/endogenous.

One issue that can be identified when considering these sets as a body of taxonomy, is that these categories are not mutually excluding (for example, a direct driver can also be natural and exogenous), which may indicate that the body of categories identified in the literature is not complete (see section 1.6.2.1). In the case of the distinction between natural and anthropogenic categories, the naming of the categories can cause further confusion, given the fact that human activities are natural phenomena as well. These issues may escalate when one is trying to identify (and categorize) drivers of change based on stakeholders' perceptions, due to the fact that verbal reports about causes of changes may contain different elements, and the researcher has to identify which one is representative of the perception. In order to conduct such analysis, it was necessary to look for suitable approaches to study individuals' perceptions.

3.1.1. Approaching the perceptions of causes of social-ecological change

The identification of a "change" results from perception processes. Perceiving a change is to conclude that an observed event cannot be allocated in any of the individual's reference categories, classified from observable events. Therefore, research that aims to understand changes must take into consideration the processes of perception, before concluding that an actual change happened. Although a large body of literature on social-ecological changes has been developed in recent NRM studies, researchers have rarely taken the perception processes into consideration (despite the fact that research in Cultural Ecology has pointed to this direction since the decade of 1980; for example, see Orlove, 1980).

Imagine a researcher investigating "climate change" by interviewing people in a small village. Suppose one research participant says that the climate is more unpredictable nowadays than it used to be when he was younger. How can this researcher distinguish between "climate

change" and a "change in an individual's perception of climate"? Based on the material collected from the interview, it is similarly possible that weather patterns actually changed, and that the individual's perception about weather patterns changed. Therefore, one cannot say that an "object" has changed without assessing the perceptual process that led to this conclusion.

A qualitative approach provides researchers with appropriate methods to analyze how individuals perceive causes of changes (Stake, 2010). When one is investigating the causes of changes, a layer of abstraction is necessary to apprehend based on perception, and cause-effect relationships come into place. Therefore, a science that aims to understand social-ecological changes has to consider all perception processes, including the ones from the researcher, because these processes guide the assessment and classification of data (Kuhn, 1974). Researchers have to be especially careful when they are assessing the causes of changes with the purpose of intervention, which is often the case of research in natural resources management – to supply decision-makers with "scientific" information. If the causes of change identified result from misleading perception, such as when researchers use a pre-defined set of categories to organize what research participants say, then scientists can trigger a process of creating "facts" from "words" (Bourdieu, 2011), which may end up exacerbating pre-existing conflicts, instead of building participatory spaces (Eastwood, Fischer and Byg, 2017).

One form of misleading perception is by prioritizing the categories in which data can be allocated. During my study, I found it difficult to imagine how to allocate specific elements from individuals' perceptions into the drivers' categories from the literature (see results section). For example, when a fisher told me that the forest has recovered (change) because of the abandonment of banana plantations (driver), this "driver" could be classified under direct, anthropogenic (as well as natural, given that the decision of abandoning banana plantations was a

human behavior - i.e. a natural phenomena), and endogenous (and even exogenous, depending on the geographic and temporal cut made to study the system). Therefore, I felt that it would be arbitrary to choose one category as the most suitable among all the others, as well as to decide which of the categories would be the most relevant since the literature does not discuss their degree of relevance or taxonomy. This type of difficulty pushed me to search for other approaches that could help me specifying which elements from the verbal report could objectively represent individuals' perceptions.

3.2. Methods: qualitative approach

Fieldwork was conducted in Tarituba, a coastal village located in the municipality of Paraty (Figure 1.1), southeastern coast of Brazil, from November 2010 to October 2011. Tarituba has a population of 800 to 1000 people. During this period, I spent 161 days living in Tarituba, in monthly trips that lasted from 6 to 18 days each (see Table 1.4). I used a qualitative approach in which participant observation was the methodological strategy to conduct informal interviews (Bernard, 2011). Qualitative approach stresses the search for the meanings that people attribute to their experiences (Michelat, 1981; Patton, 2002; Stake, 2010). More details on the theoretical approach, data collection and analysis procedures can be found in Chapter 1 (section 1.7.2).

3.2.1. Selection of participants

According to Michelat (1981), in qualitative research it is paramount to choose the most diverse group of individuals to interview. In order to capture the broadest range of occupations found in the village, I selected participants based on a purposive sampling strategy (Tongco, 2007). In Table 1.5, I summarize participants per occupation included in the sample.

Occupations included individuals whose livelihoods depend directly on local resources, such as fishers, fish market or fish processing workers, and tourism entrepreneurs; and individuals that live in Tarituba, but do not depend directly on local resources for livelihoods, such as an NGO member, public service staff, teachers, workers on the tourism, and industry workers, either seasonal or year-round. Along with occupations of village dwellers, I also included individuals whose occupations were related to the village's natural resources management, such as municipal politicians, community leaders from other villages, and environmental agency staff. The purpose and objectives of the study were explained to potential research participants, and when oral consent was obtained, the interview process started. In total, 38 participants were included in the data collection procedure.

3.2.2. Data collection procedures and analysis

As described in section 1.7.2, a participant observation strategy was used to build rapport and to conduct informal interviews. Three themes were used to prompt interviews: values and relationships people have with their environments, changes in natural resources use and social organization, and the drivers of those changes. The first two themes were analyzed on Chapter 2, where I discussed the concepts, categories and methods used for the identification of ecosystem services. In total, 107 interviews instances were registered, which lasted 21.4 minutes on average. Interviews were registered in Portuguese (native language of both researcher and participants) as soon as they finished, and no audio-recordings were used.

Along with the interviews, daily field activities were registered as field notes, which were used to complement data analysis, and to discriminate which were my own perceptions. According to Bernard (2011), one form of assuring objectivity when using a qualitative approach

is to "*become aware of our experiences, our opinions, our values*" (Bernard, 2011:370). Therefore, in my field notes' reports, I kept a separate document to register my own views of the process. Additional data was collected in documents, including reports, scientific publications (Begossi *et al.*, 2010 and Hanazaki *et al*., 2013), traditional songs and dances (Nascimento *et al.*, 2004; Andrade, 1962), and videos from movies and a soap opera filmed in study site.

After reading and re-reading the transcripts of the informal interviews (impregnation - Michelat, 1981), the material was coded using keywords to indicate where a change was reported (e.g. "change"). After coding the interviews, I organized all quotes about change on a table, and discriminated when a cause for the observed change was also reported. The nature of the observed change was also discriminated, whether they were happening on social or/and ecological domains. When more than one participant reported the same observed change and reported causes were different, this difference was also noted. Finally, participant and respective occupation was described for each quotation. After listing all the verbal reports about changes in a table, I analyzed them in order to find individuals' perceptions.

Analysis of verbal reports is the identification of the non-explicit meanings in the answers given by research participants. This approach has been successfully used by several authors in different areas, such as philosophy (Foucault, 2010), psychology (Michelat, 1981; Tunes and Simão, 1998), sociology (Weber, 1991; Bourdieu, 2011), and history (Veyne, 1971; Riscal, 2001). Succinctly, the tool presented by Tunes and Simão (1998) and Michelat (1981) consists of finding the *units of meaning* (the basic components of the verbal report) from the pool of collected verbal reports. These fundamental units of meaning are the output of the analysis of verbal reports, and they were used to specify the diversity of reports about causes of change. The

units of meaning identified were later classified according to intermediate categories which emerged during the analysis (further details on data analysis in section 1.7.2).

3.3. Results

3.3.1. The analysis of individuals' perceptions of causes of social-ecological change

In total, 72 verbal reports about social-ecological changes and their causes were collected. All the verbal reports are listed in Table 3.1, which contain the verbal report, the domain of the change (social/ecological), and the occupations of the participants. Changes, as reported by participants, include those on the social domain, for example "*increase in the number of vessels*" and "*lifestyle change*", those on both social and ecological domains, for example "*pollution*" and "*aquaculture*", and those on the ecological domain, like "*death of local algae*" and "*forest regeneration*". In all the perceived changes, however, I could identify a component of human intervention, even those on the ecological domain. Therefore, changes included in the ecological domain are those in which an ecological regulation/deregulation is the indirect result of a human intervention.

Some changes were reported by two or more participants, such as lack of fish (or decline in fish numbers), and some changes were reported by a single participant, such as change in the requirements to perform specific roles in local dances. For changes perceived by more than one participant, the perceived causes were similar in some cases, and varied in others. For example, a fisher and the president of a local environmental NGO said that there is a larger number of vessels on the Ilha Grande bay (the bay where the municipalities of Paraty and Angra dos Reis are located – see map in Figure 1.3) because of the off-shore oil exploitation (*Pré-sal*). On the

other hand, one fisher said that the observed lack of fish is due to the "*shrimp trawling activity*", while a fish market employee said it is due to the "*use of sonar by industrial fisheries*", *"which scares the fish away*".

The diversity of verbal reports about causes of changes (perceptions' products) made the classification of the findings into the available categories (from the literature) a difficult task. As explained in the introduction, some reported causes of change could be accommodated under three or four types of drivers of change, according to the categories of the literature. For example, "shrimp trawling activity" could be included in the categories "direct", "anthropogenic", and "endogenous" driver, with the same degree of relevance. In other words, the phenomenon would have three equally important "causes", if it were to be classified under the categories of the literature. For this reason, I conducted a qualitative analysis of the verbal reports collected in order to find specifications in the perceived and reported causes of change.

Table 3. 1 - Changes in social and ecological domains, their causes according to research participants' verbal reports in Tarituba, and the implicit causes inferred from the verbal reports, represented by the intermediate categories: behavioural, economic, political, administrative, and sociologic. Occupations of individuals are listed in the last column. The total number of verbal reports about causes of change is 72, and the number of participants interviewed is 38.

Perceived "change"	Domain		Perceived "cause"	Inferred perceptions (non explicit nature of the phenomena)	Occupation
	Ecol.	Social			
Increase in number of vessels		X	*Pré-sal* (off-shore oil exploitation)	Political/economic	Fisher
			Industrial fisheries (overfishing)	Behavioral	
			political decisions (larger fishing boats can fish close to the shore)	political/administrative	
			Pré-sal (off-shore oil exploitation)	Political/economic	President of environmental NGO (p.1)
Life style change		X	"More money today than in the past, but life is more difficult nowadays"	Behavioral/economic	Fisher
			Construction of the highway and nuclear power plant	Political	Cultural curator
			"Many people now work on tourism"/abandonment of agriculture	Behavioral/economic	Restaurant owner (president of community association)
Death of local algae	X		Arrival of invasive species of algae brought by ships that come to the bay	Economic	Fisher
Island use change		X	Protected areas	Political/administrative	Fisher
Poor water quality of the beach	X	X	Construction of the highway	Political	Fisher
Deactivation of the *Cerco* (pound net fishing)		X	"Not profitable because there is no fish"	Economic/behavioral	Fisher
Pollution	X	X	Release of sewage	Administrative	Fisher
Climate unpredictability	X		"It was more predictable when I was younger"	Behavioral	Fisher
			"It was easier to predict in the past"	Behavioral	*Pousada* owner (p.18)
Forest regeneration	X		Abandonment of banana agriculture	Economic	Fisher

Lack of fish (fish stocks decline)	X	X	"Industrial fisheries capture the food of the fishes that enter the cove of Tarituba"	Economic/behavioral	Fisher
			“Fish disappear during the Lent”	Behavioral	Fisher
			Shrimp trawling fisheries (overfishing)	Behavioral/economic	Fisher
			Spear-fishing and overfishing	Economic/behavioral	Cultural curator
			“Use of sonar by industrial fisheries. Sonar frighten the fish away”	Economic/behavioral	Fish market employee
			“Industrial fisheries capture the base of the marine food web”	Economic/behavioral	Public service staff (fireman)
			“Trawling activity kills juvenile fish”	Behavioral/economic	Industry worker
“More birds visiting my house”	X		“Forest recover” + “I put fruits for them to eat”	Behavioral	Fisher
“There is more fish in the cove of Tarituba”	X		Creation of a protected area by local resource users	Political/administrative	Fisher
Creation of protected area by local resource users	X	X	“Fishers reclaiming their fishing areas”	Administrative	Public service staff (fireman – former fisher)
“I am adapting my fishing boat”		X	More tourists	Economic	Fisher
Aquaculture of algae	X	X	Economic activity	Economic	Fisher
Change in social status – apprentice to official fisher		X	Accomplishment of a learning cycle	Sociologic	Fisher
“Arresting of fishers”		X	Protected areas	Political/Administrative	Fisher
“Water temperature is lower than expected for this time of the year”	X		----	Behavioral	Fisher

Punctual increase of number of fish	X		*Engodo* (nutrient input in a given area)	Behavioral/administrative	Fisher
Food habits change	X	X	Abandonment of small-scale agriculture / Arrival of "progress" / construction of the highway / Individualism	Behavioral	Cultural curator
			Trade with outsiders	Administrative/behavioral	Restaurant owner (president of community association)
Reduction of collective labor activities		X	"People are more individualistic"	Behavioral/sociologic	Cultural curator
Demographic growth (Tarituba and whereabouts)		X	"Construction of the highway and nuclear power plant"	Political/economic	Cultural curator
			Land speculation (tourism and second houses)	Economic	Public service staff
			Land speculation (second houses)	Economic/behavioral	Restaurant owner
"We cannot find oyster on the left side of the beach anymore"	X	X	"Construction of the highway increased water turbidity"	Behavioral/political	Cultural curator
Conflicts over soccer field "a pousada owner started to use the soccer field (communal) as a parking lot"		X	Lack of formal tenure of the communal soccer field	Behavioral/administrative	Fish market owner
"use of smaller mash size (100 in the past, 70 now) to catch sharks"	X	X	Intensification of fishing effort by industrial fisheries (overfishing)	Behavioral/economic	Fish market employee
"Fishers have lost territory"		X	Creation of the ESEC Tamoios (protected area)	Political/administrative	Public service staff (fireman – former fisher)
"This region is likely to change very much"	X	X	Pré-sal (off-shore oil)	Political/administrative	Chief of ESEC Tamoios (protected area)

“Change in species composition of the bay”	X		“Invasive coral species” (Tubastraea) “brought on the hull of ships that enter the bay”	Administrative	Chief of ESEC Tamoios (protected area)
“Increase of number of off-shore oil platforms”		X	Pré-sal (off-shore oil exploitation)	Economic/Political	Chief of ESEC Tamoios (protected area)
“Small-scale fishers have to travel further to not fish on protected areas”		X	Creation of the ESEC Tamoios (protected area)	Political/administrative	Chief of ESEC Tamoios (protected area)
“Palm trees have to be planted “in line” on a property in order to follow the environmental legislation, and not randomly as we did before”	X	X	Enforcement of environmental legislation	Political/administrative	Public service staff (environmental monitor)
“The sea water turned very dirty during the construction of the highway”	X	X	Construction of the highway	Political	Helper (freelancer)
Change of land tenure (from customary ownership –verbal agreement - to formal private property)		X	Arrival of “outsiders” who started buying land in Tarituba	Administrative/economic	Helper (freelancer)

"Before, Caiçaras lived from banana and manioc agriculture and artisanal fisheries"	X	X	-----	Behavioral	Restaurant owner (president of community association)
Trawling fisheries arrived in 1940's		X	"The technique was brought by the Portuguese… … When the first trawling boat arrived here, people scared the fishers away, but latter, the technique spread."	Behavioral/Sociologic	Restaurant owner (president of community association)
Change in transportation: "before, people would go to Angra or Paraty on canoes."		X	"To buy groceries or to go to the hospital"	Behavioral	Restaurant owner (president of community association)
Change in "requirements" to perform specific roles in local dances		X	"Younger girls are not familiar with the dances, so the adult women have to perform the dances themselves"	Behavioral/sociologic	Ice cream store owner
Change in fish species offered in restaurants		X	"I buy this fillet [Pangasius] from a vendor from Rio… … Local fishes are more expensive and have more bones."	Economic	Restaurant owner (p.12)
Coconut palms planted on the beach	X	X	"These trees were planted when the soap opera was filmed"	Economic	Restaurant owner (p.6)
Local rhythms and dances became a touristic attraction		X	Increased demand for touristic services	Economic	Former president of community association
"Tarituba has grown [demographically] less that other villages in the region"	X	X	"People want to preserve a quiet style of life"	Behavioral	Former president of community association (p.23)
			"People are not willing to sell their lands. Prices are higher than in neighboring villages"	Behavioral/economic	Industry worker (p.32)
			"People like to have a quiet lifestyle"	Behavioral	

			"Families that have land do not want to sell them"	Behavioral/economic	*Pousada* owner (p.10)
Death of mussels from aquaculture plot	X	X	"the water became too warm – because of natural phenomena, like El niño or La niña"	Behavioral	Industry worker (p.32)
Trawling activity established		X	"Law of minimum effort" – trawling fishers work less than do other fishers	Behavioral	Industry worker (p.32)
			Abundance of shrimp on the first years of trawling activity	Economic/behavioral	Pousada employee (former fisher) (p.25)
Expected demographic grow	X	X	*Pré-sal* and Nuclear power plant	Political/economic	President of Environmental NGO (p.1)
Dredging of the seabed	X	X	*Pré-sal* (off-shore oil exploitation)	Political/economic	President of Environmental NGO (p.1)
Aquaculture development	X	X	"Fish will reproduce inside the tanks, and rebuild the fish stocks in the bay"	Economic	President of Environmental NGO (p.1)
Death of cultivated Coquille St. Jacques (Nodipecten nodosus)	X	X	"The water temperature in the summer is too high for this species"	Economic/behavioral	President of Environmental NGO (p.1)
Houses were made with wood and mud		X	-----	Behavioral	*Pousada* owner (p.18)
Loss of fishing territories		X	Creation of the ESEC Tamoios	Political	*Pousada* owner (p.18)
Less frequent fishing		X	Lack of fish/prohibition to fish in some areas	Behavioral/political	*Pousada* owner (p.28)
Change in local fishing rules		X	Imposition of new fisheries regulation by the government (ESEC Tamoios)	Political/administrative	*Pousada* owner (p.28)
End of banana agriculture	X	X	"Banana prices were too low, and could not compete with the ones from Bahia"	Economic	*Pousada* employee (former fisher) (p.25)
End of the island agriculture		X	Land ownership conflicts	Economic/behavioral/administrative	*Pousada* employee (former fisher) (p.25)

To illustrate how I conducted this process, I will use the same example: “lack of fish” is caused by “shrimp trawling activity”. The “cause of change” mentioned (shrimp trawling activity) is, first of all, a fishing technique (“behavioral” nature), also an economic activity (“economic” nature), that happens in a “political” and “sociological” context, influenced by “administrative” reasons. After conducting this analytical process of the verbal reports about causes of change, I identified that all verbal reports obtained could be classified according to five intermediate categories that emerged from the analysis: behavioral, economic, political, administrative and sociological.

These are the definitions I used for the intermediate categories: *behavioural* refers to actions of individuals, like a fishing technique, the desire of maintaining a quiet style of life, aspirations, and change in habit. *Economic* was used when a report refers to actions oriented to an economic goal, such as trading of products, business decisions, or oil exploration. *Political* included reports that concern political decisions, for example the federal decision to build a highway, or to create protected areas. *Administrative* refers to reports concerning time and resources management, such as where and when to fish. Finally, *sociological* was used when the report refers to social phenomena, such as religious ceremonies, rehearsal of the music group, or community festivals.

While some perceived causes of change could be totally represented by a single intermediate category (see examples in the next subsection), most of the perceived “causes” have a stronger component of one of the categories, for example, behavioral, and a component of supplementary category, for example, economic. In cases like this, I classified the non-explicit nature of the phenomenon (perception) as “behavioral/economic”. I analyzed all the verbal

reports about perceived causes of social-ecological changes, in order to identify which of the categories could accommodate each perceived cause of change. Results are listed in Table 3.1.

3.3.2. Drivers of change as they are perceived by individuals in Tarituba

In total, I found 72 reported causes of social-ecological changes on the collected material. In Table 3.2, I portray the number of times each of the intermediate categories (from the verbal reports) accommodated a perceived cause of change. When more than one category could accommodate the perceived cause, the strongest one was computed, which is represented in the lines of Table 3.2. Around 39% of the perceived causes of change have a stronger behavioral nature, 29% have a stronger economic nature, and 25% have a stronger political nature. A stronger administrative nature was found in 7% of the perceived causes of social-ecological changes, and a stronger sociological nature was found in 1%.

Table 3.2 – Percentage of each type of categories of perceived causes of changes. Rows represent the "stronger" perceived cause, and columns represent the "supplementary" perceived cause in the verbal report. The total number of verbal reports analyzed was 72 (for the descriptions of the reports, see Table 3.1).

	Behavioral	**Economic**	**Political**	**Administrative**	**Sociologic**	**Total (stronger cause)**	**% (stronger cause)**
Behavioral	14	7	2	2	3	**28**	**38.9**
Economic	9	10	1	0	0	**20**	**27.8**
Political	0	5	4	9	0	**18**	**25.0**
Administrative	1	1	0	3	0	**5**	**6.9**
Sociological	0	0	0	0	1	**1**	**1.4**

The analysis using the specifications from the perceived causes of social-ecological changes informed the assignment of data under the categories from the literature. For example, when a former fisher reported that the "*fishers have lost territory after the creation of the ESEC Tamoios*" (protected area), I could identify that the direct driver (creation of a protected area) was a "political" decision, therefore has a stronger political nature. At the same time, the indirect driver of this decision is "administrative" (the decision determines where to fish). Therefore, by using this analysis, I could specify what was more relevant in each of the broad categories of drivers of change from the literature: the political decision (direct driver) and the administrative influence (indirect driver).

Most frequently, direct drivers of change contained a strong behavioral component. Behaviors that seem to directly cause a change in the social-ecological system include: 1) causes that are the result of individual behavior, such as the decision "*people want to preserve a quiet style of life*" (which is the perceived cause for the slower development rate of Tarituba, when compared to neighboring villages), or to "*put fruits for them [the birds] to eat*" (as the perceived cause for the increased visits of birds); and 2) "causes of change" that cannot be disconnected from the perceptual processes of the individual – which makes it impossible to affirm, only based on the verbal report, that a change actually happened. For example, two participants said that the climate is more unpredictable nowadays, by mentioning that "*it was more predictable when I was younger*" or that "*it was easier to predict in the past*". When the behavioral was not the sole nature of the perceived change, other causes modulated the behavioral component. For example, a participant said that Tarituba has "developed" less than other villages because "*people are not willing to sell their lands… …prices are higher than in other villages*". In this case, the stronger behavioral nature is modulated by an economic factor.

Perceived causes of change were also accommodated under the economic category. In such cases, I included the perceived causes related: 1) to the economic activities at the individual level, such as the fisher that was adapting his fishing boat for touristic trips; 2) to the economic activities of the village, such as the end of the banana agriculture because, as reported by a participant, "*banana prices were too low*"; and 3) to the national economy, such as the off-shore oil exploitation, Pré-sal, which is perceived as the cause of the "*increased number of off-shore oil platforms*". In the latter case, a political component was identified as the modulating factor (economic/political).

Among the perceived causes of change that were accommodated under a stronger political non-explicit nature are: 1) those that are the result of political decisions only, such as "*the creation of the ESEC Tamoios*", a protected area created by the federal government in 1990, which is perceived as a cause of changes in the area and; 2) those that are due to a stronger political nature, but modulated by another driver. For example, a political decision that allows larger boats to fish closer to the shore (in the areas where only boats up to 9m could fish before) is perceived by a fisher as the cause of the "increased number of vessels" in the area, so an administrative component modulates the political nature (political/administrative).

The perceived causes of changes that have a non-explicit administrative nature include for example, "*fishers reclaiming their fishing areas*" which is perceived as the cause of the creation of a local protected area, based on local rules. The administrative was the stronger non-explicit component of the perceived causes in 7% of the cases, and it was more frequently identified as a modulator of economic processes. Although I identified only one perceived cause of change which is sociological by nature ("*the accomplishment of a learning cycle*", perceived by a fisher as the cause of the "*change in status from apprentice to official fisher*"), some

perceived causes have a sociologic component as modulator of behavioral drivers. For example, a cultural curator perceived “individualism” as the cause of the “*reduction in collective labor activities*”. Therefore, the behavioral nature of the process is modulated by a sociological component.

The same rationale was used for the other categories of drivers of change identified in the literature (anthropogenic/natural; endogenous/exogenous). The analysis I conducted also specified which characteristic of the driver was more relevant in those categories. For example, regarding the perceived change "lack of fish", the strongest component of the perceived cause, "shrimp trawling activity", is behavioral. Thereby, the behavioral component is the relevant characteristic of this *anthropogenic* driver. Also, because the behavior is individual, it is also the relevant characteristic of this *endogenous* driver. Some participants reported changes on how to plant trees. According to one research participant, "*palm trees have to be planted “in line” on a property in order to follow the environmental legislation, and not randomly as we did before*". By using the intermediate categories, I could specify that the "political" decision of implementing environmental regulations was the most important characteristic of this exogenous driver.

With regards to the classification "natural" driver of change, participants seem to perceive them as linked to human activities. For example, one research participant reported an episode when all the mussels from an aquaculture plot died. According to him, "*the water became too warm because of natural phenomena, like El niño or La niña*". Discussing the same episode, another participant reported that "*the water temperature in the summer [in Tarituba] is too high for this species*". In this episode, the driver of the reported change could not be regarded as entirely natural ("*not the result of human activity*" and "*beyond human control*" - as defined by

the IPBES framework), as it was perceived as a mismatch between the species chosen to the aquaculture and the natural condition of the area. Therefore a behavioral component could be identified as the most relevant perceived characteristic of this driver, which helped to specify the cause of this change. On the next section, I illustrate how this framework could enhance the precision of the identification of drivers of change based on local people's perceptions.

3.4. Discussion

3.4.1. Verbal reports provided specifications to fill the categories of drivers of change from the literature

The NRM literature has stated that the local knowledge and local institutions are fundamental pieces to be considered in management strategies (Ruddle, 1998; Berkes, Colding and Folke, 2000; Huntington, 2000; Johannes, 2002; Begossi, 2008). Additionally, there is ample recognition of the inadequacy of top-down management strategies (those that are developed by a central government and imposed to resource users) in several instances (e.g. Nielsen and Vedsmand, 1999; Acheson, 2006). Therefore, approaches that can identify stakeholders' perceptions of their human-environment relationships (and the dynamics of these relationships) can contribute to the development of effective management strategies.

As a matter of fact, there has been a growing trend of publications using the term "perception" in the context of NRM (see Chapter 1), and current research analysing the importance of considering resource users' perceptions (Asah *et al.*, 2014; Fernández-Llamazares *et al.*, 2016). However, a review conducted on NRM literature that considers the perception of stakeholders revealed that very few studies have defined what perception mean in their studies (see Chapters 2 and 4). Sometimes, perception is used in exchange of terms like opinion or

knowledge, which has already been pointed by other authors (Fernández-Llamazares *et al.*, 2016). This interchangeability seems to be the result of a methodological inaccuracy, that happens when researchers collect statements of research participants over a set of pre-defined items, and report them as perceptions, rather than opinions (see Chapter 2).

The present study is an attempt to contribute to the specification of stakeholders' perceptions of causes of changes in social-ecological systems. By no means does this study intends to disregard the existing taxonomy of drivers in the current literature. Rather, this study aims to facilitate the assignment of different elements of stakeholders' perceptions in the categories of drivers proposed by international, policy-oriented frameworks, such as the Millennium Ecosystem Assessment (MA, 2005), and the IPBES (Díaz *et al*., 2015).

After collecting verbal reports about causes of changes in Tarituba, I found it difficult to classify the reports into the available categories of the literature, given the fact that some items could be allocated into more than one category with the same degree of relevance. The classification of the perceived causes of change was also difficult because of the diversity of emphasis found on the verbal reports. For the same perceived change, participants emphasized different phenomena or different processes of the same phenomenon (see Table 3.1). For example, participants referred to different causes of current lack of fish: one participant said that the "*trawling activity kills the juvenile fish*", another said that the sonar used by the industrial fisheries "*scares the fishes away*", and still another said that "*fish disappear during the Lent*". The richness of emphasis found even for the same perceived change impelled me to look for an approach that could accommodate these nuances.

The qualitative analysis of the verbal reports was suitable to access these nuances. Based on the specifications in the verbal reports, five intermediate categories emerged from the

analysis, and they could accommodate all the perceived causes of change from the material collected in the field: behavioral, economic, political, administrative, and sociological. These intermediate categories made the process of deciding when to include the perceived causes of change under the categories from the literature easier. Figure 3.1 is a schematic representation of the framework used to assign the perceptions of causes of change to the available categories of the literature.

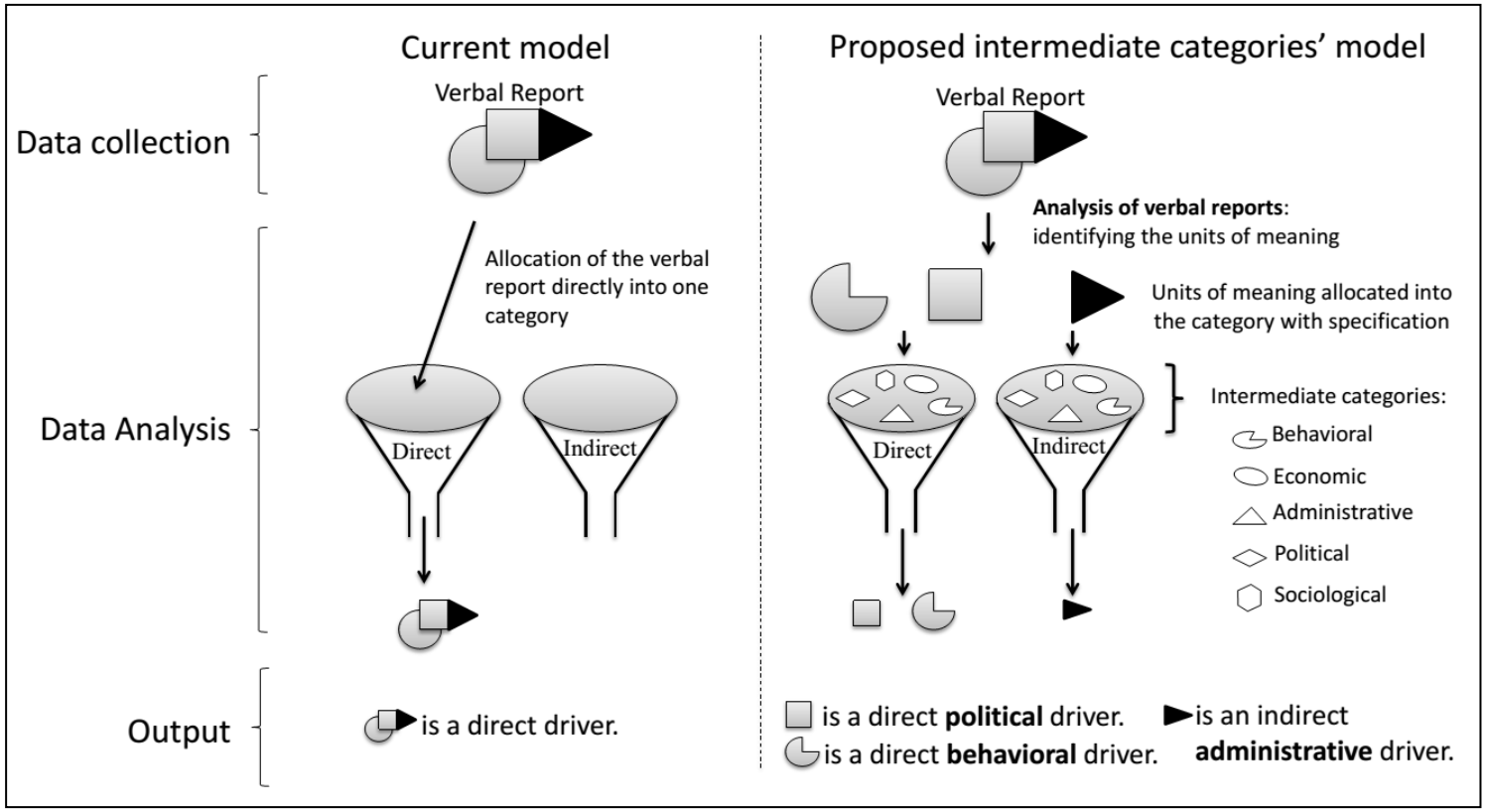

Figure 3.2 - Schematic representation of data collection, data analysis and output obtained by using a) the current model of identification of drivers of change, according to the categories of the literature; and b) the proposed model of analysis used in our study, which includes the specifications (intermediate categories) revealed from the analysis of verbal reports. The output obtained using the proposed model contains specifications of the broad categories of the literature.

Most of the reported causes of change could be represented by the intermediate category "behavioral". For example, a research participant mentioned that the cause for the slower development rate of Tarituba, when compared to neighboring villages is that "*people want to preserve a quiet style of life*". Therefore, the nature of the perceived driver of change is behavioral, the desire to preserve a quiet style of life, which is the direct driver. Sometimes, the behavioral category was the strongest one, but a supplementary category was identified as the modulator of the behavioral component. For example, one participant mentioned that because of the intensification of the industrial fisheries, the mesh size of the nets used to catch sharks is smaller now ("*before it was 100, now it is 70*"). So, the indirect driver of the behavior (fishing technique) is economic (industrial fisheries, as an economic activity).

By conducting this analysis for all the perceived causes of change, I could tell when the driver was either direct or indirect, and even specify the nature of the driver. For the other categories of the literature the same logic holds. For example, when the participant mentioned that there has been an increase in the number of vessels because of the activities of the *Pré-sal* (off-shore oil exploitation), I could identify that a political decision at the national level was the exogenous driver that was perceived as an impact to the local social-ecological system. Therefore, perceived and reported causes of change in which the behavior was the specific direct driver could be considered endogenous, because they were happening at the individual level. The implication of this finding for decision-making processes is that competent interventions are likely to modify endogenous drivers in order to reach desirable outcomes. However, a competent intervention in behavior will demand truly interdisciplinary approaches, with professional support for behavioral interventions.

With regards to the categories anthropogenic and biophysical (natural), I identified that all the perceived and reported changes and their causes contain a component of human intervention. Either the intervention is the direct cause of the observed phenomena (for example the coconut trees were planted on the sea shore during the production of a soap opera filmed in the area, in 1992), or the intervention leads to an ecological regulation/deregulation (for example the "death of local algae" was perceived as result of the introduction of exotic species of algae, brought by ships that come from outside the bay). Sometimes, the perceived cause of change is reported as a natural phenomenon, for example, one participant said the *El niño* caused the death of local mussels in the aquaculture plot. However, another participant mentioned that the cultivated mussels, exotic to this area, cannot cope with the summer in the area, because water temperatures in Tarituba are higher than the water temperatures of southern regions where this mussel comes from. Therefore, I could not identify from the verbal reports, a "natural" (biophysical) driver totally disconnected from human actions.

The use of the specifications found in the verbal reports (intermediate categories) helped to allot the perceived causes of change under the categories from the literature more precisely. Moreover, all the verbal reports could be allocated by using the intermediate categories: behavioral, economic, political, administrative and sociological. The evaluation of this framework by other researchers, studying other social-ecological systems may contribute to its refinement and improvement in the research of natural resources management. The interdisciplinary nature of our field of research allowed me to use methods and approaches from other disciplines. Specifically with regards to the approach used here (analysis of the verbal reports), it has been successfully used in other disciplines, such as psychology (Tunes and

Simão, 1998; Michelat, 1981), sociology, and history (Veyne, 1971; Riscal, 2001), and provided effective results.

3.4.2. Implications of the findings for the research in natural resources management

Research in natural resources management has begun a shift from approaches that are based exclusively on managers' expertise to approaches that include the knowledge, experiences, and perspectives of resource users as well (Berkes, Colding and Folke, 2010). Several researchers have been working in order to make this shift happen. Some prominent approaches are co-management (Berkes, 2009b), adaptive co-management (Armitage *et al.*, 2008), place-based management (Young *et al.*, 2007), ecosystem-based management (Robert C Francis *et al.*, 2007), fishing agreements (de Castro, 2002), just to cite a few. Sometimes with blurred boundaries, those approaches share the assumption that the management of social-ecological systems has to consider the complexities inherent to these systems, and to include multiple perspectives (different forms of knowledge), especially those of resource users, in order to strengthen the diagnosis and management strategies.

This study shares the same assumption, and my research focused on finding ways to fully represent the diversity of research participants' perceptions about drivers of change in social-ecological systems. The diversity of perceived causes of change reported by research participants was, at first, difficult to accommodate under the categories of drivers of change from the literature. The main reason for this difficulty is that the categories of the literature are too general. The analysis of the nuances (specifications) mentioned by research participants, using the technique of analysis of verbal reports (Tunes and Simão, 1998), disclosed fine-grained data about causes of change. In the same way that these specifications guided the classification of key

processes of change in social-ecological systems (diagnosis), they could also inform the planning of interventions based on specific aspects that are relevant for those involved in the use and management of natural resources in a given area. Therefore, the present study can also contribute to approaches that look for better ways to integrate local knowledge into management plans (e.g. Berkes, Colding and Folke, 2000; Begossi, 2008).

Because of the exploratory characteristic of this study, some issues should be recognized as they could be tackled in future studies. The ultimate goal of NRM studies is to develop management strategies that can assure the sustainable use and management of natural resources, in order to guarantee livelihood options for those who depend on them. In the present study I did not develop an intervention based on the perceptions of resource users. Despite the fact that this was not the objective of the study, this process could reveal other elements of perception that were not fully captured by intermediate categories identified. Additionally, in order to assure the accuracy of the identified intermediate categories, it would be recommended to conduct another degree of verification, in which research participants could review the categories of perception identified, and assess their accuracy. This process could also assist the refinement of the results found. Although important, these steps were not conducted in the present study due to the fact that it was not initially planned, and due to time constraints. An example of intervention, planned on the basis of the qualitative analysis of verbal reports, can be found in Tunes and Simão (1998).

3.5. Conclusion

Verbal reports about changes in social and ecological domains varied among research participants, and even the same participant reported various aspects of a single change in

Tarituba. Reported changes were identified to be happening both on social and ecological domains, however, research participants seem to perceive ecological changes as a function of human activities - which often lead to an ecological deregulation. Perceived causes (drivers of change) also varied, and participants emphasized different aspects of the same perceived cause. A behavioral nature of the reported causes were the most frequent perceived characteristic of drivers of change, followed by economic, political, administrative and sociological.

The categories of drivers of change from the main frameworks available in current literature revealed themselves too general to represent stakeholders' nuanced perceptions. On the one hand, by using the categories of the literature, I would miss detailed specifications of drivers of change as perceived by research participants; on the other hand, one perceived driver could be assigned to more than one category with the same degree of importance. This imprecision was identified when I considered the current taxonomy of drivers from the literature, which contain categories that are not mutually excluding, and therefore could be regarded as an incomplete set of categories.

A framework was proposed to assist the assignment of the specifications found in the verbal reports to the categories of the literature, which provided detailed information about the most important characteristic of the driver of change, as perceived by research participants. This may enhance the diagnosis of causes of social-ecological change, and provide specific information for possible interventions. Although the qualitative analysis of verbal reports used here has been successfully applied in other disciplines, the evaluation of this approach by other researchers in the field of NRM may contribute to its improvement and refinement to address specific issues of this field.

CHAPTER 4. STAKEHOLDERS' PERCEPTION IN PARTICIPATORY SCENARIO PLANNING APPROACH

4.1. Introduction

Chapters 2 and 3 explored two key concepts of the Millennium Ecosystem Assessment framework, respectively ecosystem services and drivers of change. These concepts have been used to identify the relationships humans have with their environment, and changes in these relationships. In this chapter, I will address the scenario planning approach, which has been recommended as a tool that may assist NRM research and practice, by helping researchers and stakeholders to understand the implications of current actions for the future of a social-ecological system.

Based on the findings that linear, top-down, single species/sector-based approaches to NRM have often been insufficient to achieve sustainable use of natural resources, current research have searched for approaches that are capable of considering the inherent complexities of social-ecological systems. Scenario planning is one of these approaches which aim at considering the unpredictable, non-linear, hierarchical, and complex characteristics of social-ecological systems, by creating alternative perspectives about the future of a given geographic area (Pahl-Wostl, 2008). The analysis of the internal dynamics of such alternative scenarios would enhance stakeholders' capacity to make informed decisions (MA, 2005).

The scenario planning approach was developed, at its beginnings, as a military game, but then it was adapted to the field of business management. One example reported as a successful application of this approach in business is the one of the oil company Shell (van der Heijden 2005; Schwartz, 1996). One landmark of the application of scenario planning in the context of environmental issues was the publication of the International Panel on Climate Change's reports

(IPCC, 2000), where scenarios were used to extrapolate current and alternative trends of emission of greenhouse gases, in order to illustrate what would be the effect of different patterns of emissions along the years.

The publication of the preliminary volume of the Millennium Ecosystem Assessment, in 2003, seems to have further fostered the incorporation of the scenario planning approach into the field of natural resources management, given the influence of this international, policy-oriented document. As a result, there is a growing trend of publications linking scenario planning and natural resources, especially after the year 2003 (Figure 4.1). Accordingly, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, launched in 2012 (https://www.ipbes.net/about), which also recommends the use of scenario planning, may further consolidate scenarios' approach in NRM's research, practice, and policy agendas.

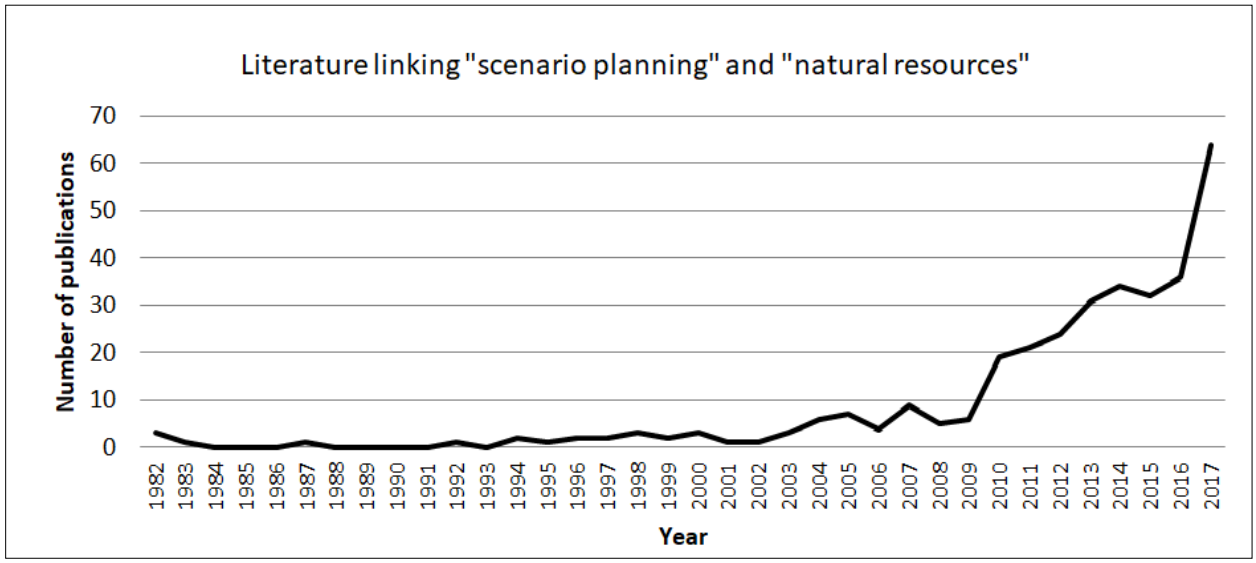

Figure 4.3 - Number of publications per year retrieved by the Web of Sciences' database using the keywords: "scenario planning" and "natural resources". Notice that there is a growing trend of publications linking these two terms, especially after the year 2003. Search conducted in October 2017.

Following the trend of participatory approaches to NRM, as of 2007, researchers have coined the term "participatory scenario planning" (Kok, Biggs and Zurek, 2007; Enfors *et al.*, 2008; Pahl-Wostl, 2008). According to Reed *et al*. (2013), there are numerous reasons supporting participation of stakeholders in scenario planning, such as the democratic right of people be part of an analysis concerning their own future, empowerment of stakeholders, co-production of knowledge between researchers and resource users, and the pragmatic end of delivering higher quality scenarios, by considering relevant local knowledge. However, the degree and phase of stakeholders involvement in scenario planning exercises are highly variable, ranging from more consultative, less participatory approaches (in which final scenarios are presented to stakeholders to elicit reactions), to those with high degree of participation, in which stakeholders are involved since the initial phases of scenario development (Palacios-Agundez *et al.*, 2013; Reed *et al.*, 2013).

In the perspective of increasing participation of stakeholders, the term perception has also been incorporated in the scenario planning discourse in various forms, such as stakeholders' perceptions, problem perception, perception of future, perception change. According to Villamor *et al*. (2014), by incorporating stakeholders' perceptions in decision-making process, "*conservation plans and efforts will likely better achieve desired goals and targets*" (Villamor *et al.* 2014:2). However, based on a review of current participatory scenario planning literature there has been no evaluation on how the concept of perception has been applied in this literature yet (see Chapter 1, section 1.4). I believe that such assessment could contribute to this literature by reflecting on possibilities of operationalization of the concept perception in NRM research.

Thus, the purpose of this chapter is to assess the applicability of participatory scenario planning practice to consider stakeholders' perceptions of social-ecological systems. In order to

do so, my specific objectives are: 1) to describe how the concept of perception has been used in current participatory scenario planning literature, with a focus on assumptions and methods; 2) to assess the efficacy of participatory scenario planning to inform decision-making processes based on stakeholders' perceptions; and 3) to evaluate the use of the qualitative analysis of verbal reports as a potential tool disclose drivers of change based on stakeholders' perceptions.

4.2.Methods

This chapter is based on a critical review (Creswell, 2009) of the current literature linking "participatory scenario planning" and "perception" in the context of "natural resources management". Therefore these terms (in brackets) were used as keywords to select research items published from 2000 to 2017. I used Scopus, ScienceDirect and GoogleScholar databases, and the literature search was conducted in September 2017. Databases were set up to retrieve research items which contained the keywords anywhere in the text (including references), and included journal articles, book chapters, and grey literature (working papers, technical reports, and thesis). Grey literature was considered only if scenario planning was the main subject of the study, in order to assure the relevance of the research item to the objectives of this study.

Retrieved research items were initially organized according to three aspects: 1) whether or not perception was reported as result within the study; 2) whether or not the concept perception was defined; and 3) methodological approach, whether qualitative, quantitative or mixed methods. Following this first categorization, studies which actually described the application of a participatory scenario planning exercise were qualitatively analyzed regarding (a) how perception was reported, (b) the aim of considering stakeholders' perceptions, and (c) the use of ecosystem services and drivers of change as operational concepts.

Data collected during my field research in Tarituba (see methods section - Chapter 1) were considered in the discussion, as follows: results obtained in Chapter 2, regarding the perception of ecosystem services, and in Chapter 3, regarding the perceived categories of drivers of change were used to evaluate the use of the analysis of verbal reports as a tool to address methodological issues identified during the literature review.

The operational definition of perception used in this analysis is "*the extraction and use of information about one's own environment (exteroperception) and about one's own body (interoception)*" ("perception." The Cambridge Dictionary of Philosophy, 2nd ed. 1999). As for the objectives of the present analysis, exteroperception and the perception of facts (which is dependent on individuals' knowledge, system of beliefs, and cognitive systems - ex. memoir, concepts) will be considered.

4.3. Results

4.3.1. Perception in current participatory scenario planning literature

As previously described in section 1.4, databases' search for publications resulted in 57 research items which were considered in this review (five "grey literature" items were excluded, as they were grey literature, and did not report the application of participatory scenario planning). Although I set up the search mechanism to retrieve publications from 2000 to 2017, publications including the term perception in participatory scenario planning started in 2008, and since then, the number of publications per year has increased. Therefore it can be assumed that this is a recent phenomenon in NRM research.

Downscaling global scenarios such as those developed in the Millennium Ecosystem Assessment (MA, 2005) and IPCC (IPCC, 2000), along with the normative discourse of broad

participation in NRM (Oteros-Rozas *et al.*, 2015) seem to be the main leading assumptions for the development of participatory scenario planning literature. Although the MA (2005a) framework was the most cited scenarios' definition and reference framework among the reviewed literature (cited in 20 research items), a variety of frameworks were also used (Peterson, Cumming and Carpenter, 2003; Börjeson *et al.*, 2006; Bradfield, 2008; Tompkins, Few and Brown, 2008; NEA, 2011; Hunt *et al.*, 2012; Waylen *et al.*, 2015). Additionally, many researchers used their own frameworks, for example Brown *et al.* (2016), Capitani *et al.* (2016), Mitchell *et al.* (2016), and Johnson and Karlberg (2017). Still other studies did not provide a definition or reference framework of scenario planning (e.g. Villamor *et al.*, 2014; Schauppenlehner-Kloyber and Penker, 2015; Düspohl and Döll, 2016).

With regards to the methodological approach used, among the 34 studies that collected empirical data, most of them used qualitative approach (16), followed by mixed-methods approach (14), and the least used approach was the sole quantitative one (4 studies). Data collection procedures varied, and the more frequently used included: workshops, semi-structured interviews, questionnaires (surveys), and focus groups; among those less frequently used were: photograph-based Q methodology, participant observation, brainstorming, role-playing, GIS mapping, and participatory mental model approach. The choice of methodological approach and data collection procedures is a relevant issue because qualitative approaches have been recommended to study individuals' perceptions (Creswell, 2009; Patton, 2002). Questionnaires and surveys, which are frequently used data collection procedures in the literature reviewed are quantitative techniques (Stake, 2010), and therefore its use to address individuals' perception seems to be misplaced.

With regards to the involvement of stakeholders during the scenario planning exercise, the review of the literature also revealed that, in some instances, the data collection procedures were not able to access individuals' perceptions. Frequently, research participants are given a list from which they are asked to select/rank a set of pre-defined items (e.g.: ecosystem services, drivers of change, scenarios, policy directions), and later the output of this selection is reported as individuals' perceptions. For example, Palomo and Montes (2011) designed a questionnaire "*that was used to collect quantitative data regarding the perception of ecosystem services use, ecosystem services vulnerability, protected areas management, and environmental institutions in the Doñana social-ecological system, and regarding the main problems of the region*", as part of their scenario planning exercise (Palomo and Montes, 2011:7). They also explained that "[i]*nterviews and surveys used a panel with photographs containing the ecosystem services previously identified in Doñana as explicative material*" (p.7), which constitute presenting stakeholders with a set of pre-defined items. However, in their results, they report that "[o]*ut of all the ecosystem services perceived as vulnerable, 40% were provisioning, 34% were regulating, and 26% were cultural*" (p.9). Although authors reported stakeholders' opinions and preferences over a set of items, results reported do not necessarily represent stakeholders' perceptions.

In another study, stakeholders were asked to "*discuss and list factors that they thought would be important drivers of change in the area in the coming 25 years*" (Enfors *et al*., 2008:7), which could provide material to reach individuals' perceptions. However, following this step, participants were presented a list of pre-selected items "*where these factors were ranked both after their relative importance and after their level of uncertainty*" (p.7), and results are presented as such "[t]*he table also shows the participants' perception of how these factors will*

change in the coming decades" (p.8). Similarly to the previous example (Palomo and Montes, 2011), stakeholders' opinions regarding drivers of change (if better or worse) were reported as perceptions.

The imprecision of confounding perception with opinions, was also found in other studies. Table 4.1 lists the 27 studies from the literature review which actually described the application of participatory scenario planning exercises[10]. As reported on Table 4.1, the use of perception in exchange of opinion was the most common imprecision identified. Other studies used the term perception in exchange of "knowledge" (Johnson and Karlberg, 2017) , a desired "perception change" (Pert *et al.*, 2010; Falconnier, 2016), "preferences" (Grace B Villamor *et al.*, 2014) or "mental models" (Düspohl and Döll, 2016). Although knowledge, preferences and mental models could be considered components of individuals' perceptions, the lack of definition of perception in the reviewed studies (none of the research items defined perception - see Chapter 1) is confusing, and may lead to conceptual and methodological imprecision.

[10] For consultation, the remaining 30 research items considered in this literature review are listed in section 1.4 of Chapter 1.

Table 4. 3 - Description of how perception was reported in the 27 publications which report the application of participatory scenario planning. Research items were described according to the aim of considering stakeholders' perceptions, use of the concepts ecosystem services and drivers of change. Also, publications were analyzed regarding what perception meant in the context of the study. Examples were provided to highlight key passages as they related to the findings of the analysis, however, they are meant to be illustrative, as the results are based on the analysis of the whole documents.

Reference	**Perception presented as result (Yes/No)**	**Example(s) of how perception is reported**	**In the context of the study, "perception" means:**	**Aim(s) of considering perception**	**Key concepts of the MA (2005)'s framework used in the study:**	
					Ecosystem services	**Drivers of change**
(Enfors *et al.*, 2008)	Yes	"*The table also shows the participants' perception of how these factors will change in the coming decades*" (p.7)	Opinion	Engaging stakeholders	Yes	Yes
(Pert *et al.*, 2010)	Yes	*"(...) stimulating considerable interest and providing the foundation for workshop participants to commonly perceive that the threat being faced was real*" (p.303)	Perception change	Changing local perspectives	Yes	Yes
(Bohensky, Butler and Mitchell, 2011)	Yes	"*Table 2: Perceptions of biggest threat to Milne Bay ecotourism (...) pre- and post-scenario exercise*." (p.5)	Knowledge; Perception change	Knowledge integration; Changing local perspectives	Yes	Yes
(Palomo and Montes, 2011)	Yes	"*Out of all the ecosystem services perceived as vulnerable, 40% were provisioning, 34% were regulating, and 26% were cultural.*" (p.9)	Opinion	Knowledge integration; Changing local perspectives	Yes	Yes
(Quinlan, 2012)	Yes	*" the two drivers selected were perceived as important drivers of change" (p. 137)* *"Changing how one perceives the environment and their place in it is a major challenge but there are examples of communities who have changed how they view* (...)" (p.168)	Opinion	Changing local perspectives	Yes	Yes
(Harvey *et al.*, 2013)	Yes	"*What is less clear at this stage is whether this will lead to longer term behaviour change in a more flexible approach to farming (and hence building adaptive capacity) or whether this was one-off*	Perception change	Social learning; Changing local perspectives	No	No

		action as a result of a perceived "emergency" for that season " (p.48)				
(Palacios-Agundez *et al.*, 2013)	No	"*Therefore, in this local, participatory scenario-planning process, we could focus more on society's perceptions and reactions to the described plausible futures, and consequently, work on constructing alternatives and response options*" (p.12)	Perception change; opinion	Changing local perspectives	Yes	Yes
(Plieninger, Bieling, *et al.*, 2013)	Yes	*"(...) we present insights on local actors' perceptions of quality of life, ecosystem services, and major drivers of change*" (p.2)	Opinion	Enhancing scenarios plausibility	Yes	Yes
(Reed *et al.*, 2013)	Yes	" *This ensured the initial scenarios were based primarily on stakeholder perceptions of system structure, function and likely futures*"(p.359)	Opinion; knowledge	Knowledge integration; empowerment	Yes	Yes
(Grace B Villamor *et al.*, 2014)	Yes	"*We discuss how stakeholders perceive and value their environments*(...)" (p.1) "*In this sense, one aspiration of the researchers was to reach a consensus among participants for what they perceived to be a sustainable future* " (p. 5)	Knowledge; preference	Changing local perspectives; Assessing management options	Yes	No
(Ruiz-Mallén, Corbera, Calvo-Boyero and Reyes-García, 2015)	Yes	*" During village focus groups we identified and discussed participants' perceptions on who were likely to become the winners and losers under each of the plausible futures described by each storyline*." (p.402)	Opinion	Assessing management options	Yes	Yes
(Waylen *et al.*, 2015)	No	" *This step was based on the literature because relying only on local perceptions to identify drivers may risk missing important drivers of change*" (p.2)	Knowledge	Knowledge integration	No	Yes
(Oteros-Rozas *et al.*, 2015)	Yes	" *Enhanced capacity of partners and beneficiaries within 1 year of the scenario planning process. This is manifested as changes in their perceptions, values, learning, social networks, partnerships, institutions and governance*." (p.56)	Knowledge	Changing local perspectives; enhancing scenarios plausibility	Yes	Yes
(Schauppenlehner-Kloyber and	No	*" The willingness of the participants to adjust their perceptions and openness to a learning process*	Opinion	Changing local perspectives	No	No

Penker, 2015)		*are fundamental conditions to reach these goals*" (p.59)				
(Düspohl and Döll, 2016)	Yes	" *The perception of each stakeholder is elicited through an interview and depicted in a so-called perception graph*" (p.221)	Mental model	Changing local perspectives	No	Yes
(Bennett, Kadfak and Dearden, 2016)	No	" *The communities were selected from those with whom our partner organizations already worked based on perceived need and potential receptiveness to a participatory planning process*" (p. 1774)	Generic	Non-applicable	No	Yes
(Brown *et al.*, 2016)	Yes	" *Several driver states were perceived as having potential to cause significant internal change and potential system instability." (p.1690)* *" However, the systematic exploration of drivers and variables was suggested by participants to have provided new insights into future change by challenging existing perceptions*." (p.1691)	Opinion	Social learning; changing local perspectives	No	Yes
(Capitani *et al.*, 2016)	Yes	" *(...) among the direct drivers of LULCC, population growth was perceived to have the highest impact in the Northern Zone* (...)" (p. 6)	Opinion; knowledge	Knowledge integration; enhancing scenarios plausibility	Yes	Yes
(Falconnier, 2016)	Yes	" *Field trials and "try-outs" create practical knowledge and improve farmers perception*" (p.151)	Opinion; perception change	Learning; Changing local perspectives	No	Yes
(Graham, 2016)	Yes	" *These images (...) allowed stakeholders in subsequent activities to consider the aesthetic implications and the relationship to their perceptions of PBC feasibility, placement, and impact on field and farm management*." (p.23) "*They also include altered management methods in each scenario that better-reflect the farmers' perceptions of management viability*" (p.27)	Opinion	Knowledge integration; Assessing management options	Yes	No
(Pearson *et al.*, 2016)	Yes	"*From the narratives and scenarios of the focus groups we inferred the extent to which capitals were perceived as 'sunk' or 'flexible/latent' and*	Opinion; mental models;	Assessing management options	No	Yes

		community preparedness to commit to future scenarios." (p.201)				
(Mitchell *et al.*, 2016)	Yes	" (...) *participants perceived the effect of the more formal governance options (...) on key SES drivers of change as having a better outcome for biodiversity*." (p.565)	Opinion	Assessing management options	No	Yes
(de Bruin, Kok and Hoogstra-Klein, 2017)	Yes	" *6 actions can be classified as not robust (are considered not be effective in all scenarios by the scenario groups AND perceived by the experts as probably not robust ("red" in one of more of the working groups and "red" by the experts*)" (p.10)	Opinion	Knowledge integration; Assessing management options; enhancing plausibility of scenarios	Yes	No
(Eastwood, Fischer and Byg, 2017)	Yes	" *some members of the governance body perceived a risk of losing control over the responsible stewardship of the estate*." (p.1696)	Opinion	Engaging stakeholders	Yes	Yes
(Hertzog *et al.*, 2017)	Yes	" *The scenario workshops with the three stakeholders' groups revealed different perceptions of current and future functioning (dimensions and scales of management) of the ON area (based on social, technical or institutional development).*" (p.25)	Opinion	Enhancing plausibility of scenarios; assessing management options	No	Yes
(Johnson and Karlberg, 2017)	Yes	" *The substantive argument for participatory nexus scenario planning emphasizes the importance of local knowledge and perceptions in fully understanding the water-energy-food security nexus in a particular context*." (p.8)	Opinion; knowledge	Enhancing plausibility of scenarios; engaging stakeholders; knowledge integration	Yes	Yes

The objective(s) of considering stakeholders' perceptions in participatory scenario planning exercises also varied (Table 4.1). Six different objectives could be identified from the literature, according to their occurrence: changing local perspectives (11 studies), knowledge integration (7 studies), assessing management options (7 studies), enhancing scenarios plausibility (5 studies), (social) learning (3 studies), and engaging stakeholders (3 studies). Although I recognize that there is no clearly defined boundary among these identified objectives (for example, knowledge integration may be associated with learning, which in turn is associated with changing local perspectives), I categorized them according to the emphasis given in each publication.

Overall, the objectives of considering stakeholders' perceptions relate to the reported reasons for engaging stakeholders in scenarios development. According to Reed et al. (2013:347), "*stakeholder engagement in scenario development may empower those involved, through the co-generation of knowledge with researchers and increasing participants' capacity to use this knowledge. Scenarios can communicate complex information about socio- ecological change in ways that can be easily understood by stakeholders from a variety of backgrounds, giving people the opportunity to use this information to shape their future or adapt to changing conditions*". The reasons described by Reed et al. (2013) embrace the objectives of changing local perspectives, knowledge integration, learning, and engaging stakeholders. With regards to assessing management options and enhancing the plausibility of scenarios, these objectives are also related to what Reed et al. (2013) calls "*pragmatic arguments for involving stakeholders*" (p.347).

Although many frameworks were used for developing scenarios, I identified a prevailing use of two core concepts of the Millennium Ecosystem Assessment (MA, 2003b), ecosystem

services and drivers of change, among the 27 studies that described the development of participatory scenarios (Table 4.1). According to the framework proposed by MA (2003b), scenarios should consider the main “drivers of change” that may influence future use and availability of “ecosystem services”. The concept of drivers of change was used in 21 publications, while the concept of ecosystem services was used in 16. The identification of drivers of change according to stakeholders' perceptions is a key topic in the literature reviewed. Oteros-Rozas *et al.* (2015) reviewed 23 cases of the application of participatory scenario planning exercises, and they reported that *"[a]ll but 2 cases identified drivers of change through participatory methods, particularly through workshops (17 cases), but also by way of interviews and surveys (9 cases)*" (p.5).

Plieninger et al. (2013) developed a participatory scenario planning in the Swabian Alb, a biosphere reserve in Germany. As authors described, "*participants (...) prepared a list of relevant actors and driving forces that they perceived as potentially determining for future local landscape change*" (Plieninger *et al.* 2013: 6). This approach would potentially lead to a list of perceived drivers of change. However, authors explained that "*to get the workshops going, the researchers provided an introduction to the scenario technique and an overview of past landscape changes in the area, based on statistical data, maps, and aerial photographs*" (p.6). Although authors acknowledged that the workshop was planned in such a way to avoid predetermination of drivers or events by researchers, there was no consideration on how the explanation of past trends by experts might have influenced the subsequent verbal reports of participants. Additionally, after the identification of drivers, participants were asked to rank a pre-defined list of 27 ecosystem services, and one of eight dimensions of quality of life, which would lead to a collection of "opinions" rather than perceptions about those items.

Similarly, Pearson *et al.* (2016:202) reported that: "*[f]uture scenarios were designed as the second part of the focus group. Initially an introduction was provided which ran through the key external forces onto the community and some suggested future environmental predictions based on climatic modelling (i.e. lower rainfall, higher evaporation, larger number and more extreme weather events like droughts and floods, etc. based on Chiew, Cai, and Smith 2009)"*. The previous examples are not uncommon in the participatory scenario planning literature. In their review of 23 cases, Oteros-Rozas *et al.* (2015) also identified that "*formal scientific knowledge from outside of the participatory process, e.g., previous research or predefined drivers by researchers, was also used to identify drivers in all cases*"(p.5). Given that the importance of stakeholders' participation and perceptions are widely recommended in the literature, this methodological issue (presenting participants with a pre-defined set of items) might be preventing researchers to capture the full range of stakeholders' perceptions regarding drivers of change. Therefore, this is a shortcoming that should be addressed.

The review of how perception is being used in current participatory scenario planning literature revealed three important issues: 1) there was an overall lack of attention by authors on how (or whether) they were defining perception and in turn operationalizing it within their research. Often perception was confounded with other concepts, such as opinion, knowledge, mental models, preferences, and changing local perspectives; 2) the Millennium Ecosystem Assessment framework and its operational components (ecosystem services and drivers of change) play an important role in this thread of literature; 3) there are methodological shortcomings that might prevent researchers from capturing the full range of stakeholders' perceptions in development of scenarios, as data collection procedures introduce pre-defined

categories to stakeholders. The implications of these findings for the current participatory scenario planning literature is assessed below.

4.3.2. Assessing the applicability of participatory scenario planning to inform decision-making based on stakeholders' perceptions

The literature on participatory scenario planning has presented many compelling outcomes for the use of this approach. Reed *et al.* (2013) highlights the fact that involving stakeholders in the development of scenarios can benefit both researchers and participants, "*leading to the development of more consistent and robust scenarios that can better prepare people for the future*" (p.360). Oteros-Rozas *et al.* (2015) listed a series of important results of the approach, such as: enhancing stakeholder engagement; supporting diversity, equity, and legitimacy of environmental decision-making; improving the quality of dialog among stakeholders; creating new local understanding of both global and local environmental changes and their impacts; enhancing complexity thinking of participants; and the potential of scenarios being "*disseminated to trigger engagement and reflection among the wider public*" (Oteros-Rozas *et al.* 2015:13). Capitani *et al.* (2016) also stated that the participatory scenario planning exercise proved successful in engaging a wide range of stakeholders in Tanzania. Villamor *et al.* (2014) highlighted that *"[s]upporting/final values elicited by PSP can be considered as a powerful asset to understand complex issues and foster long term thinking*" (p.9).

Based on statements like the ones above, six main objectives of using participatory scenario planning could be distilled from the reviewed literature: changing local perspectives, knowledge integration (or co-production of knowledge), assessing management options, enhancing the plausibility of scenarios, learning, and engaging stakeholders (Table 4.1). Wright, Bradfield and Cairns (2013) reviewed the literature on scenario planning in business contexts,

and identified three main reported objectives: enhancing understanding, challenging conventional thinking (reframing participants perceptions), and improving decision making. Overall, it seems that the objectives of using participatory scenario planning identified in the present literature review, within the context of Natural Resources Management, are similar to those identified by Wright, Bradfield and Cairns (2013), despite the fact that they reviewed the use of scenarios in business context. The objectives for the development of scenarios, as identified by Wright, Bradfield and Cairns (2013) were: 1) *enhancing understanding* (which may represent the objectives "knowledge integration", "enhancing scenarios plausibility", and "learning", identified in the present review); 2) *challenging conventional thinking* (which can represent the objective "changing local perspectives"); and 3) *improving decision making* (which can represent "assessing management options" and "engaging stakeholders").

Despite the desirable and persuasive objectives of using scenario planning, researchers have called attention to the lack of studies formally evaluating long-term results of the practice of scenario planning in the context of NRM (Grace B Villamor *et al.*, 2014; Oteros-Rozas *et al.*, 2015; Eastwood, Fischer and Byg, 2017), as well as in the context of business (Wright, Bradfield and Cairns, 2013). More importantly, in the context of NRM, based on the literature reviewed, no study formally assessed long-term effects of scenario planning in changing local perceptions (despite some reported pre- and post-workshop, short-term, stakeholders' perception change - Schauppenlehner-Kloyber and Penker, 2015; Mitchell *et al.*, 2016).

Oteros-Rozas *et al.* (2015), who reviewed 23 participatory scenario planning case studies, found that "*monitoring and evaluation stages were largely missing in the cases we assessed*" (p.12), and explained that "*although a goal of PSP is to promote action, it is challenging to produce evidence that PSPs have actually led to management actions, new partnerships and*

collaborations between stakeholders, or social learning processes" (p.12). Out of the 23 cases, Oteros-Rozas and colleagues (2015) identified that in the majority of cases (20 out of 23 studies) outcomes and impacts of the scenario planning exercises were not formally evaluated. In the present review, I identified only one study that formally evaluated the long-term outcomes of a participatory scenario planning exercise (Eastwood, Fischer and Byg, 2017). Eastwood, Fischer and Byg (2017) conducted a participatory scenario planning on a estate in Scotland during which they monitored the whole process with regards to engagement and participation of stakeholders. They found that, instead of fostering the engagement of stakeholders, the scenario planning exercise in fact exacerbated pre-existing tensions among stakeholders, and ultimately "*may have actually hindered rather than facilitated the estate's steps to transformation*" (p. 1694).

Similar to the challenges that participatory scenario planning faces in NRM context, critiques of the use of this approach were found in the context of business management. After assessing the methodological basis of scenario planning studies, Wright, Bradfield and Cairns (2013:631-632) stated that "*scenario methods do not in themselves incorporate methods and tools for making fully-informed decisions and, thereby, formulating strategies and plans. They merely inform the process, if utilized appropriately and successfully. On this basis, we pose the challenge that the ubiquitous term "scenario planning " is a misnomer*".

Lack of formal assessments of the long-term outcomes of participatory scenario planning, and the lack of evidence that this approach leads to improved management decision-making, engagement of stakeholders, reframing perceptions, and social learning, is a major challenge towards operationalization of this participatory tool in NRM. The confounding use of the concept perception identified in the present literature review may contribute to further misunderstanding, such as when researchers interchange the use of perception and opinion, which ultimately will

hinder this research area's advance for lack of comparable results. Given the increasing trend of participatory scenario planning practice, international policy-research frameworks advocating its use (such as IPBES - Díaz *et al.*, 2015), and a tendency of considering the perceptions of stakeholders, more attention should be given to finding approaches capable of producing comparable results. As stated by Oteros-Rozas *et al.* (2015:13), "*[t]o improve the future success of PSP, including those evolving within IPBES, we suggest that scientists and practitioners engaged in PSP should be more self-aware and build a community of practice to improve the quality of individual PSP processes, as well as provide a platform for diverse, new groups of people to conduct PSP processes that build on and improve current methods, tools, and processes. We hope that this comparative assessment is a first step toward building such a community"*.

Consistent with what was found regarding the practice of ecosystem services (Chapter 2), very few studies were found that considered how the use and practice of scenario planning may affect research participants' long-term attitudes and local discourses (e.g. Eastwood, Fischer and Byg, 2017). Hermelingmeier (2014) analyzed researchers' perspectives regarding potential negative effects of the ecosystem services' research on the perception of human-nature relationships. She found that researchers presented a rather uncritical position, suggesting an unreflective perspective regarding methodological implications of ecosystem services' research. Reflecting over a long-term assessment of a participatory scenario planning application in Scotland, Eastwood, Fischer and Byg (2017) stated that "*[t]here would have thus been a need to be more strongly aware of the potential impacts that the ongoing research could have on 'real life'*" (p. 1694), after realizing that the research process exacerbated pre-existing conflicts among participants with divergent perspectives.

These findings reinforce the necessity to look for complementary tools which could enhance the precision of scenario planning approaches, produce comparable results, and ultimately lead to comprehensive assessments and refinement of this technique. In the next subsection I discuss the application of the analysis of verbal report as a possible complementary tool to identify stakeholders' perceptions of drivers of change.

4.4. Discussion

4.4.1. Analysis of verbal reports as a tool to access the perception of drivers of change in participatory scenario planning

Current literature on participatory scenario planning, in the context of natural resources management, has recommended the identification of drivers of change based on stakeholders' views and perceptions (e.g. Bohensky, Butler and Mitchell, 2011; Palomo and Montes, 2011; Reed *et al.*, 2013; Villamor *et al.*, 2014; Oteros-Rozas *et al.*, 2015; Mitchell *et al.*, 2016). The main argument for doing so is that local stakeholders retain fine-grained knowledge about the dynamics and the forces that influence their social-ecological systems (Kok, Biggs and Zurek, 2007; Reed *et al.*, 2013). Additionally, most of the scenarios developed are based on key uncertainties or driving forces that may influence the dynamics of the social-ecological systems under analysis (Reed *et al*., 2013; MA, 2005c). Therefore, the identification of drivers of change is a crucial step towards the application of scenario planning. In this section, I propose the analysis of verbal reports as a complementary tool to construct drivers of change according to stakeholders' perceptions. By doing so, I intend to contribute to the operationalization of the concept of perception in participatory scenario planning approaches.

Analysis of verbal reports is a qualitative tool that aims to disclose the meanings of what people say, and therefore it is suitable to access information about individuals' perceptions. Succinctly, the analysis of verbal reports consists of finding the *units of meaning* from a pool of collected verbal reports about a theme under investigation (Michelat, 1981; Tunes and Simão, 1998). In order to collect verbal reports about a specific topic, non-directive interviews (which includes unstructured and informal interviews - Bernard, 2011) are necessary. Non-directive interviews confer research participants a degree of freedom (of course relative, given the presence of the researcher and conversation themes proposed) that facilitates the emergence of information from deeper levels than those that emerge from a questionnaire (structured interviews) (Michelat, 1981). This profound socio-affective information that emerges from non-structured interviews is the type of necessary information to understand an individual's perceptions.

The perception of drivers of change, falls into one area of perception research, called perception of facts ("perception." The Cambridge Dictionary of Philosophy, 2nd ed. 1999). The underlining assumption of the analysis of verbal reports is that what people perceive is not necessarily what people say (verbal report), especially about facts, mainly because of defense mechanisms (Freud, 1969). Therefore, the use of questionnaires (quantitative approach) to allocate what people report into a set of pre-defined categories may be insufficient to access the diversity of perceptions about drivers of change. The analysis of verbal reports demands the use of open-ended interviews, which may be time consuming, however, their use results in fine-grained information about stakeholders' perceptions.

Qualitative approaches and interviews have already been used in participatory scenario planning exercises. According to Reed *et al.* (2013), interviews are recommended to explore in-

depth material, which would not be captured by using only focus groups (workshops are the main data collection procedure in the reviewed literature). Therefore analysis of verbal reports may contribute to the identification of stakeholders' perception of drivers of change (perception of facts), by providing a tool to disclose the perceptions from verbal reports.

In Chapter 3, I described the use of the analysis of verbal reports to identify drivers of social-ecological changes as perceived by stakeholders in Tarituba, a coastal village in Brazil. The steps I utilized to conduct such analysis clarifies its application. The first step to identify perceived drivers of change was to conduct informal (open-ended) interviews with stakeholders (n = 38), identified from a purposive sample to include the broadest range of occupations found in the village (Tongco et al. 2007; Bernard, 2011). The interview process was conducted using participant observation for data collection (Bernard, 2011) from September 2010 to October 2011 (see Table 1.4). Interviews were transcribed as soon as they finished, and no audio-recording was used. From a pool of 107 interview instances (for details, see Chapter 1 - methods section), I identified 72 verbal reports about social-ecological changes and their causes. The analysis of these 72 verbal reports consisted of reading and re-reading these reports (a process called impregnation - Michelat, 1981), and coding them according to their emerging categories.

For example, one research participant (p.23) reported that "*Tarituba has not grown* [in terms of urban development] *as much as other surrounding villages because people want to preserve a quiet style of life*". Therefore, this was identified as a reported driver of change, and its emerging perceived category was "behavioral", since the desire "*preserve a quiet style of life*" is a behavior. Likewise, another research participant (p.25) reported that Tarituba used to have banana farms during his grandparents' generation; he stressed that "*at that time, bananas had good prices*", and when I prompted him asking why he thought people stopped planting bananas,

he answered that "*banana prices went too low because there was a lot of banana production in Bahia* [another state]". In this case, the emerging perceived category of this reported driver of change is "economic".

By conducting this analysis of all of the 72 reported changes identified from the interviews (see Table 3.1), five categories of perceived drivers of change emerged: behavioral, economic, political, administrative and sociological. The analysis of stakeholders' verbal reports about changes and their causes, allowed the specification of reported drivers of change according to categories of perceived drivers, which could be further analyzed according to its frequency and relationships. For example, the analysis revealed that behavioral and economic are the most frequently perceived causes of changes in Tarituba (Table 3.2). The analysis also revealed that in some cases, one reported driver of change could be predominantly described by one perceived category (ex. behavioral), but modulated by another category (ex. economic). Therefore, as reported in Chapter 3, the analysis of verbal reports proved to be a valid tool to specify the varied and nuanced reports of stakeholders into five categories of perceived drivers of change. Also, the intermediate categories identified specified the most important components of the general categories of drivers of change from the literature (e.g.: direct/indirect, natural/anthropogenic, endogenous/exogenous).

Analyzing verbal reports to identify stakeholders' perceptions of drivers of change is being proposed here as a complementary tool for those undertaking participatory scenario planning. As explained in Chapter 3, this tool has been successfully applied and refined in areas such as psychology (Freud, 1969; Michelat, 1981; Tunes and Simão, 1998), history (Veyne, 1971; Riscal, 2001), sociology (Weber, 1991; Bourdieu, 2011), and philosophy (Foucault, 2010). However, its use in natural resources management context requires further test, refinement, and

validation. Additionally, as one might expect, stakeholders' perceptions of social-ecological systems dynamics will likely vary, according to different contexts, and therefore, categories shall be context-specific. The intention of this proposal is to contribute to the development of the participatory scenario planning literature towards its operationalization with respect to the growing trend of this literature to consider stakeholders' perceptions.

4.5. Conclusion

Despite a growing trend of considering stakeholders' perception in participatory scenario planning literature, the review of current publications using this approach in NRM context revealed that the concept of perception has not been properly defined, which confounds its use with other concepts like opinion and knowledge. Given that the study of perception is a vast field encompassing various disciplines, the lack of definition observed in the reviewed literature is a major issue. One recommendation that can be made for future studies is to clearly define what authors mean by perception, which can specify its use in the context of participatory scenario planning.

In addition to lacking proper definition, stakeholders' perceptions, as often reported in the reviewed literature, were described utilizing pre-defined categories. Frequently, researchers have asked participants to choose, rank, and give opinions regarding pre-defined categories, and reported the outcome of this process as stakeholders' perceptions. This was a gap identified in the literature that should be taken into consideration in future applications of the participatory scenario planning approach. Defining perception in the research context, and using appropriate methods to deal with this complex concept may contribute to the improvement of the participatory scenario planning.

Critiques, such as low rate of formal evaluations of the outcomes of participatory scenario planning (Oteros-Rozas *et al.*, 2015), lack of evidence of its contribution to fostering decision-making (Wright, Bradfield and Cairns, 2013), and unexpected exacerbation of pre-existing conflicts among stakeholders rather than fostering stakeholders' engagement (Eastwood, Fischer and Byg, 2017), suggest more critical research is needed for scenario planning. One suggestion is that more attention needs to be given to the definition of perception and the methods by which categories are established to allow for comparable results.

The analysis of verbal reports was proposed as a complementary tool that may contribute to specify stakeholders' perceptions of drivers of change, a crucial step towards participatory scenarios development. As an inherently interdisciplinary approach, NRM research could benefit from an approach that has been successfully applied in disciplines like psychology, history, and philosophy. Considering the exploratory character of the analysis conducted here, and the necessity of its verification, refinement, validation (or refusal) by future studies, the analysis of verbal reports can be a step towards the operationalization of perception in participatory scenario planning research and practice, which can further contribute to enhancing local participation in NRM decision-making processes.

CHAPTER 5. DISCUSSION AND CONCLUSION

The objective of this chapter is to position the findings of this thesis in relation to the broader literature on natural resources management research. Beforehand, I would like to recall some important choices as they relate to this positioning. First, the overall assumption of this thesis was that effective NRM strategies need to take into consideration local stakeholders' perspectives, knowledge, and institutions (Berkes, Colding and Folke, 2000; Ostrom, 2005; Pahl-Wostl, 2008; Palacios-Agundez *et al.*, 2013; Reed *et al.*, 2013; Grace B Villamor *et al.*, 2014). Second, this study is part of a body of literature that has recommended integrated, ecosystem-based, interdisciplinary, participatory approaches to NRM (Pahl-Wostl and Hare, 2004; Robert C. Francis *et al.*, 2007; Sinclair, Sims and Spaling, 2009), in order to overcome single species/sector, top-down, government centralized models which failed in many instances (Ruddle and Hickey, 2008). Finally, this study was motivated by my own interest in perception of human-environment relationships and social-ecological changes, which impelled me to investigate these processes in Tarituba.

In order to focus my research, I selected the Millennium Ecosystem Assessment as a initial framework to guide my research process. Therefore, this choice has to be evaluated. The MA (2005a) framework was selected due to its influence on current NRM research (Carpenter *et al.*, 2009; Fisher, Turner and Morling, 2009), for its and to its focus on human-environment relationships and causes of social-ecological changes. Within this framework, the concept of ecosystem services suited my objective of studying human-environment relationships, the concept of drivers of change provided a basis for studying and classifying changes in social-ecological systems, and scenario planning a practical tool to enable the incorporation of

stakeholders' perceptions in management plans. As depicted in Figure 1.2, the term perception has gained momentum within these three literature areas, which justified my decision to investigate how stakeholders' perceptions have been identified within this framework.

After the Millennium Ecosystem Assessment, other international research/policy-oriented frameworks have been proposed to understand human-environment relationships in the context of NRM. One of such prominent frameworks is the IPBES (Díaz *et al*., 2015). Despite some proposed novelties, such as the explicit consideration of institutions, governance, and decision-making, the core concepts, ecosystem services and drivers of change, as well as the use of scenarios, are integral parts of this framework. With regards to the concept of ecosystem services, the IPBES framework represents this kind of human-nature relationship as "nature's benefits for people" (Díaz *et al*., 2015:5), however, it acknowledges that this term encompasses ecosystems goods and services, as well as nature's gifts. Therefore, although the MA was the main framework used, the results identified in my study may also be considered in relation to core concepts used in the IPBES framework, which is an updated international policy-research approach in NRM.

5.1. Concepts, categories, and perceptions

One of the main results of the literature review I conducted on the three focal areas (ecosystem services, drivers of change, and participatory scenario planning) was the overall lack of definition of the concept perception. This was a striking result because even studies that reported perceptions as results did not provide specification regarding which components of perception were investigated, or even what perception meant in their research (see Table 2.3). Despite the fact that stakeholders' perceptions have been considered critical for developing

effective management strategies (Oldekop *et al.*, 2012; McCarthy *et al.*, 2014), there is still a lack of studies that have empirically addressed this claim (but see Fernández-Llamazares *et al.*, 2016). The fact that studies focusing on the perceptions of individuals are not presenting a clear definition of perception makes the assessment of this claim even harder. The importance of defining concepts used is even more relevant in interdisciplinary research, because different disciplines have their own epistemologies (Raymond *et al.*, 2010; Yeh, 2016). As stated by Yeh (2016:34), "*much greater appreciation across epistemological differences is necessary for inclusive collaborative efforts, which in turn requires explicit discussion of what those differences are*".

As demonstrated in Chapters 2 and 4, perception is often employed within NRM studies as if its meaning is commonsense without attention to the specific meanings from other fields of research. Other times, perception conflated with terms like knowledge and opinion (see Table 4.1). This interchangeable use of perception in the context of NRM was also pointed out by other authors (Fernández-Llamazares *et al.*, 2016). However, the study of perception is a vast field of knowledge, encompassing different disciplines, such as philosophy, psychology and ethology. Thus, the lack of definition identified in the current NRM literature leads to studies of perception with incommensurable results, which hinders their comparison, assessment, and ultimately, advances in our understanding of how stakeholders perceive their human-environment relationships in the NRM contexts. The basic definition used in this study is that of the Cambridge's Dictionary of Philosophy (1999, 2nd Ed.), while far from being a comprehensive discussion about the concept of perception, situated the identification of two important components of perception in NRM research: the exteroperception and the perception of facts.

With regards to the perception of ecosystem services literature, I found that the way research participants referred to their human-environment relationships differed from the underlining assumption that "people receive benefits from nature", adopted by the main conceptual frameworks in current literature (MA, 2005a; TEEB, 2010; IPBES - Díaz *et al.*, 2015). In Tarituba, people talk about the means of fulfilling their needs, thereby stressing their activities, and do not seem to passively wait for benefits from nature. Other authors stated that the definition of ecosystem services may be underestimating the importance of the agency of individuals in obtaining their provision (Brown and Westaway, 2011; Turnhout *et al.*, 2013; Spangenberg *et al.*, 2014).

Another fundamental issue identified in the literature that addresses the perception of ecosystem services is that most studies treat this concept as a "real entity" - like an object whose existence is beyond doubt -, rather than an abstract conceptualization. This finding is based on the fact that authors have frequently questioned "which" ecosystem services individuals perceive (e.g.: Raymond *et al.*, 2009; García-Nieto *et al.*, 2013; Plieninger, Dijks, *et al.*, 2013; Zagarola, Anderson and Veteto, 2014; Castro *et al.*, 2016) (as if the meanings of the concept and categories of ecosystem were shared beyond reasonable doubt between researcher and research subjects) rather than "if" individuals perceive ecosystem services (but see Asah *et al.*, 2014). In that sense, the approach used in this thesis differs from most of the literature consulted. In my study, I treated ecosystem services as an abstraction, which allowed me to evaluate *if* the ecosystem services concepts and categories could represent the diversity of human-environment relationships perceived by individuals in Tarituba.

Based on the data collected, current concepts and categories of ecosystem services could not fully represent the diversity of human-environment relationships identified in Tarituba,

especially the dynamics of these relationships (see Chapter 2). These results relate to a body of recent literature that have identified shortcomings in ecosystem services concept and categories (Flint *et al.*, 2013; Asah *et al.*, 2014; Hermelingmeier, 2014), and even to some recent developments, such as the proposal of the concept of ecosystem disservices (Lyytimäki, 2015). Hermelingmeier studied the concept of ecosystem services in the context of modern approaches to environmental sustainability, and concluded that: "*whereas the ES concept was initially treated as potential facilitator to overcome the modern predicament by facilitating interdisciplinary collaboration, a reflection on the concept as a modern phenomenon in itself supports the suspicion that the concept could hinder rather than advance efforts towards sustainability*" (Hermelingmeier, 2014:43).

With regards to the concept and categories of drivers of change, I identified that the broad characteristic of the main categories of the MA framework (direct/indirect; natural/anthropogenic; endogenous/exogenous) would lead to an unspecific placing of elements of stakeholders' perceptions of social-ecological changes (see Chapter 3). This is due to the fact that the verbal reports regarding causes of changes in social and ecological domains contained different elements that could not be specified if directly assigned into one of the available categories. For example, one research participant reported that small-scale fishers have to travel further in order to not fish inside the protected area (Table 3.1). So, the driver (creation of a environmental protected area) of the reported change (fishers travelling further) could be allocated under the category direct driver of change, because the driver caused a direct impact on the social-ecological system. However, assigning "creation of a protected area" to the category direct driver of change would result in losing a great deal of information, such as the fact that the

creation of the protected area was a political decision, and that it influenced how small-scale fishers decide where to fish (the administrative effect).

Although the classification analyzed here belongs to the MA framework, more recent ones have not provided better specification on the characteristics of drivers of change (see IPCC, 2014; IPBES - Díaz *et al*., 2015). According to IPBES, a driver is a "*natural or anthropogenic (human-induced) factor that directly or indirectly causes a change in nature*" (Díaz *et al.*, 2015:13). The dichotomy anthropogenic vs. natural poses an even greater challenge, because the implicit assumption of this categorization is that human actions are not natural. In Tarituba, I found that even changes reported as happening on ecological domain were perceived as related to human interventions. Therefore, the classification of these perceived drivers of change according to the definition of IPBES would result only in anthropogenic drivers, and no natural driver could be identified according to participants' perceptions.

The categories natural/anthropogenic drivers echoes the dualist, body-soul, Cartesian worldview. Although authors have defined natural drivers as those that are non-human induced (MA, 2005a; Díaz *et al.*, 20150, the choice of the names of the categories reinforce the idea that human actions are not part of nature. The possibility of reaching this conclusion is odd, given that the objectives of approaches like MA and IPBES are exactly the opposite, as they aim at overcoming simplistic approaches to the complex problem of natural resources management. However, the Cartesian worldview was one of the most influential perspectives in sciences (Capra, 2012). Likewise, the fragmentation of human-environment relationships into ecosystem services (units) also echoes the Cartesian mechanistic model (Capra, 2012), which was also noticed by Hermelingmeier (2014).

5.2. Methodological issues

5.2.1. Qualitative approach

In studying perceptions of social-ecological relationships and changes in these relationships, I used a qualitative approach, in which participant observation was a strategic procedure to build rapport and to conduct informal interviews. My choice of methodological approach and data collection procedures was guided by authors that recommend the use of qualitative methods to study individual's perceptions (Patton, 2002; Stake, 2010), and by authors that recommend the use of non-directive interviews to access profound socio-affective information, from which perceptions can be identified (Michelat, 1981; Bernard, 2011).

Although most of the literature reviewed on perception of ecosystem services, drivers of change and scenario planning used a mixed (qualitative and quantitative) methods approach, there was a number of studies in which pure quantitative approach was used (e.g., Saxena *et al.*, 2002; van Riper *et al.*, 2012; Khan *et al.*, 2014), and perceptions were presented as part of the results, which seems misplaced. On the other hand, there is also a number of researchers who used solely qualitative analysis (e.g., Bryan *et al.*, 2010; Pert *et al.*, 2010; Cerdán *et al.*, 2012; Plieninger, Bieling, *et al.*, 2013; Asah *et al.*, 2014).

5.2.2. Data collection procedures

With regards to data collection procedures, the use of informal interviews (non-directive) as opposed to questionnaires or surveys (directive interviews) seemed to have an effect on the results. This effect was noticed on the comparison of results regarding perceived ecosystem services. In my study, I found that the MA's category regulating services rarely represented

individuals' perceptions about human-environment relationships, and no perception could be represented by the supporting services category (Chapter 2). Similarly, Asah *et al*. (2014), used open-ended questions to investigate how Native American tribal members in Central Oregon, USA, expressed themselves regarding human-environment relationships, and then compared these self-expressed relationships to the categories of ecosystem services, as proposed by the MA's framework. They found that research participants rarely mentioned regulating and supporting services. In that sense, using the same data collection procedure (non-directive interviews), my results were similar to those found by Asah *et al.* (2014).

On the other hand, Derak and Cortina (2014) used a questionnaire (quantitative approach) and asked participants to rank a pre-selected set of ecosystem services according to their importance. Authors found that provisioning and supporting services were perceived as more important than provisioning and cultural. De Vreese *et al.* (2016), used a quantitative mapping approach, in which semi-structured interviews were used, and participants scored a pre-defined list of 32 ecosystem services according to their importance. Authors found that regulating services were perceived as more important than provisioning services. Derak and Cortina (2014) and de Vreese *et al.*, (2016) used directive interviews as data collection procedure and found similar results, however, their results were opposed to those of Asah *et al.* (2014) and I found, using non-directive interviews. Although this comparison is far from a comprehensive analysis of the implications of data collection on results, these discrepancies could be investigated in future research.

Presenting a pre-defined list of items (ecosystem services, drivers of change, scenarios, human well-being components) to participants, asking them to choose or rank those items, and later reporting the result of this choice as stakeholders' perceptions was a main issue I identified

in the literature reviewed (see Chapters 2 and 4 for detailed examples). This was a methodological issue that could be clearly identified in several of the reviewed publications (e.g., Raymond *et al.*, 2009; Zagarola, Anderson and Veteto, 2014; Mukhtarov *et al.*, 2015; Castro *et al.*, 2016; De Vreese *et al.*, 2016; Martínez-Sastre *et al.*, 2017; Queiroz *et al.*, 2017). For example, Klain and Chan wrote: "*we framed questions about non-monetary values based on the cultural ES identified in the Millennium Ecosystem Assessment*" (Klain and Chan, 2012:106). In the same lines, Waylen *et al.* (2015:2) described: "*Each team preselected drivers for presentation to the community by reviewing the drivers identified by a regional scenario-planning exercise for Latin America (The Millennium Project 2010) and selected 5 drivers to fit with the so-called STEEP typology, i.e., social, technological, environmental, economic, and policy (Bradfield et al. 2005)".*

In other studies, authors did not present a set of pre-defined items for participants to choose, however, they explained beforehand the concepts they were investigating, and latter asked participants to express themselves in those terms, which is equivalent to the previous issue described. For example, both Berbés-Blázquez (2012) and Plieninger *et al.* (2012) aimed at understanding how local people perceived and valued ecosystem services. However, before starting their interviews, they explained the ecosystem services framework (from the literature) to research participants. This approach organizes beforehand the answers of participants, and all data collected will probably fit under the framework that was explained. Sometimes, this framing of possible answers was not clearly stated, however, it could be identified. For example, Lamarque *et al.* (2011) did not explain beforehand the concept of ecosystem services to research participants, however, their data collection procedures contained instruments to "*check that people understand correctly the concept*" (Lamarque *et al.*, 2011:794).

The tacit result of this methodological issue is that current NRM has been documenting and reporting "perceptions" of ecosystem services and drivers of change, as if they were concrete objects in the world. However, most studies did not evaluate *if* research participants perceive their human-environment relationships as such. As identified in this research, the concept and categories of ecosystem services could not represent the diversity of human-environment relationships in Tarituba, especially the dynamics of these relationships. The process of documenting the "perception" of human-environment relationships by presenting individuals a pre-defined set of categories, and/or explaining concepts beforehand, may result in creating, and documenting a fact that may not exist, similar to the process of fabrication of madness described on the book "*Madness and Civilization: A History of Insanity in the Age of Reason*", by Michel Foucault. The long-term effects of the continued use of these approaches with research subjects could be devastating to local institutions. Regarding the concept of ecosystem services, and its inherent component of commodification of nature (Turnhout *et al.*, 2013), especially in frames like the Payment for Ecosystem Services, Gómez-Baggethun *et al.* (2010:1216) stated: "*by creating economic incentives for conservation, market-based mechanisms can induce logics of individualism and competition in societies previously structured upon community and reciprocity values*".

5.2.3. Data analysis

The analysis of verbal reports, the main data analysis used in this thesis, derives from the theory of functional (Skinner, 1978), as well as phenomenological (Michelat, 1981; Bicudo, 1990; Martins, Boemer and Ferras, 1990), analysis of verbal behavior. The development of this body of theory has stressed the importance of *analysing* what people say (verbal reports) in order

to identify the units of meaning within the reports, and, ultimately, the matrix that structures the pool of verbal reports collected. In this regard, the present study differs from most of the literature consulted regarding the perception of ecosystem services, drivers of change, and participatory scenario planning. Despite the fact that the vast majority of the reviewed studies dealt with verbal reports (collected via questionnaires, surveys, interviews, workshops, focus groups), I noticed a lack of reflexivity regarding the theoretical basis of verbal behavior. This was especially striking in face of several developments made in this area, since the 1950's (Skinner, 1957; 1974; Chomsky, 1959; Pinker, 2002; Geer, 2008; , Leme, Bolsoni-Silva and Carrara, 2009; Giorgi, 2012). Therefore, it can be recommended that future NRM studies should make explicit the theoretical basis used for the analysis of verbal reports collected.

Chapter 3 described how the analysis was conducted on the 72 verbal reports collected regarding changes in social and ecological domains. As previously stated, the diversity of verbal reports about causes of changes gathered and their nuanced characteristic made the process of defining them, according to the categories from the literature, a difficult task. The analysis of verbal reports helped to specify the different elements contained within the reports, which made the process of deciding where to assign them to the categories of the literature easier, without losing nuanced information. Also, the specifications found provided fine-grained information for intervention purposes.

On Chapter 4, after reviewing the literature on participatory scenario planning, I suggested that this analysis could be used to specify the identification of perceptions of drivers of change, since interviews and qualitative analyses were commonly used and recommended in those studies (Reed *et al.*, 2013; Oteros-Rozas *et al.*, 2015). This suggestion was made because authors have identified few formal assessments of the outcome of scenario planning approaches

in NRM contexts (Oteros-Rozas *et al.*, 2015), lack of evidence that they foster better management decisions (Wright, Bradfield and Cairns, 2013), and some negative results identified when long-term assessments were conducted (Eastwood, Fischer and Byg, 2017). Therefore the use of a standardized method to identify drivers of change according to stakeholders' perceptions would allow the emergence of comparable results, and ultimately, foster the advancement of this participatory approach.

5.3. Further reflections on the limitations of this study

Far from being an exhaustive analysis on how the perception of individuals has been incorporated into NRM research, I would be satisfied if the present study sufficiently problematizes perception and in doing so draw attention for more care in the use of the term and systematic research. The exploratory characteristic of the present study does not allow me to make generalizations beyond the shortcomings identified when I compared my results with the selection of the literature I investigated - a fragment of the ecosystem services, drivers of change, and scenario planning literature, which is a fragment of the current literature on NRM. There are, of course, several other limitations of the approach used here, such as the focus on a single framework (Millennium Ecosystem Assessment).

Despite its importance, and relevance for current NRM research and practice, the Millennium Ecosystem Assessment framework is one among many other approaches that have devoted efforts to finding ways in which we can achieve better, sustainable, equitable natural resources management outcomes, such as the Resilience Approach (Folke, 2006; Berkes and Ross, 2013), the study of Commons (David Feeny *et al.*, 1990; Levin, 2006; Kamran, Aijaz and Shivakoti, 2017), institutional analysis (Ostrom, 1990; Elinor Ostrom *et al.*, 1999),

adaptive/social learning (Davidson-Hunt and Berkes, 2003; Pahl-Wostl and Hare, 2004; Brown *et al.,* 2016), amongst other contemporary approaches in NRM. The focus on a single framework made the research feasible because of its clear cut boundaries, and was warranted due to its influence on contemporary NRM practice.

The qualitative approach used in this study was sufficient for the purpose and objectives proposed in this study. However, the subjective characteristics of both the research topic (perception), and my role as a researcher studying perception has its own shortcomings that should be recognized. First of all, some critiques can be made regarding my own subjective judgements and influence on the results. This critique is not only pertinent, but also part of the research process with human subjects. This subjective characteristic of the research was not only considered, but assessed throughout the research process. Some techniques allowed me to reach a degree of objectivity, such as acknowledging my own thoughts, views and perceptions on separate field notes, as recommended by Bernard (2011). Also, the choice of writing the thesis in first person was meant to make explicit my own views throughout the manuscript. I also used some other techniques to avoid deception during the participant observation approach, such as presenting a formal (written) document to gatekeepers (the head of the community association), and being clear starting with my first approach to research participants, at which time I made clear I was a researcher collecting data. As previously mentioned, avoiding deception limited the amount of participants included in the sample.

In spite of these limitations I would encourage further research using the qualitative approach and analysis of verbal reports. I would recommend future studies embarking in this endeavor to conduct a fourth step of data verification, which is recommended when there is a purpose of intervention. After identifying the matrix that structures the verbal reports (in my

case, the intermediate categories), it is recommended that this matrix be discussed with research participants in order to assess their significance, which could result in its refinement. I recommend Tunes and Simão (1998) as a reference for the application of analysis of verbal reports with intervention purposes. This continuous process was, unfortunately, beyond the scope and timeframe of this research.

However, the findings presented here raise questions that could be pursued in future NRM research and practice, the most important of them, are current concepts, categories, and methodological approaches in NRM research sufficient to truly incorporate individuals' perceptions of human-environment relationships in decision-making processes?

5.4. Synthesis and final conclusion

My purpose was to investigate how people perceive their social-ecological relationships and possible changes in these relationships in Tarituba. The outcome of this investigation was used to assess assumptions, concepts, and methods developed in the Millennium Ecosystem Assessment framework. In Tarituba, I found that individuals perceived that their actions (occupations and activities) were the means through which they relate to their environments (social-ecological system). Therefore, the assumption that people receive benefits from nature, as presented by the main ecosystem services definitions could not fully represent individuals' perceptions. In addition, intrinsic values of some of the human-environment relationships differed from the mainstream economic valuation within the ecosystem services approach. It is possible to conclude that the concept of ecosystem services, as discussed in the literature did not account for the diversity of human-environment relationships perceived in Tarituba.

The classification of causes of change, according to the concept and categories of drivers of change, was troublesome for two main reasons. On the one hand, the general characteristic of the categories from the literature provided few specification of causes perceived, in other words, classifying the perceived cause into one of the categories of the literature would result in losing relevant information provided by research participants. On the other hand, when the typology of drivers of change was considered as a taxonomy of causes of social-ecological changes, perceived causes could be allocated in two or more categories with the same degree of importance. The specifications of stakeholders' perceptions of drivers of change, revealed via analysis of verbal reports, facilitated the objective classification of perceived drivers according to the categories of the literature.

Regarding the participatory scenario planning, I proposed that the identification of drivers of change as perceived by research participants could be made using the qualitative approach of analysis of verbal reports. This methodology could help researchers to disclose fine-grained information from stakeholders' perceptions, in an operational way. The operationalization of stakeholders perceptions is key to generate comparable results, and therefore, refine this participatory approach.

The overall conclusion reached was that “perception” requires a very precise definition, and its use as commonsense or in exchange for other concepts (as identified in most of the literature consulted throughout this study) may hinder rather than facilitating the inclusion of local perspectives in NRM decision-making. In order to access research participants’ perceptions, explicit definition as well as precise methods of data collection and analysis are necessary. The interdisciplinary nature of the research in natural resources management has to be put in place and, methods and concepts from disciplines that have long studied people’s

perceptions have to be consulted, understood, and applied in order to find meaningful results. This procedure shall enhance our understanding of the relationships human beings have with their environments, which ultimately will provide sound data for interventions that aim to enhance people's well-being.

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Appendix 1: Copy of the letter handed to research participants with information about research objectives and methods.

UNIVERSITY OF MANITOBA

Natural Resources Institute
70 Dysart Rd, Winnipeg, MB
Canada - R3T 2N2
http://www.umanitoba.ca/institutes/natural_resources/

UNICAMP

Universidade Estadual de Campinas
Campinas, SP, Brasil
http://www.unicamp.br/

Novembro de 2010

Meu nome é Luiz Eduardo Chimello de Oliveira e estou atualmente desenvolvendo o meu projeto de doutorado pela Universidade de Manitoba, no Canadá, em parceria com a Universidade Estadual de Campinas - SP (UNICAMP). Eu iniciei meus estudos de doutorado na área de manejo de recursos naturais no ano de 2009 no Canadá e agora me encontro em Paraty para realizar a minha pesquisa de campo, onde permanecerei, pelo menos até setembro de 2011. Minha pesquisa é financiada pelo CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico - Brasil) e pelo Centro de Pesquisa em Desenvolvimento Internacional (IDRC), do Canadá.

Na minha pesquisa de doutorado, intitulada "*Forças de mudanças, planejamento de cenários e opções futuras para comunidades costeiras em Paraty, RJ*"[1], eu pretendo investigar como os aspectos sociais e ambientais têm mudado na região de Paraty e quais são as causas de tais mudanças. Para isso, gostaria de entender como as pessoas da comunidade de Tarituba se relacionam com o ambiente em que vivem, quais são os benefícios que as pessoas obtêm desta interação e como a interação com o ambiente se relaciona com o bem-estar social das pessoas da comunidade.

A participação dos moradores de Tarituba é chave para o desenvolvimento desta pesquisa. Agradeço desde já aqueles que estiverem dispostos a participar. Em outubro de 2011 voltarei ao Canadá para analisar os dados que obtive e volto a Paraty no meio de 2012 para compartilhar com vocês os resultados da minha pesquisa e verificar que a minha análise está de acordo com as informações que obtive junto à comunidade.

Atenciosamente,

Luiz Eduardo Chimello de Oliveira

[1] Esta pesquisa foi aprovada pelo Comitê de Ética da Universidade de Manitoba, processo número: #J2010:100

Appendix 2 – Copy of Ethics Approval certificate

UNIVERSITY OF MANITOBA | Ethics
Office of the Vice-President (Research)

CTC Building
208 - 194 Dafoe Road
Winnipeg, MB R3T 2N2
Fax (204) 269-7173
www.umanitoba.ca/research

APPROVAL CERTIFICATE

August 26, 2010

TO: **Luiz Oliveira** (F.Berkes)
Principal Investigator

FROM: **Brian Barth, Chair**
Joint-Faculty Research Ethics Board (JFREB)

Re: **Protocol #J2010:100**
"Drivers, Scenario Planning, and Future Options for Coastal Communities in Paraty, Brazil"

Please be advised that your above-referenced protocol has received human ethics approval by the **Joint-Faculty Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement. This approval is valid for one year only.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Please note:

- **if you have funds pending human ethics approval, the auditor requires that you submit a copy of this Approval Certificate to Eveline Saurette in the Office of Research Services, (e-mail eveline_saurette@umanitoba.ca, or fax 261-0325), including the Sponsor name, before your account can be opened.**

- **if you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.**

The Research Ethics Board requests a final report for your study (available at: http://umanitoba.ca/research/ors/ethics/ors_ethics_human_REB_forms_guidelines.html) **in order to be in compliance with Tri-Council Guidelines.**

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