

MARIANA MARTINS DE ANDRADE

Empirical evidence of the role of Ecosystem-Based Management in  
qualifying Marine Environmental Impact Assessment

Thesis submitted to the Oceanographic  
Institute of the University of São Paulo in  
partial fulfillment of the requirements for  
the degree of Masters in Science, program  
of Oceanography, Biological Oceanography  
area.

Advisor: Prof. Dr. Alexander Turra

São Paulo

2018

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Oceanographic Institute

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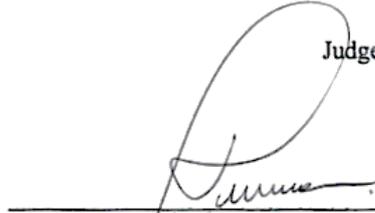
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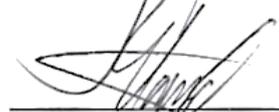
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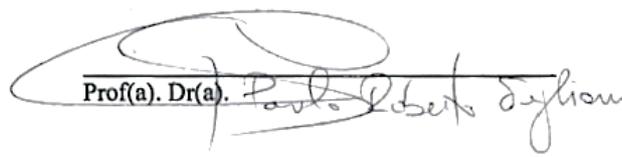
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*“Maybe histories are just data with a soul.”*

*Brene Brown*

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## RESUMO

As externalidades causadas por transformações humanas na estrutura e funcionamento dos ecossistemas têm ameaçado a qualidade ambiental e o bem-estar social em todos os sistemas socioecológicos, incluindo as zonas costeiras. A Avaliação de Impacto Ambiental (AIA) é um instrumento amplamente utilizado para avaliar a viabilidade de empreendimentos e projetos que podem provocar potenciais mudanças no ambiente biofísico-humano. No entanto, a abordagem genérica e fragmentada da AIA não tem devidamente considerado as pessoas e as particularidades ambientais, como os processos e valores sociais, na tomada de decisões. A Abordagem Baseada em Ecossistemas (ABE) surgiu recentemente como uma estratégia que pode qualificar a AIA, abrangendo processos e serviços ecossistêmicos (SE), dimensões humanas, engajamento social e Conhecimento Ecológico Local, Tradicional e Científico. Utilizando um estudo de caso de uma contestada ampliação portuária em São Sebastião, São Paulo, que ameaçou a sustentabilidade de uma baía adjacente (a Baía de Araçá), selecionamos categorias analíticas que compreendem diferentes *stakeholders* (ou principais atores), serviços ecossistêmicos e cenários de perturbações para entender o papel da ABE na AIA costeira. Presumimos que os *stakeholders* com relações mais profundas com o local poderiam fornecer avaliações mais abrangentes sobre mudanças na disponibilidade dos principais SE locais, como resultado de maior senso de pertencimento, acesso a diferentes fontes de conhecimento e oportunidades para participar socialmente. Além disso, assumimos que a ABE proporcionaria uma AIA mais robusta, ou seja, com uma perspectiva mais ampla e mais integrada dos impactos na provisão dos SE do que Estudo de Impacto Ambiental da expansão portuária. Realizamos entrevistas em profundidade com quatro grupos diferentes de *stakeholders* e analisamos o conteúdo por meio de análise de discurso e testes estatísticos para avaliar as ocorrências dos SE no cenário atual (ANOVA de duas vias) e nos cenários de perturbações (ANOVA de medidas repetidas e PERMANOVA), além dos principais padrões de argumentação dos *stakeholders*. Comparamos esses resultados com o Estudo de Impacto Ambiental da ampliação do Porto para afirmar a robustez do método. Os grupos apresentaram diferentes percepções uns dos outros, o que dependeu do cenário e do SE avaliado. Nós corroboramos as hipóteses: grupos com relações mais próximas, mais profundas e mais comprometidas com o local tiveram avaliações mais abrangentes das mudanças dos SE; e as percepções dos *stakeholders* refletiram os *trade-offs* (ou qualidade, aspecto) dos conflitos urbanos locais, proporcionando avaliações mais variadas e integradas de impactos do que o Estudo de Impacto Ambiental da expansão portuária. A diversidade de formas de conhecimento, comportamentos e funções, em escalas temporais e espaciais, se provaram valiosas para avaliações dos grupos sobre os recursos e o território, e a escolha das categorias analíticas foi fundamental para consolidar a compreensão dos processos socioecológicos locais. Concluímos que o método testado foi eficiente e respeitou a variabilidade intrínseca das zonas costeiras e sua função como um sistema socioecológico, o que afirmou que a ABE tem um grande potencial para melhorar a eficácia da AIA.

Palavras-chave: serviços ecossistêmicos; Conhecimento Ecológico Local; participação social; conservação marinha

## ABSTRACT

Externalities caused by human transformations in ecosystems structure and functioning has been threatening environmental quality and social welfare in all socioecological systems, including coastal zones. Environmental Impact Assessment (EIA) is an instrument widely used to evaluate the feasibility of developments and projects that can potentially provoke changes in biophysical-human environment. However, EIA generic and fragmented approach has not properly been considering people and environmental particularities, such processes and benefits to society, in decision making. Ecosystem-Based Management recently emerged as a strategy that can qualify EIA, by embracing ecosystem processes and services (ES), human dimensions, social engagement and Local, Traditional and Scientific Ecological Knowledge. Using a case study of a contested Port expansion in São Sebastião, São Paulo, Brazil, that endangered the sustainability of an adjacent bay (Araçá Bay), we selected analytical categories comprising different stakeholders, ecosystem services and disturbances scenarios to understand the role of EBM in coastal EIA. We presumed that stakeholders with deeper relationships with the place could provide more comprehensive assessments about changes in the availability of main local ES, as a result of greater sense of place, access to different sources of knowledge and opportunities to social participation. Also, an EBM approach would provide a more robust, i.e., a wider and more integrated assessment of impacts in the provision of the ES than the Environmental Impact Study (EIS) of the port expansion. We performed in-depth interviews with four different groups of stakeholders and analyzed their speeches with discourse analysis and statistical inquiries to assess ES scores of occurrences in current (Two-way ANOVA) and disturbances scenarios (Repeated measures ANOVA and PERMANOVA), besides their main argumentation patterns. We compared these results with the port expansion EIS to assert to robustness of the method. The groups had different perceptions from each other, which depended on the scenario and ES evaluated. We corroborated the hypotheses: groups' closer, deeper and more engaged relationships with the place had more comprehensive assessments of changes in the ES; and stakeholders perceptions reflected trade-offs of the local urban conflicts, providing a higher variety and more integrated assessments of impacts than the Environmental Impact Study of the Port expansion. The diversity of forms of knowledge, behaviors and functions, in temporal and spatial scales, proved to be valuable for the groups' assessments of resource and the territory, and the choice of the analytical categories was fundamental to consolidate the understanding of local socioecological processes. We concluded that the method tested was efficient and respected the intrinsic variability of coastal zones and its function as a socioecological system to assert that EBM has a great potential to improve the effectiveness of EIA.

Key-words: Ecosystem services; Local Ecological Knowledge; social participation; marine conservation

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## ACRONYMS INDEX

|           |  |
|-----------|--|
| AF        | Artisanal fishing  |
| ANOVA     | Analysis of variance                                     |
| CS        | Culture support  |
| CZ        | Coastal Zone   |
| D1        | Disturbance scenario 1                                   |
| D2        | Disturbance scenario 2                                   |
| E0        | Type of equivalence 0                                    |
| E1        | Type of equivalence 1                                    |
| E2        | Type of equivalence 2                                    |
| E3        | Type of equivalence 3                                    |
| EBM       | Ecosystem-Based Management                               |
| EIA       | Environmental Impact Assessment                          |
| EIS       | Environmental Impact Study                               |
| ER        | Education and research                                   |
| ES        | Ecosystem services                                       |
| G         | Guardians  |
| LDU       | Local Direct Users                                       |
| LEK       | Local Ecological Knowledge                               |
| LIU       | Local Indirect Users                                     |
| MA        | Millennium Ecosystem Assessment                          |
| NS        | Non-significant difference                               |
| PERMANOVA | Permutational multivariate analysis of variance          |
| PL        | Preliminary License                                      |
| R         | Researchers  |
| SE        | Standard error   |
| SES       | Socioecological system                                   |
| SK        | Scientific Knowledge                                     |
| SSP       | São Sebastião Port                                       |
| TEK       | Traditional Ecological Knowledge                         |
| UNCED     | United Nations Conference on Environment and Development |

## 1 INTRODUCTION

It is almost a truism that environmental cycles and the arrangement of societies are mutually influenced (TURNER et al., 1990; REID et al., 2006; LUCK, 2007; ROCKSTROM et al., 2009; BARRETO, 2017). The undergoing and widespread human transformation in ecosystems properties, structure and functioning (CHAPIN et al., 2009; JACOBI, 2017) has been eroding environmental quality and stability (STEFFEN et al., 2015) – what assigned the denomination of *Anthropocene* to the current geological age (CRUTZEN, 2002). The prospection for conservation and sustainability strategies to better address environmental issues was intensified after 1992, when the United Nations Conference on Environment and Development (UNCED) attested the unquestionable worldwide requirement to develop efficient management and research approaches dedicated to this theme (CICIN-SAIN, 1993; OLSEN, 2003; BILLÉ, 2007; REMOUNDOU et al., 2009).

Ever since, classical studies and frameworks (e.g., EHRLICH & HOLDREN, 1971; MEADOWS et al., 1972; CLARK, 1976; GRUMBINE, 1993; NORDHAUS, 1994; COHEN, 1998) have extensively explored methods to assess and manage the human-environment intertwined relationship (TURNER et al., 2003a; LUCK, 2007; SCHLÜTER et al., 2017). More recently, researches on global environmental change (MA, 2003; GRIMM et al., 2008; HALPERN et al., 2012; IPCC, 2014; DÍAZ et al., 2015; STEFFEN et al., 2015) have addressed the current challenges of adapting the context of global movements, goals and topics (e.g., climate change, loss of biodiversity) to regional and local boundaries and human dimensions (TURNER et al., 2003a; YOUNG et al., 2006; LOOMIS & PATERSON, 2014; HICKS et al., 2015; SCHLÜTER et al., 2017).

In order to achieve that, it has been fundamental to qualify the synergies between human and biophysical subsystems as elements of a *socioecological system* (SES), once it acknowledges the complexity and variability of ecological, economic, cultural and institutional features inherent to ecosystems and societies (BERKES & FOLKE, 1998; GUNDERSON & HOLLING, 2002; BERKES et al., 2003; DÍAZ et al., 2006; CHAPIN et al., 2009; FISCHER et al., 2015). The functional characteristics of SES, such as levels of organization, hierarchy, learning and adaptation (BERKES et al., 2003; MAHON et al., 2008), are convenient concepts used to understand and develop

management strategies, especially applicable to the coastal zone (CZ) (BERKES et al., 2003; CHAPIN et al., 2009).

The interaction of people and CZ dates back to long time scales (CLARK, 1996; MCGRANAHAN et al., 2007). Currently, 38% of the world's population live within 100 km of CZ (UN, 2016) and benefit from its intrinsic functional diversity, socioeconomic conditions, high productivity and resources (SMALL & NICHOLLS, 2003; MA, 2005; LOTZE et al., 2006; LESLIE & MCLEOD, 2007; HALPERN et al., 2012) to value and perform several uses (CICIN-SAIN, 1993; CLARK, 1996; GRUBBER et al., 2003; JENTOFT & CHUENPAGDEE, 2009). Additionally, human-induced environmental changes have jeopardized coastal goods and services by delivering contentious environmental hazards and causing socioecological vulnerability (SMALL & NICHOLLS, 2003; ADGER et al., 2005; DOLAN & WALKER, 2006; MCGRANAHAN et al., 2007; COLLOFF et al., 2017).

Particularly, urbanization and externalities generated by human activities and interventions in the exploitation of CZ resources have threatened the environmental integrity of these areas (RUIZ-LUNA & BERLANGA-ROBLES, 2003; SMALL & NICHOLLS, 2003; LUCK, 2007; MCGRANAHAN et al., 2007), requiring approaches that assess the impacts arising from urban and development projects and attest their feasibility. In this context, Environmental Impact Assessment (EIA) (SÁNCHEZ, 2006; GENELETTI, 2013; BALFORS et al., 2016) is the most widely used tool to identify and manage effects of changes in the biophysical-geographic environment taking into account the political, economic, social and cultural contexts of a territory<sup>1</sup> (CLARK, 1996; BARTLETT & KURIAN, 1999; SÁNCHEZ, 2006; MORGAN, 2012; GENELETTI, 2013; BENHAM & DANIELL, 2016).

Since its origin as a formal appraisal system in the 1970s in the United States of America (MORGAN, 2012), EIA have reached limitations of effectiveness mainly due its generic and fragmented features (OLIVEIRA & BURSZTYN, 2001; CASHMORE, 2004; CARMO, 2016). This model does not embrace the holistic perspective necessary to comprehend CZ complexity, its resources and users (FEITAL, 2016). Hence, appropriated solutions and alternatives to manage the coexistence of a diversity of uses, stakeholders and natural features in the coastal space especially

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<sup>1</sup> In this research, the definition of territory follows the precepts of Lefebvre (1986) and Raffestin (2005) as a social constructed space that includes physical, biotic and abiotic elements that surround living beings and their interrelationships. Here, this concept is used as a synonym for socioecological systems.

converge to Ecosystem-Based Management (EBM – or *Ecosystem Approach*) (ARKEMA et al., 2006; BEAUMONT et al., 2007; CURTIN & PRELLEZO, 2010; ALTMAN et al., 2014; GIEBELS et al., 2015; LONG et al., 2015), which is suitable to enhance EIA (ROSA & SÁNCHEZ, 2015; CARMO, 2016; HOOPER et al., 2016; TURRA et al., 2017).

Emerged from UNCED and Integrated Coastal Management (GRANEK et al., 2009; ANDRADE et al., 2011), EBM is a strategy that aims to promote conservation and sustainable use of land, water and living resources (ARKEMA et al., 2006; BEAUMONT et al., 2007; LESLIE & MCLEOD, 2007; SHEPHERD, 2008; GIEBELS et al., 2015) by assuming that a systemic approach to identify cultural, social and natural values affected by environmental changes is the first step to understand the extent of the SES and its proper governance (BEAUMONT et al., 2007; RAYMOND et al., 2008; SHEPHERD, 2008; GRANEK et al., 2009; ANDRADE et al., 2011; BENNET et al., 2015; FISCHER et al., 2015).

Therefore, EBM have been commonly bonded to SES and to the concept of ecosystem services (ES) (REID et al., 2006; FISHER et al., 2009; BARNAUD & ANTONA, 2014; UNEP, 2014; HICKS et al., 2015) ever since the publication of the Millennium Ecosystem Assessment (MA) raised new demands to understand how ecosystem transformations can alter human well-being and guide decision-making processes (MA, 2003; MA, 2005). In this context, ES – or benefits that societies obtain from ecosystems (COSTANZA et al., 1997) – emerged as elements that enclose the relationship of environmental attributes with social concepts such as *sense of place, perception, power, interest and legitimacy* (BOWEN & RILEY, 2003; BIERMANN et al., 2009; HERNÁNDEZ-MORCILLO et al., 2013; BENNET et al., 2015; HICKS et al., 2015; BÉNÉ et al., 2016).

Modeling social and environmental values, experiences, expectations and responsibilities of different actors is challenging, but imperative (BENNET et al., 2015; BARRETO, 2017; PASCUAL et al., 2017). For such, it is invaluable to promote social engagement and participation (BUCKLAND & RAHMAN, 1999; REED, 2008; REED et al., 2008; HAGE et al., 2010; KITTINGER et al., 2014; COLVIN et al., 2016) and to consider diversified sources of information (CHRISTIE & WHITE, 1997; RUDDLE, 2000; GIEBELS et al., 2015; PASCUAL et al., 2017) as Local and Traditional Ecological Knowledge (LEK and TEK) (BERKES et al., 2000; USHER, 2000; JACKSON et al., 2001; SALOMON et al., 2007; SHEPHERD, 2008) and Scientific

Knowledge (SK) (RUDDLE, 2000; LESLIE & MCLEOD, 2007; OLSEN & NICKERSON, 2003). This diversity is fundamental to interpret perceptions about the magnitude of changes (LOTZE & WORM, 2008; UNEP, 2014) and to legitimate multiple uses and users in planning and applying ecosystem stewardship (HAGE et al., 2010; PETERSON, 2011; BENNET et al., 2015; KARRASCH, 2016; PASCUAL et al., 2017).

There is a growing interest in the implementation of decentralized, integrated and comprehensive approaches to manage natural resources and territories (CHRISTIE & WHITE, 1997; USHER, 2000; BIERMANN et al., 2009; CURTIN & PRELLEZO, 2010; BENNET et al., 2015; DÍAZ et al., 2015; GENELETTI, 2016a; RAYMOND et al., 2017; STORI et al., 2017; TURRA et al., 2017). Hence, holistic frameworks that use EBM to comprise anthropogenic drivers of ecological transformation have been designed to assess environmental and social risks and impacts (SHEPHERD, 2008; GROOT et al., 2010; IFC, 2012a; WORLD BANK, 2013; EPA, 2013; GENELETTI, 2013; BÉNÉ et al., 2016); to enhance strategic environmental assessments (UNEP, 2014; ROSA & SÁNCHEZ, 2015; GENELETTI, 2016b); to facilitate a broader inclusion on different human perceptions in decision-making processes (GIEBELS et al., 2015; KARRASCH, 2016; SCHLÜTER et al., 2017); to proceed to a broader mitigation strategy (QUÉTIER & LAVOREL, 2011) and nature-based solutions (RAYMOND et al., 2017); to estimate impacts at landscape levels (BALFORS et al., 2016); and to improve both spatial modeling (MANDLE & TALLIS, 2016) and marine spatial planning (DOMÍNGUEZ-TEJO et al. 2016).

All of them addressed and proposed techniques to enhance the governance of SES by operationalizing and providing guidance on how to properly model human welfare and environmental quality, a breakthrough for the knowledge of the topic. However, they only glimpse the coupling of EBM, EIA and ES for local problems and for coastal zones. Le Cornu et al. (2014) also reached these conclusions when conducting the first global assessment of the incorporation of social data in coastal and ocean planning. The authors argued that ecosystem services assessments hold a great potential to provide targets to accomplish human and biodiversity management (LE CORNU et al., 2014).

Indeed, some factual (GENELETTI, 2013; UNEP, 2014; GIEBELS et al., 2015; ROSA & SÁNCHEZ, 2015; BALFORS et al., 2016; KARRASCH, 2016) and hypothetical (HOOPER et al., 2014; 2016; TURRA et al., 2017) environmental and

social impact assessments have found evidences of improvements on considering ES and EBM. The authors aforementioned stimulated the discussion and advance of the theme and especially emphasized that empirical research remains as the main demand for robust and comprehensive understanding of EIA qualification by EBM.

In order to contribute in the improvement of knowledge regarding this theme, we conducted a study case to explore the role of EBM in evaluating changes in ecosystems services and functions in a coastal territory. As EBM considers social participation in the management of SES, the approach included assessing the perception, knowledge and social engagement of different stakeholders that have experienced an EIA process of a port expansion. The framework of this study aimed to evidence the relevance of social participation and the different sources of knowledge on the structure, functioning and importance of the environment to the qualification of the EIA.

## 2 CASE STUDY

The EIA process was formally introduced to Brazil in the early 1980s as a method to prevent potentially polluting initiatives (OLIVEIRA & BURSZTYN, 2001; SÁNCHEZ, 2006). Although norms and regulations were created to establish standards for Environmental Impact Studies (EIS), the focus on Brazilian economic growth and institutional barriers within regulatory agencies had enhanced developmental interests and weakened the EIA (CARMO, 2017). This can be observed in assessments that neglect to integrate impacts to climate change scenarios (TURRA et al., 2017) and conservation goals (FERREIRA et al., 2014). Currently, Brazilian EIA frequently result in projects that are filled with uncertainties and inaccuracies (BORIONI et al., 2017; DUARTE et al., 2017; RITTER et al., 2017), because, among other causes, does not couple with social participation, do not consider different sources of knowledge (i.e., LEK, SK) and adapts the socioenvironmental aspects to projects instead of the reverse, as would be expected under the EIA framework (ZHOURI, 2008).

The environmental impact assessment of São Sebastião Port (SSP) expansion – in São Sebastião municipality, northern coast of São Paulo state – is an example of EIA limitations in Brazil and worldwide. In operation since 1955, the SSP experienced significant structural changes over time, which increased the port area due to a series of landfills in the adjacent area – the Araçá Bay – especially in the late 1980s. This remodeling engendered controversy and a Civil Inquiry (Nº 03/95) to evaluate its consequences, but the extensive process did not prevent the landfill installation and was filed more than 20 years later (SANTOS et al., 2017). However, such transformations unquestionably shaped local environmental features (e.g., circulation and sedimentological patterns), the city's growth and the relationship of the local population to the territory (CUNHA, 2003; AMARAL et al., 2010; MANI-PERES et al., 2016).

In 2004, a new expansion project began to be discussed, which was justified mainly by the natural depth of the São Sebastião Channel and the possibility of the SSP to receive vessels of greater drafts (TEIXEIRA & IWAMA, 2017). Formalized in 2009 and adapted in 2011, the proposal planned to land 85% of the Araçá Bay (SÃO PAULO, 2011), which could suppress and compromise the provision and the access to goods and services in the region (AMARAL et al., 2010; AMARAL et al., 2015; SANTOS & TURRA, 2017; STORI et al., 2017; TURRA et al., 2017). This project was socially rejected and its EIS was contested in public hearings (FEITAL, 2016), mainly

by researchers and Non-governmental organization, arising new Civil Inquiries (N° 105/11; N° 07/12) to ascertain its environmental feasibility and to deal with interventions in areas of ecological importance. Ultimately the EIS was considered insufficient by the licensing agency (SANTOS et al., 2017).

Nevertheless, in the following years, the SSP negotiated with federal authorities the addition of complements to the project, replacing the landfill by a structure of slabs and pillars (Figure 1 – A) over 75% of the bay (TURRA et al., 2017). This procedure was not transparent to all stakeholders and public consultations were disproportionate to the amount of doubts and completions requested. In 2013, a new adapted proposal (Figure 1 – B) that intended to cover 34% of the Araçá Bay (SÃO PAULO, 2013) was considered sufficient for the licensing agency to grant a Preliminary License (PL) certifying the development feasibility (CARMO, 2017; TURRA et al., 2017).

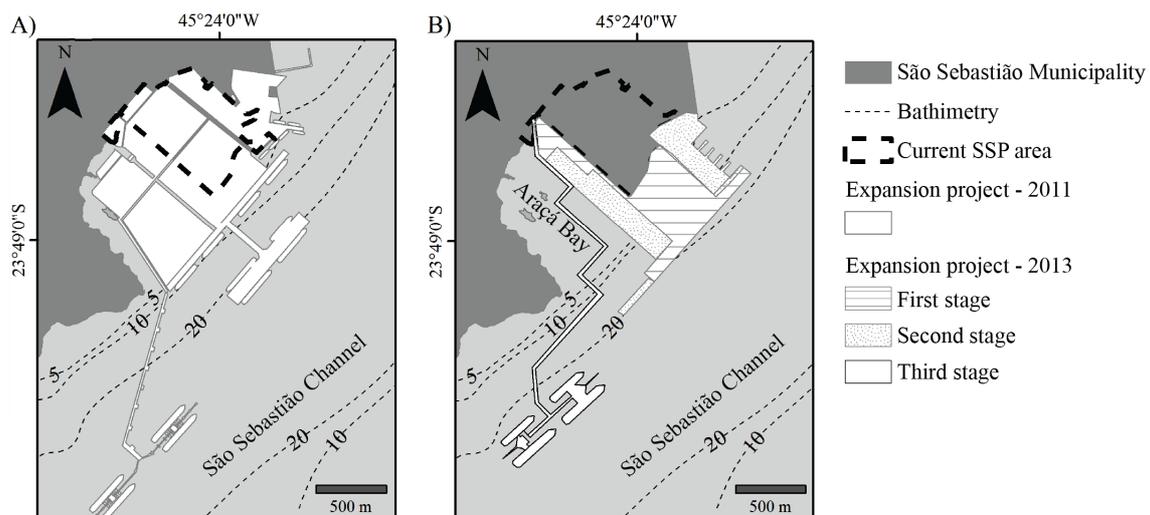


Figure 1. Map of the expansion projects for the São Sebastião Port proposed in the Environmental Impact Study of 2011 (A) and its adaptation in 2013 (B). System of Coordinates: WGS 1984; Projection: Mercator; Data source: Earth and bathymetry: I3Geo / MMA (accessed February 2017); Expansion Project – 2011: Plan Director of the Municipality of São Sebastião and São Paulo (2011); Expansion Project – 2013: São Paulo (2013). (Adapted by Luciana Y. Xavier from Turra et al. (2017)).

The Federal Public Prosecutor Office and the São Paulo State Public Prosecutor Office recommended the suspension of the PL, but the licensing agency did not concur with these recommendations (SANTOS et al., 2017). In 2014, social repercussions originated a Public Civil Action (N° 000398-59.2014.403.6135) officially requesting the cancellation of the PL. Two years later, the PL was invalidated based on

scientific arguments and the lack of adherence to the complementation required to the EIS (NETO et al., 2017; TURRA et al., 2017).

Several stakeholders requested to participate in this decision-making process (CARMO, 2017) as a response of the diversity of uses performed in the Araçá Bay. Sheltered in the central part of the São Sebastião Channel, adjacent to the city's downtown and dominated by tidal currents, the bay gathers a traditional community<sup>2</sup> of artisanal fishermen self-labeled *caiçaras*<sup>3</sup> (RESSUREIÇÃO, 2002; MANI-PERES et al., 2016); scientific research for over than 70 years (AMARAL et al., 2010); housing and anthropogenic activities from urban increment and the SSP operation (TEODORO et al., 2011); and conservation aims given by the presence of Marine Protected Areas – Marine Environmental Protection Area of the North Coast of the State of São Paulo and the Municipal Environmental Protection Area of the Alcatrazes (TURRA et al., 2017; XAVIER et al., 2018).

This diversity of uses is linked to a wide variety of natural habitats including rocky shores, mangrove remnants and an extensive tidal flat (AMARAL et al., 2010; 2015). The region's environmental complexity strengthens its protectionist vocation and socioecological plurality, therefore it would be expected that developmental initiatives recognize these features (RESSUREIÇÃO, 2002; NETO et al., 2017). However, the failure in equally and substantially incorporating social participation and environmental information, the resistance to carry out a new and proper EIS (even though legally necessary), and the slowness and the lack of transparency in the process have not only threatened the area's sustainability (NETO et al., 2017), but have also limited the improvement of the performance of the SSP. And, above all, EIS and EIA did not fulfill their objective of contributing to environmental management (CARMO, 2017).

A special setting to test the applicability of EBM in EIA meets the opportunity to analyze the Araçá Bay's conflict – including the diversity of stakeholders and uses, the attendance of social engagement and the availability of information. We presume that more *comprehensive* perceptions about local ecosystem services and processes threatened by the SSP expansion are proportional to deeper temporal and spatial relationships with the Araçá Bay, as a result of greater sense of place, LEK and SK

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<sup>2</sup> As proposed to Berkes et al. (2007), *traditional community* refers to “historical and cultural continuity”.

<sup>3</sup> Population that occupy part of the south-southeast coast of Brazil that share and “develop a set of material and immaterial practices, linked to the sea and land, synchronized to natural cycles and social and cultural relationships in the spatial and historical context” (DIEGUES, 2012).

and/or social participation (*hypothesis 1*). We assumed that this strategy allows a more *responsive* and *robust*<sup>4</sup> assessment of environmental impacts when compared to the traditionally employed method based on a positivist, fragmented and technocratic approach (GENELETTI, 2013; CARMO, 2017; TURRA et al., 2017) used in the contested EIS of the São Sebastião Port (*hypothesis 2*).

To test both hypotheses we did not intend to perform a socioeconomic diagnosis – as it is usually carried out in an EIS. Otherwise, we wanted to explore a technique to evaluate the subjectivity of the relationships of individuals and environmental assets in order to assess impact perception of different groups of stakeholders about the provision of ecosystem services (as multiple scales indicators) in disturbances scenarios. By understanding methodological limitations and particularities of the role of Ecosystem-Based Management in marine Environmental Impact Assessment, this study intends to fill some of the current gaps of empirical evidences and allow an improvement in the EIA effectiveness.

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<sup>4</sup> For the terms *comprehensive*, *responsive* and *robust* mentioned in the hypotheses of this research, the following definitions were considered, respectively: several aspects within a context; what responds quickly and appropriately to the situation; solid and sharp evaluation.

### 3 METHODS

#### 3.1 Study framework

We designed a systematic method to test the hypotheses, personalized for the Araçá Bay and SSP contexts, guided by literature surveys and field observations and based on three components – stakeholders, ecosystem services and disturbances scenarios. Although the bay concentrates several users and ES (AMARAL et al., 2015) and the SSP expansion may result in various disturbances (TURRA et al., 2017), we chose some key elements from each of these components, as described below, to respond hypothesis 1 and create subsidies to test hypothesis 2.

After a year of interaction with the local community and specialists who conducted on-site researches, we judged it was necessary to consult representatives of five types of relationships with the Araçá Bay: residence with resource exploitation (e.g., fishing); residence without resource exploitation (e.g., recreation); social participation in Araçá Bay conflicts, without local residence but living in the São Sebastião municipality; research; and, acknowledgment of the place's existence, without local residence, but living in the São Sebastião municipality. However, when we tried to access stakeholders from the last group, we realized that this lack of attachment distanced them too much from the problem, nullifying the willingness to express opinions about a territory that is not their own. Besides this information provides indirect evidence on the importance of local residents in EIA, this group could not be further considered in the study design. The other four groups were used to test the hypothesis 1, considering that they all interacted with the Araçá Bay in different ways and intensities. The groups were tracked and named (Table 1), respectively, as *local indirect users (LIU)*, *local direct users (LDU)*, *guardians (G)* and *researchers (R)*.

Table 1. Selection criteria used to sort individuals to compose the chosen groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) that supported the study framework in the test of hypothesis 1 (evidences on differences among stakeholders in environmental impact assessment) and hypothesis 2 (evidences of ecosystem-based management in the improvement of marine environmental impact assessment).

| Group | Relationship category | Selection criteria |
|-------|-----------------------|--------------------|
|-------|-----------------------|--------------------|

|     |                      |  |
|-----|----------------------|--|
| LIU | Local Indirect Users | Residents on the surroundings of the Araçá Bay and other districts of the Municipality of São Sebastião that use indirect non-monetary benefits from the place. They do not perform extractivism activities. |
| LDU | Local Direct Users   | Residents on the surroundings of the Araçá Bay that use direct benefits and exploit resources in the area.   |
| G   | Guardians            | Residents of São Sebastião municipality, they are components of an organized group of civil society that discusses solutions to social and environmental problems of the Araçá Bay.                          |
| R   | Researchers          | Specialists who have been involved in multidisciplinary researches in the last 5 years in the Araçá Bay <sup>5</sup> .   |

From the results of Carrilho (2016), PLDS/Araçá (2016) explored the ecosystem services concept with the local community, mapping and prioritizing 26 goods and services provided by the Araçá Bay. A participatory process classified *artisanal fishing*, *culture support* and *education and research* as the most important ES of the place (PLDS/ARAÇÁ, 2016). Once these are also benefits that partially or totally contemplate the selected stakeholders, they were convenient to compose the framework of this research.

Searching for secondary data that evaluated environmental features of SSP expansion proposal (AMARAL et al., 2010; ALBUQUERQUE, 2013; AMARAL et al., 2015; CARMO, 2016; MANI-PERES, 2016; SANTOS & TURRA, 2017; TURRA et al., 2017) we identified two main disturbances: the *set up of slabs and pillars* and the *increase in circulation of ships*. Such pre-conclusions proved to be useful by indicating scenarios of different phases of the development (i.e., installation and operation stages).

To test hypothesis 1, related to evidence on differences among stakeholders in environmental impact assessment, the four groups of selected stakeholders (Local Indirect Users; Local Direct Users; Guardians; and Researchers) identified the effect of two disturbances (set up of slabs and pillars; increase in circulation of ships) from São Sebastião Port expansion on three ecosystem services (artisanal fishing; culture support; education and research), considering variables (Group characteristics: period of interaction with the Araçá Bay and categories of use of the Araçá Bay; Impact

<sup>5</sup> We opted to consult only specialists who conduct on-site researches in Araçá Bay recently due to the existence of a thematic project (Biota-Araçá/FAPESP Project: “Biodiversity and functioning of a subtropical coastal ecosystem: subsidies for integrated management”) during 2012 and 2017, specially designed to understand the physical, biological and social processes of the Araçá Bay. We supposed that the chief-researchers involved with the project would be the most appropriate to be consulted. Additionally, participatory initiatives from Biota-Araçá/FAPESP Project motivated the arising of the group of Guardians.

assessment: assessment of ES in current, disturbance 1 and disturbance 2 scenarios; and arguments to explain eventual changes in ES assessment after the disturbances – named “whys”; for more details see item 3.2) to reveal differences among groups assessments. To test hypothesis 2, related to evidences of ecosystem-based management in the improvement of marine environmental impact assessment, the results from hypothesis 1 were summarized and compared to the assessment presented in the environmental impact study of the expansion proposed to address the potential of EBM in qualifying EIS and the EIA process. The study framework is summarized in Figure 2.

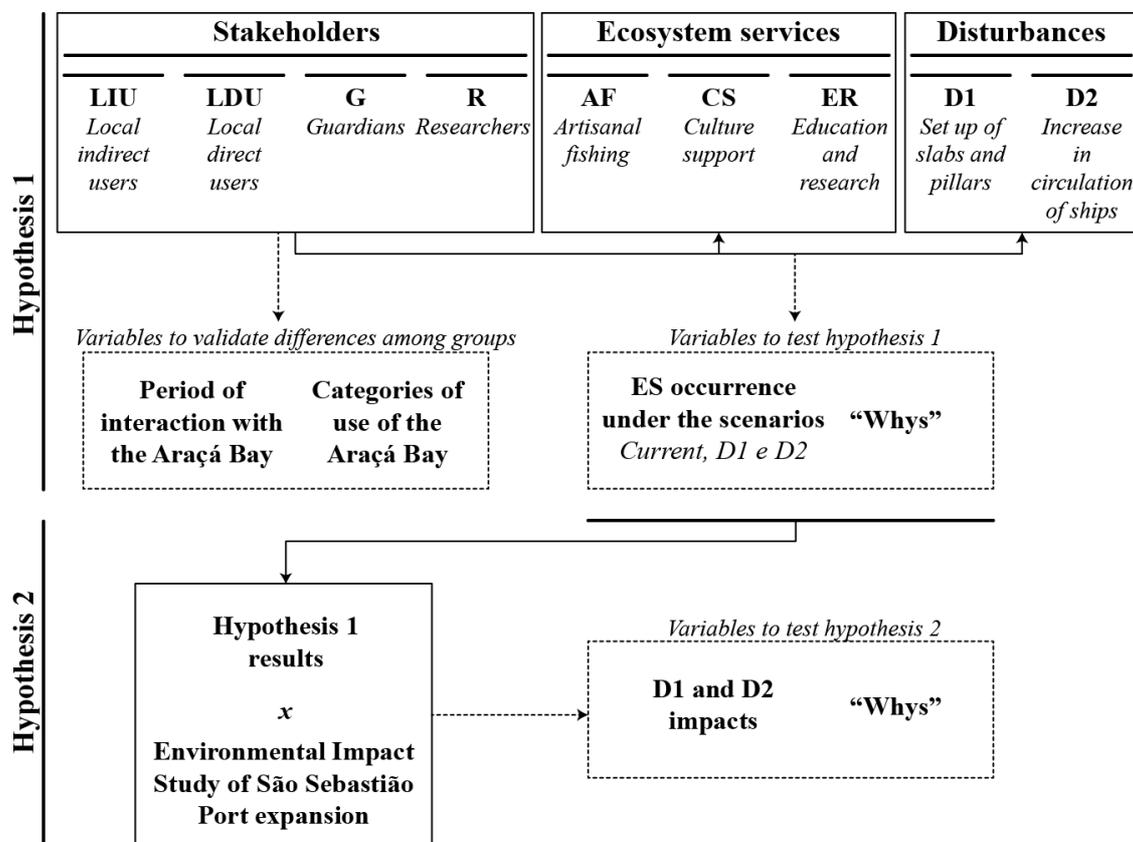


Figure 2. Study framework to test hypothesis 1 (evidences on differences among stakeholders in environmental impact assessment) and hypothesis 2 (evidences of ecosystem-based management in the improvement of marine environmental impact assessment) based on groups of stakeholders (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers); ecosystem services (AF = artisanal fishing; CS = culture support; ER = education and research) and scenarios (Current; D1 = set up of slabs and pillars; D2 = increase in circulation of ships). The variable “Whys” represents arguments used by the stakeholders to explain eventual changes in ES assessment in the disturbance scenarios.

### 3.2 Data collection and analysis

3.2.1 Evidences on differences among stakeholders in environmental impact assessment (*hypothesis 1*)

To investigate the groups' perceptions about changes in the provision of the ecosystem services in the scenarios, we set up a semi-structured script<sup>6</sup> to perform in-depth interviews (LEGARD et al., 2003) with the stakeholders. For such purpose, we visited Araçá Bay several times during 2017, randomly approaching residents and passers-by that suited into LIU and LDU categories. We opted to equal the number of stakeholders consulted for each group (n = 11) since there are a steady number of individuals available to compose R<sup>7</sup> group, who were sampled in a purposelessly non-probabilistic way, personally or by phone. Similarly, G was also limited in number of representatives (n = 12) and one individual did not agree in being consulted. We conducted 44 interviews, in a format of free conversation, through the acceptance of the interviewees to provide their statements – that were recorded, when consented (APPENDIX 2).

Exploratory questions about time of interaction and local usage categories were used to validate differences among groups (Table 2, Figure 2). Scenario questions contained qualitative scores to measure levels of ES availability in the current and disturbances scenarios (Table 2). Initially we intended to use a scale from 0 (null) to 10 (great) to assess the ES, however, this score was not well received by the interviewees. Once they frequently brought categorical evaluations in their speeches, we established a metric of 0 to 5 (0 = null; 1 = very little; 2 = little; 3 = medium; 4 = considerable; 5 = great) to dimension ES occurrence. Farther, the attributes of impacts from the disturbances scenarios were specified and classified according to the criteria from Brasil (1986) (Nature: positive, negative; Scope: direct, indirect; Duration: permanent, temporary; Time scale: immediate, medium-long term; Magnitude: small, medium, great; and Reversibility: reversible, irreversible), being the interviewee able to choose one or more options of each category. All scenario questions were accompanied by the inquiry “why?”, especially to distinguish argumentation patterns in the stakeholders' speeches and reveal different stimuli and sources of information and knowledge among groups.

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<sup>6</sup> Evaluated and corroborated by the Brazilian Ethics Committee (Plataforma Brasil) that designates norms of conduct for researchers with human beings in the country (APPENDIX 1).

<sup>7</sup> As described previously, chief-researchers from Biota-Araçá/FAPESP Project were chosen to represent the groups of stakeholders from Research category. There were 12 individuals available, but one of them (responsible for the Integrated Management module of the project) was not interviewed for contributing directly to the achievement of all phases of this research.

The contents of the interviews and metrics were described, interpreted and reorganized, based on discourse analysis (CAREGNATO & MUTTI, 2006; ROCHA & DEUSDARÁ, 2005; MARTINS, 2008). The results<sup>8</sup> were submitted to statistical tests to strengthen interpretations about differences among groups. One-way Analysis of Variance (ANOVA; Tukey post-hoc) was used to check divergences about the period of interaction of the groups with the Araçá Bay. Two-way ANOVA (Tukey post-hoc) was used to evaluate differences among the current scenario answers about the provision of ES. Repeated measures ANOVA (Tukey post-hoc) were applied to compare differences in the ES occurrence between current and each disturbance scenario. And further, a Permutational Multivariate Analysis of Variance (PERMANOVA) tested the existence of contrasts about the impact attributes (BRASIL, 1986) in the ES under each disturbance scenario.

Table 2. Types of questions, questions, metrics and statistic tests employed in the data collection and analysis of groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) assessments of ES (AF = artisanal fishing; CS = culture support; ER = education and research) in the scenarios (current; D1 = set up of slabs and pillars; D2 = increase in circulation of ships) used to respond hypothesis 1 (evidences on differences among stakeholders in environmental impact assessment).

| Type of question   | Question   | Metric   | Statistic test applied                                   |
|--|--|--|--|
| Exploratory  | How long do you know the Araçá Bay?  | Years  | One-way ANOVA  |
|  | Do you somehow use the Araçá Bay?  | Usage categories   | –  |
| Current scenario of ES   | How do you evaluate the occurrence of <i>artisanal fishing /education and research</i> activities in the Araçá Bay? Why?                         |  | Two-way ANOVA  |
|  | How do you evaluate how much the Araçá Bay <i>supports culture</i> ? Why?  | <input type="checkbox"/> Null – 0<br><input type="checkbox"/> Very little – 1<br><input type="checkbox"/> Little – 2<br><input type="checkbox"/> Medium – 3<br><input type="checkbox"/> Considerable – 4<br><input type="checkbox"/> Great – 5 |  |
| Occurrence of ES considering the disturbance scenarios (separately): | How do you evaluate the future occurrence of <i>artisanal fishing /education and research</i> activities in Araçá Bay considering D1 or D2? Why? |  | Repeated measures ANOVA for current and future scenarios |
| (D1) Set up of slabs and pillars;<br>(D2) Increase in                | How do you evaluate how much the Araçá Bay will <i>support culture</i> considering D1 e D2? Why?   |  |  |

<sup>8</sup> For all groups on all questions there were respondents who chose to refrain from responding. These results also made up the groups of samples analyzed here. Only for the presentation of simple arithmetic means they were corrected considering only the interviewees who chose to answer the equivalent question.

|   |  |   |
|---|--|---|
| circulation of ships;   | If no change is perceived, what is the cause? Why?   |   |
| Impact attributes (BRASIL, 1986), considering the disturbance scenarios (separately): | Rank the attributes of impacts on their nature, scope, duration, time scale, magnitude and reversibility for each ES, considering D1 and D2. Why did you make this choice? |   |
| (D1) Set up of slabs and pillars;   |  | Nature:<br><input type="checkbox"/> Positive<br><input type="checkbox"/> Negative                                 |
| (D2) Increase in circulation of ships;  |  | Scope:<br><input type="checkbox"/> Direct<br><input type="checkbox"/> Indirect                                    |
|   |  | Duration:<br><input type="checkbox"/> Permanent<br><input type="checkbox"/> Temporary                             |
|   |  | Time scale: PERMANOVA<br><input type="checkbox"/> Immediate<br><input type="checkbox"/> Medium-long term          |
|   |  | Magnitude:<br><input type="checkbox"/> Small<br><input type="checkbox"/> Medium<br><input type="checkbox"/> Great |
|   |  | Reversibility:<br><input type="checkbox"/> Reversible<br><input type="checkbox"/> Irreversible                    |

### 3.2.2 Evidences of ecosystem-based management in the improvement of marine environmental impact assessment (*hypothesis 2*)

We compared results obtained from the test of the hypothesis 1 with the São Sebastião Port expansion EIS (SÃO PAULO, 2011), in order to evaluate if the stakeholders speeches embraced systemic and more comprehensive assessments of impacts and changes in the provision of the ecosystem services. Since an EIS should attempt to capture a diversity of opinions, we gathered all stakeholders in a single group (n = 44) and constructed a matrix to express the comparisons. We reinforce that this strategy was restricted to lists and matrices of impacts of the EIS and results specifically about the three ecosystem services and the two disturbances scenarios evaluated in hypothesis 1.

In order to achieve that, we scanned the EIS content, identifying, selecting and classifying similarities with the interviews results (hypothesis 1) on different types of equivalence (Table 3). Additionally, we were able to link the impacts presented in the matrix to the argumentation patterns (from “whys” inquiries) previously detected in the speeches of the stakeholders, to validate sources and justifications about the impacts.

Table 3. Types of equivalence between the stakeholders assessment and the Environmental Impact Study of the São Sebastião Port expansion assessment of the ES (AF = artisanal fishing; CS = culture support; ER = education and research) in the scenarios (current; D1 = set up of slabs and pillars; D2 = increase in

circulation of ships) used to respond hypothesis 2 (evidences of ecosystem-based management in the improvement of marine environmental impact assessment).

| <b>Type of equivalence</b> |   | <b>Criteria</b>   | <b>Purpose of interpretation</b>   |
|----------------------------|---|---|--|
| E0                         | No equivalence  | Impacts identified by the stakeholders, but neglected in the EIS.   | Identified impacts that were not considered in the EIA process.  |
| E1                         | Impact and disturbance equivalence                            | Impacts from disturbance scenario 1 or 2 identified by the stakeholders and corresponded in the EIS.  | Stakeholders and EIS had similar understanding, but it does not necessarily mean that both had the same motivations or assessed the same processes to reach equal conclusions. |
| E2                         | Partial impact equivalence                                    | Impacts from disturbance scenario 1 identified by the stakeholders, but attributed to disturbance scenario 2 by the EIS. The opposite also applied.       | Stakeholders presented a broader and less fragmented interpretation of the disturbances than the EIS.  |
| E3                         | Equivalent to EIS impact list, but no equivalent to D1 and D2 | Impacts from disturbance scenario 1 or 2 identified by the stakeholders, but attributed to another disturbance (not covered by this research) by the EIS. | Stakeholders and the EIS indeed had different reasons for assigning the classification of impacts.   |

## 4 RESULTS

### 4.1 Evidences on differences among stakeholders in environmental impact assessment (*hypothesis 1*)

#### 4.1.1 Group characterization

The groups interacted with the Araçá Bay over different periods of time (One-way ANOVA:  $F = 3.3660$ ,  $p = 0.027$ ,  $DF = 3$ ). No differences were identified between LIU, LDU and G, who are part of or interacted with the local community on average for 3 to 4 decades. However, LIU showed a trend to a lower mean period of interaction than LDU and G (Figure 3). Researchers had the lowest mean period of interaction, and their contact with Araçá Bay was divided into two sub-groups, i.e., one group ( $n = 6$ ) with an average of 5 years of interaction, and a second group ( $n = 5$ ) with 39 years of experience in Araçá Bay.

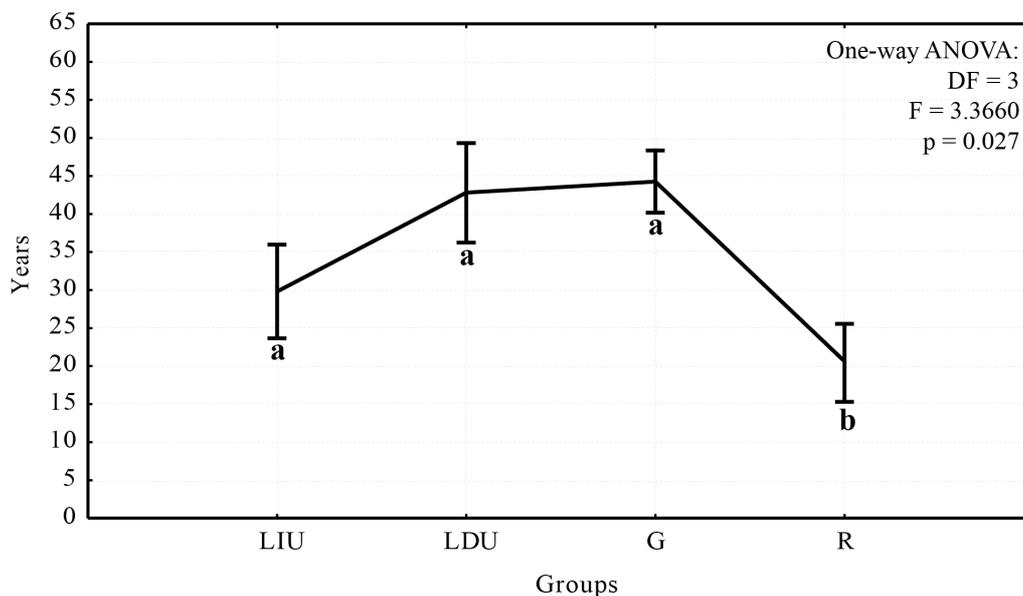


Figure 3. Differences in the mean period of interaction (years) (mean  $\pm$  SE) with the Araçá Bay among groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers). Corresponding letters (a, b) indicate non-significant differences in the Tukey test.

The groups mentioned 11 different use categories in the Araçá Bay (Figure 4). Local Indirect Users participated in few categories mainly focused on leisure activities, such as recreation and landscape appreciation. Otherwise, Local Direct Users realized 9

out of the 11 identified uses, predominantly fishing, vessel housing, habitation, trade and boat repairs. Guardians shared similar LDU uses, but they cited more frequently categories like social participation and preservation, both uses also performed by Researchers, whose main use reported was research.

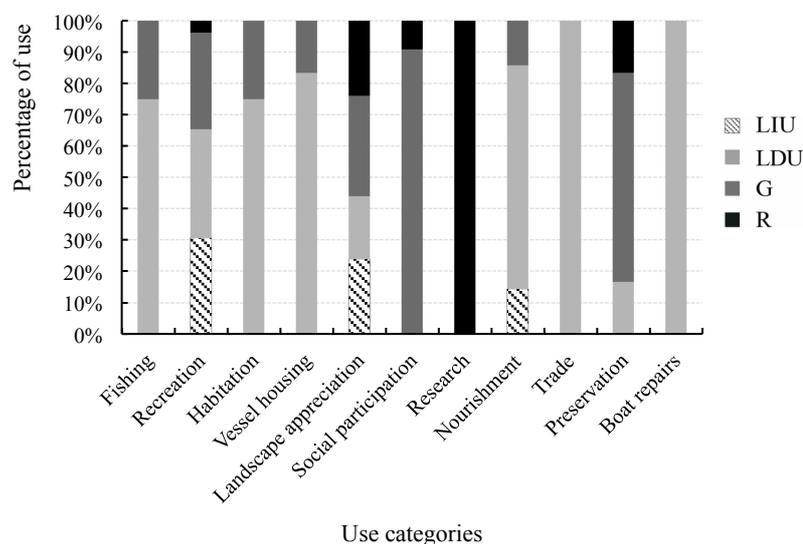


Figure 4. Percentage of citation of usage categories (fishing; recreation; habitation; landscape appreciation; social participation; research, nourishment, trade, preservation; boat repairs) performed by the groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) in the Araçá Bay.

#### 4.1.1 Assessment of the ecosystem services at the current scenario

The groups presented different assessments about the ES occurrences in the current scenario, which were also evaluated differently from one another (Table 4, Figure 5). The perception of the groups depended on the ecosystem service considered (see Groups\*ES, Table 4), so differences among the groups were then interpreted within each ES.

Table 4. Two-way analysis of variance (ANOVA) to evaluate differences between groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) assessment of the ecosystem services (ES – artisanal fishing, culture support, education and research) in the current scenario of the Araçá Bay.

| Source    | DF | MS       | F        | p       |
|-----------|----|----------|----------|---------|
| Intercept | 1  | 1758.503 | 1411.559 | < 0.001 |
| Groups    | 3  | 7.471    | 5.997    | < 0.001 |
| ES        | 2  | 5.339    | 4.286    | 0.016   |

|           |     |       |       |       |
|-----------|-----|-------|-------|-------|
| Groups*ES | 6   | 3.803 | 3.053 | 0.008 |
| Error     | 111 | 1.246 |       |       |

There were no differences between LDU, G and R groups considering the 3 ES evaluated. LIU presented lower evaluations of artisanal fishing (Figure 5 – A) from G assessment. LIU also rated a lower score for culture support (Figure 5 – B) than LDU and G classifications. Within education and research (Figure 5 – C), LIU presented the smallest rating, differing from the other groups.

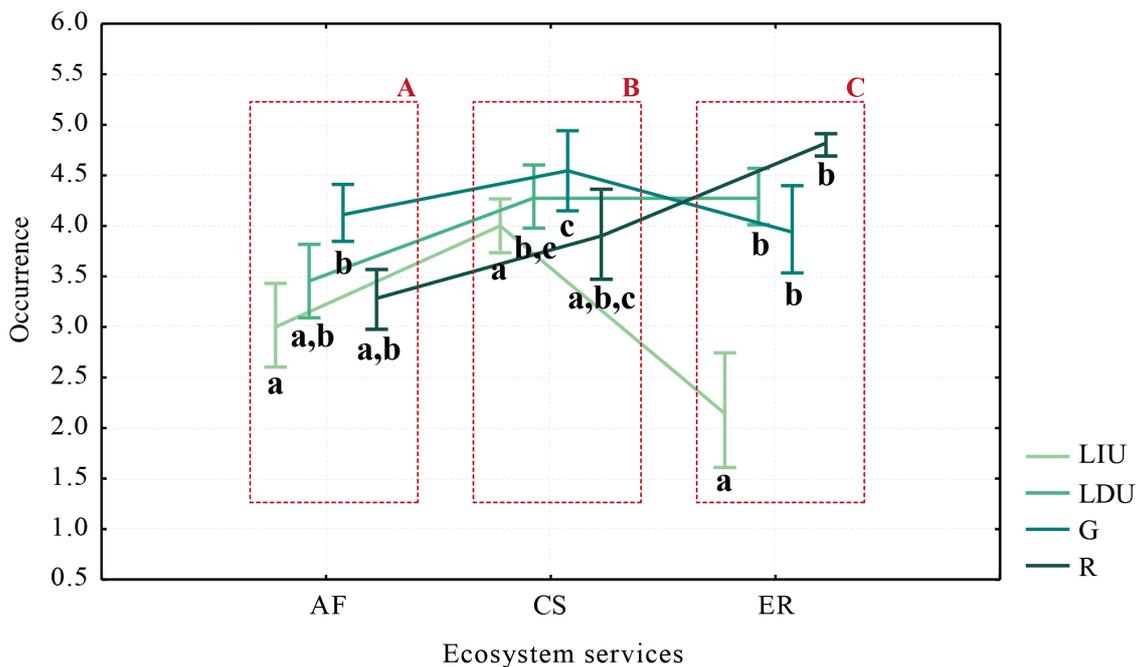


Figure 5. Variation in occurrence (5 = great; 4 = considerable; 3 = medium; 2 = little; 1 = very little; 0 = null) (mean  $\pm$  SE) of the ecosystem services (AF = artisanal fishing; CS = culture support; ER = education and research) in current scenario among different stakeholder groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) in the Araçá Bay. Dashed boxes indicate different scales of interpretation per ecosystem service (A – artisanal fishing; B – culture support; C – education and research). Corresponding letters (a, b, c) indicate non-significant differences according to the Tukey test used to interpret differences among groups within each ecosystem service.

#### 4.1.2 Assessment of the effect of disturbance scenario 1 (*set up of slabs and pillars*) on the ecosystem services

In general, the set up of slabs and pillars scenario changed the perceptions of all groups, reducing their assessments about the occurrence of ES (Table 5, Figure 6), which depended on the group (see R1\*Groups, Table 5) and the ecosystem service considered (see R1\*ES, Table 5). Once again differences among groups were interpreted within each ES.

Table 5. Repeated measures analysis of variance (ANOVA) on the assessment of the ecosystem services (ES: AF = artisanal fishing; CS = culture support; ER = education and research) in current and disturbance 1 (set up of slabs and pillars) scenarios among different groups of stakeholders (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) in the Araçá Bay.

| Source       | DF | MS      | F       | p       |
|--------------|----|---------|---------|---------|
| R1           | 1  | 278.572 | 164.206 | < 0.001 |
| R1*Groups    | 3  | 7.987   | 4.708   | 0.004   |
| R1*ES        | 2  | 8.318   | 4.903   | 0.009   |
| R1*Groups*ES | 6  | 1.262   | 0.743   | 0.615   |
| Error        | 88 | 1.696   |         |         |

Comparing current and disturbance scenarios (Figure 6 – A), LDU, G and R observed differences in the provision of artisanal fishing; and LDU and R presented differences for the classification of culture support. A decrease higher than 50% was recorded in the scores of the occurrence of these two ecosystem services. However, only Researchers recognized significant changes in the education and research occurrence. LIU assessments on the three ecosystem services were not different from the current scenario (APPENDIX 3). Within the disturbance scenario 1 (Figure 6 – B), the groups did not differ from each other in the rating of each ES.

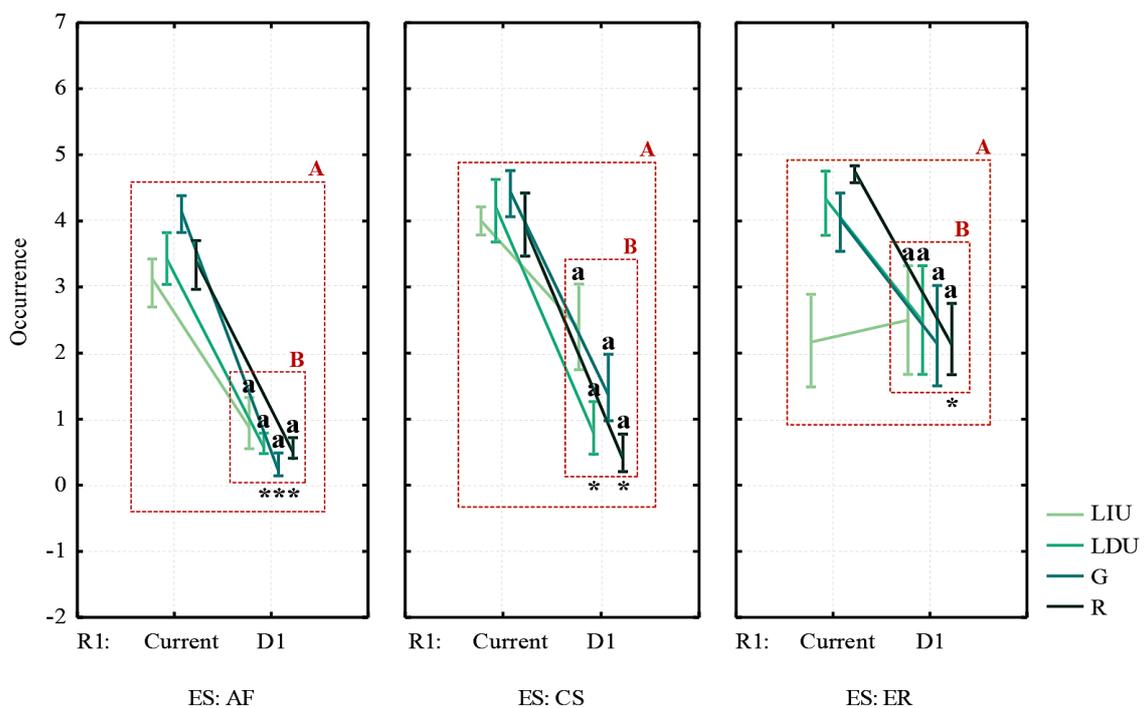


Figure 6. Variation in occurrence (5 = great; 4 = considerable; 3 = medium; 2 = little; 1 = very little; 0 = null) (mean  $\pm$  SE) of the ecosystem services (ES: AF = artisanal fishing; CS = culture support; ER = education and research) among groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) comparing current and disturbance scenario1 (D1; set up of slabs and pillars) in the Araçá Bay. Dashed boxes indicate different scales of interpretation (A = comparison

between scenarios; B = within disturbance scenario 1). The symbol \* indicate significant differences from the Tukey test used to interpret differences among groups within each ecosystem service in the comparison of scenarios. Corresponding letters (a) indicate non-significant differences from the Tukey test used to interpret differences among groups within each ecosystem service within disturbance scenario 1.

The impact attributes determined by Brasil (1986) and used to specify variations in the ES provision under the disturbance scenario 1 were differently assessed by the groups (see Groups, Table 6) and varied between the ecosystem services (see Groups\*ES, Table 6). So, the comparisons were made among groups and among ES separately.

Table 6. Permutational multivariate analysis of variance (PERMANOVA) on impact attributes (BRASIL, 1986) in the assessment of the ecosystem services (ES: AF = artisanal fishing; CS = culture support; ER = education and research) in current and disturbance 1 (set up of slabs and pillars) scenarios among different groups of stakeholders (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) in the Araçá Bay.

| Source    | DF  | MS     | Pseudo-F | p     |
|-----------|-----|--------|----------|-------|
| Groups    | 3   | 36.449 | 30.977   | 0.006 |
| ES        | 2   | 73.386 | 62.368   | 0.001 |
| Groups*ES | 6   | 53.359 | 0.453    | 0.957 |
| Res       | 120 | 11.767 |          |       |
| Total     | 131 |        |          |       |

Considering the classification of all categories on all ES, LIU differed from LDU ( $p = 0.049$ ) and G ( $p = 0.004$ ), the last one also differing from Researchers' scores ( $p = 0.015$ ). Artisanal fishing (Figure 7 – A) and culture support (Figure 7 – B) varied mainly on scope (direct, indirect) and did not differ from each other. Although Groups\*ES interaction was not significant, the post-hoc test revealed differences between LIU and R ( $p = 0.012$ ) for artisanal fishing and culture support.

The groups did not consider education and research (Figure 7 – C) provision differently. However education and research differed from artisanal fishing ( $p = 0.002$ ) and culture support ( $p = 0.004$ ) because of its variability on nature (positive, negative) and scope (direct, indirect).

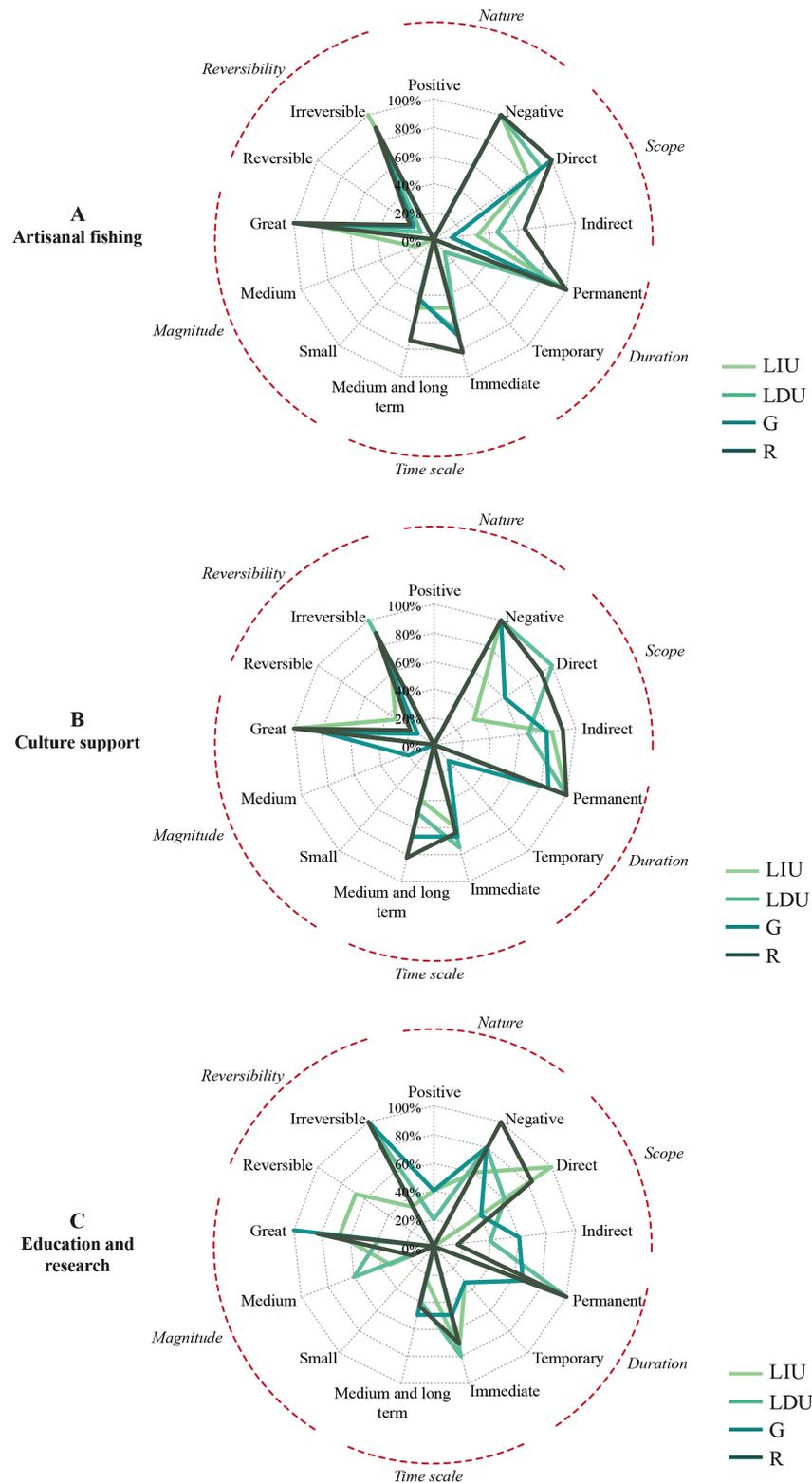


Figure 7. Percentage of impact attributes (Nature: positive, negative; Scope: direct, indirect; Duration: permanent, temporary; Time scale: immediate, medium-long term; Magnitude: little, medium, great; Reversibility: reversible, irreversible – BRASIL, 1986) in the provision of the ecosystem services (A = artisanal fishing; B = culture support; C = education and research) under disturbance scenario 1 (set up of slabs and pillars), assigned by different groups of stakeholders (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) in the Araçá Bay.

#### 4.1.3 Assessment of the effect of disturbance scenario 2 (*increase in circulation of ships*) on the ecosystem services

For the disturbance scenario 2, the groups perceived a reduction of ES occurrences from the current status, such as in the disturbance scenario 1 (Table 7, Figure 8). However, such differences among groups (see R1\*Groups, Table 7) were not influenced by the ecosystem services analyzed (see R1\*ES, Table 7).

Table 7. Repeated measures analysis of variance (ANOVA) on the assessment of the ecosystem services (ES: AF = artisanal fishing; CS = culture support; ER = education and research) in current and disturbance 2 (increase in circulation of ships) scenarios among different groups of stakeholders (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) in the Araçá Bay.

| Source       | DF | MS      | F       | p       |
|--------------|----|---------|---------|---------|
| R1           | 1  | 196.851 | 947.889 | < 0.001 |
| R1*Groups    | 3  | 9.888   | 47.613  | 0.004   |
| R1*ES        | 2  | 4.26    | 20.515  | 0.135   |
| R1*Groups*ES | 6  | 2.377   | 11.447  | 0.345   |
| Error        | 73 | 2.077   |         |         |

Guardians and Researchers pointed reductions of nearly 90% in the occurrence of artisanal fishing, comparing to the current scenario (Figure 8 – A, APPENDIX 4); and Researchers' scores for the occurrence of culture support were 85% lower than the current scenario.

Although LDU indicated a decrease near to 50% in the provision of all ES, their evaluations were not significant different from the current scenario. As in disturbance scenario 1, LIU were not sensitive to changes in none of the ES. Moreover, no group identified differences from the current status in the availability of education and research. Within the disturbance scenario (Figure 8 – B), the groups did not rate the ES differently.

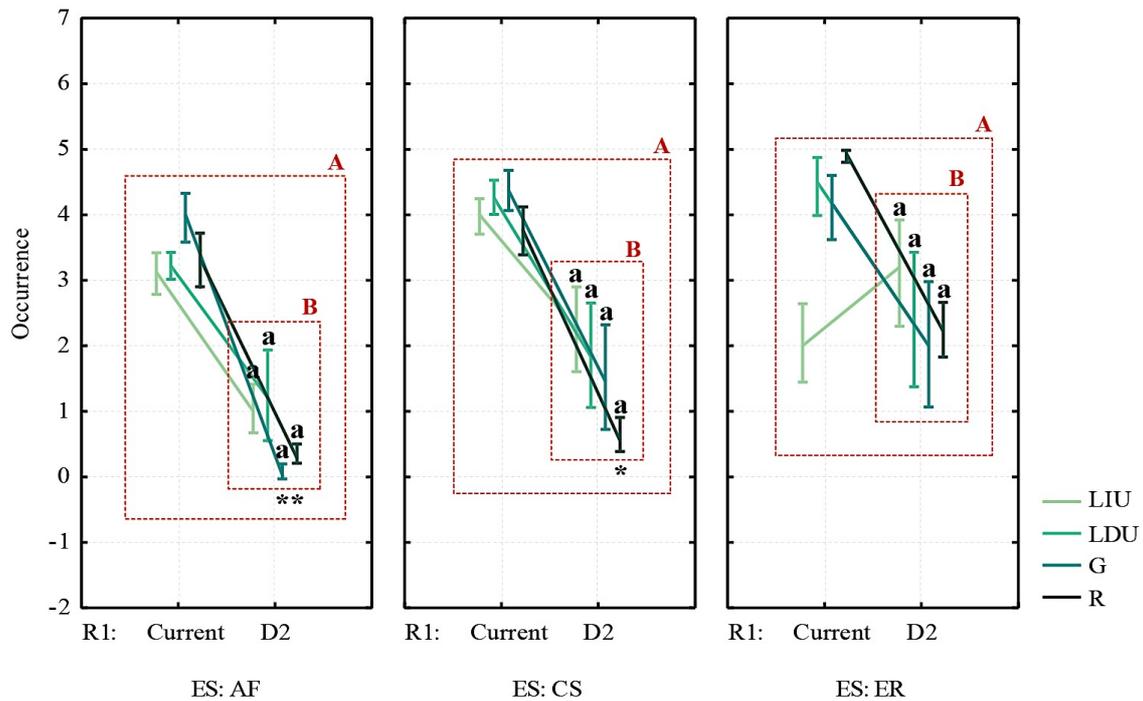


Figure 8. Variation in occurrence (5 = great; 4 = considerable; 3 = medium; 2 = little; 1 = very little; 0 = null) (mean  $\pm$  SE) of the ecosystem services (ES: AF = artisanal fishing; CS = culture support; ER = education and research) among groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) comparing current and disturbance 2 (D2; increase in circulation of ships) scenarios in the Araçá Bay. Dashed boxes indicate different scales of interpretation (A = comparison between scenarios; B = within disturbance scenario 1). The symbol \* indicate significant differences from the Tukey test used to interpret differences among groups within each ecosystem service in the comparison of scenarios. Corresponding letters (a) indicate non-significant differences from the Tukey test used to interpret differences among groups within each ecosystem service within disturbance scenario 2.

The groups did not assess the impacts attributes (BRASIL, 1986) caused by the increase in circulation of ships differently (post-hoc NS<sup>9</sup>), which reinforces the dissimilarity in the interpretation between the two disturbances investigated. However, there were differences in the assessment of the effect of the disturbance 2 on the ecosystem services (see R1\*ES, Table 8).

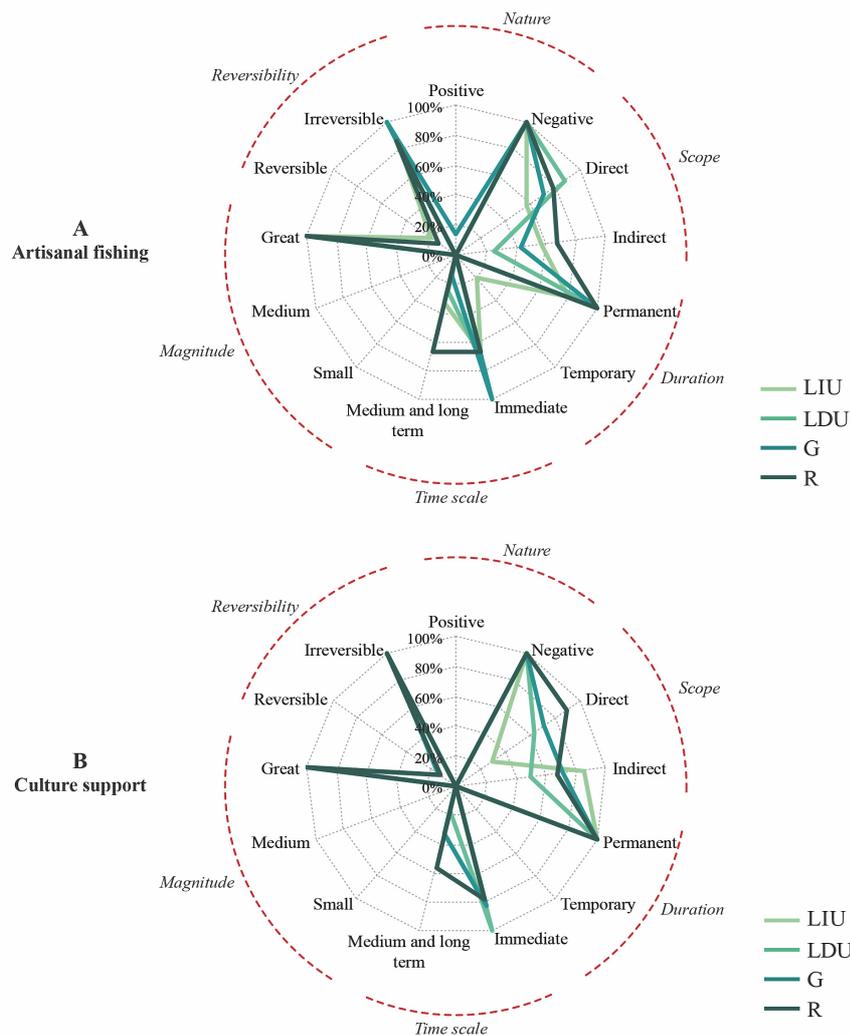
Table 8. Permutational multivariate analysis of variance (PERMANOVA) on impact attributes (BRASIL, 1986) in the assessment of the ecosystem services (ES: AF = artisanal fishing; CS = culture support; ER = education and research) in current and disturbance 2 (increase in circulation of ships) scenarios among different stakeholder groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) in the Araçá Bay.

| Source    | DF  | MS     | Pseudo-F | p     |
|-----------|-----|--------|----------|-------|
| Groups    | 3   | 20.753 | 1.502    | 0.181 |
| ES        | 2   | 45.765 | 33.123   | 0.021 |
| Groups*ES | 6   | 65.934 | 0.47721  | 0.907 |
| Res       | 120 | 13.817 |          |       |
| Total     | 131 |        |          |       |

<sup>9</sup> Non-significant difference.

As observed in scenario 1, artisanal fishing (Figure 9 – A) varied mainly on scope (direct, indirect). Otherwise, culture support (Figure 9 – B) presented variability in scope (direct, indirect) and time scale (immediate, medium-long term). Both ES did not differ from each other. However, in education and research (Figure 9 – C) there were oscillation on nature (positive, negative), scope (direct, indirect), time scale (immediate, medium-long term), magnitude (small, medium, great) and reversibility (reversible, irreversible) categories, which justified differences between this ES and artisanal fishing ( $p = 0.014$ ) and culture support ( $p = 0.044$ ).

Although the PERMANOVA did not show evidences of the effect of groups in the assessment of changes, the post-hoc comparison revealed a marginal, but significant difference between LIU and R ( $p = 0.045$ ), possible caused by a near-significant trend in the assessment of impact attributes of education and research ( $p = 0.074$ ).



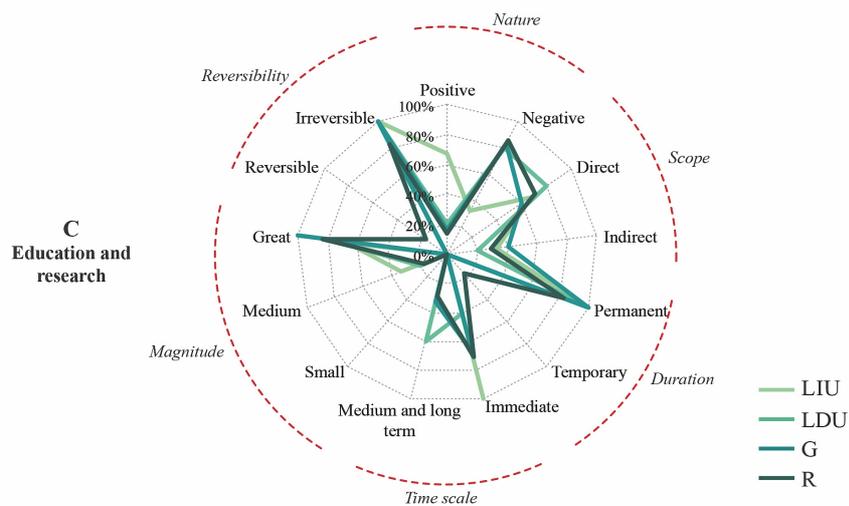


Figure 9. Percentage of impact attributes (Nature: positive, negative; Scope: direct, indirect; Duration: permanent, temporary; Time scale: immediate, medium-long term; Magnitude: little, medium, great; Reversibility: reversible, irreversible – BRASIL, 1986) in the provision of the ecosystem services (A = artisanal fishing; B = culture support; C = education and research) under disturbance scenario 2 (increase in circulation of ships), assigned by different groups of stakeholder (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) in the Araçá Bay.

#### 4.1.4 The “whys”

The argumentation patterns distinguished from answers to the scenario questions revealed socioecological systemic notions in the groups’ speeches, which helped to strengthen differences among the groups and in their interpretations of the ecosystem and impacts. The groups used seven general lines of argumentation (Figure 10, APPENDIX 5), concomitantly or not, to express cause and effect arguments, direct and indirect sources of transformations and space-time linkages about changes in the ES provision due to the disturbance scenarios 1 and 2.

The most cited arguments were related to direct sources of impact or consequences to the ES, such as *pollution* of the marine environment, e.g. sewage, waste and chemical sources; *loss of territory*, representing the decrease of physical space to perform the usage categories in the Araçá Bay; and *damage in ecological functions*, related to loss or decrease of ecological attributes of the bay.

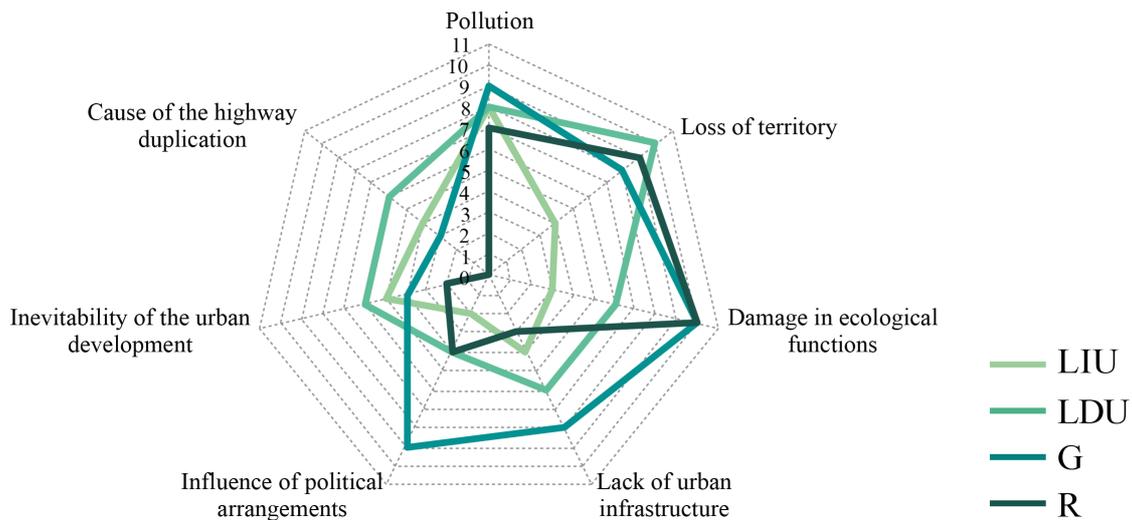


Figure 10. Number of responses of the seven lines of argumentation (pollution; loss of territory; damage in ecological functions; lack of urban infrastructure; influence of political arrangements; inevitability of urban development; cause of the highway duplication) used by the groups (LIU = Local Indirect Users; LDU = Local Direct Users; G = Guardians; R = Researchers) to explain systemic relationships on the three ecosystem services (artisanal fishing; culture support; education and research) due to the disturbances scenarios (D1: set up of slabs and pillars; D2: increase in circulation of ships).

The others four arguments concentrated secondary and indirect consequences of the disturbances, closely related to social and urban problems. Although with greater variability between groups, the most quoted arguments were *lack of urban infrastructure*, which problematized an indirect dimension of the SSP expansion that could prejudice the welfare of the local population and favor the occupation of the area by foreign residents, often used when the users were asked about culture support; and *influence of political arrangements*, which represented a privilege of the interests of the entrepreneur not shared with the local population.

Lastly, the investigated disturbances were relate to the *inevitability of urban development*, as a resigned argument to justify losses in the ES of the Araçá Bay in favor of the city's economic development (usually accompanied by the words “progress” and “growth”); and, as the *cause of the highway duplication*<sup>10</sup>, an indirect impact that could boost the SSP expansion and intensify problems such as lack of urban infrastructure. These were the arguments that were least pointed by all the groups.

All the lines of argumentation appeared in the discourses of LIU, LDU and G. However, they were slightly cited by Local Indirect Users, which were mainly limited

<sup>10</sup> The duplication of the Tamoios highway (SP-099) is a development project paired to the expansion of the São Sebastião Port that intends to support the connection of urban-industrial centers of São Paulo with the coast of the state, to increase the flow of vehicles and products.

to pollution causes. Local Direct Users have brought both evidences of direct and indirect consequences, covering them similarly and being predominant in quoting urban development inevitability, cause of the highway duplication and the loss of territory. Guardians presented the greatest range of citations, heading part of the arguments, especially the influence of political arrangements and lack of urban infrastructure. Ultimately, Researchers quoted few times the arguments related to indirect consequences, focusing on damage in ecological functions and loss of territory.

#### **4.2 Evidences of ecosystem-based management in the improvement of marine environmental impact assessment (*hypothesis 2*)**

The hypothesis 1 indicated several types of differences in the groups' assessments of the ES provisions under the disturbance scenarios. Additionally, different arguments aroused systemic understandings about changes in the Araçá Bay, broader and diversified for some groups and less frequent for others. Therefore, the total sample was composed by heterogeneous and complex answers about objective and subjective parameters. This bulk of information was compared to the EIS of the SSP expansion (SÃO PAULO, 2011) to test hypothesis 2.

The stakeholders and the EIS did not assess the impacts from the two disturbances similarly. From the studied ecosystem services, the EIS considered that only artisanal fishing would be impacted by the set up slabs and pillars. It was the only case of equivalence type 1 (E1; Table 9), i.e. where the EIS and interviewees had similar understanding, but not necessarily the same motivations to reach the same conclusion. The stakeholders also attributed impacts to artisanal fishing from the increase in circulation of ships, which was not reported by the EIS and was classified as equivalence type 2 (E2), indicating that the interviewees presented a broader and less fragmented interpretation of the disturbances than the EIS.

Culture support appeared on the EIS list but was not associated to any of the analyzed disturbances, contrary to the stakeholders' assessment (equivalence type 3 – E3, i.e. indicating that users and the EIS indeed had different reasons for assigning the classification of impacts); and education and research was not mentioned throughout the EIS list (E0), although the stakeholders recognized impacts in this ES.

Table 9. Impact equivalence (E0 = No equivalence; E1 = impact and disturbance equivalence; E2 = partial impact equivalence; E3 = equivalent to EIS impact list, but no equivalent to D1 – set up of slabs

and pillars, and D2 – increase in circulation of ships) matrix crossing the stakeholders' assessments and São Sebastião Port (SSP) environmental impact study (EIS) evaluations about impacts on the ecosystem services (ES: artisanal fishing, culture support, education and research) investigated.

| Impacts on the ES                      | Type of equivalence between stakeholders' assessment and SSP EIS |   |
|--|--|---|
|  | <i>Set up of slabs and pillars</i>                               | <i>Increase in circulation of ships</i> |
| Interference in artisanal fishing      | E1   | E2                                      |
| Interference in culture support        | E3   | E3                                      |
| Interference in education and research | E0   | E0                                      |

The strategy of setting the ecosystem services and disturbances as landmarks and establishing a parallel between them stimulated the stakeholders in conducting a wide assessment of impacts, attributing additional aspects of the SSP expansion to the scenarios explored. From the entire amount of impacts (n = 52) listed by the EIS (not exclusively related to D1 and D2; APPENDIX 6), 33 were quoted by the stakeholders (Table 10). An overlay (indicated as gray lines in Table 10) in the assessment of stakeholders was observed between the two disturbances analyzed (D1: n = 29; D2: n = 15).

Most impacts that the stakeholders linked to the set up of slabs and pillars (n = 14) and the increase in circulation of ships (n = 6) were not tied to these disturbances by the EIS (E3). From the stakeholders point of view, such impacts were especially linked to processes and cause and effect relationships stimulated by the ecosystem services analyzed and the arguments used during impact interpretation. *Land use changes*, for example, was an impact from the set up of slabs and pillars mentioned only by the stakeholders and attached to loss of territory, lack of urban infrastructure, inevitability of the urban development and cause of the highway duplication – urban indirect dimensions that were not captured by the EIS.

The same was applied to *increased demand for housing, social conflicts* and *deprecation of the Historic Center* from D1 and *interference with traditional culture* from D2, which were not considered by the EIS as associated impacts from the disturbance scenarios. The stakeholders attributed changes from indirect sources of urban expansion to them, potentially capable of changing the quality of life of local residents and features of the Araçá Bay and surroundings.

In fact, the numerous cases of E3 evidence that the interviewees covered a broader range of links in the assessment of the disturbances than the EIS. This wide understanding was strengthened by the classification of several impacts as E2,

recognized by the stakeholders, but poorly (or not logically) classified by the EIS. Both types together counted nearly 60% of the stakeholders' assessment for D1 and more than 70% for D2. *Change in air quality*, for example, was an impact the EIS assigned only to the increase in circulation of ships, although the users also recognized it in the disturbance scenario 1, in both cases attached it to pollution. This integration of impacts was underutilized by the EIS, but frequently assessed by the stakeholders, as noted for *degradation of SSP surroundings* and *attraction of population* for D1 and *interference with artisanal fisheries* and *change in operating conditions of the local road system* for D2, all also commonly associated to urban changes in the Araçá Bay.

Impact equivalence type 1 (E1) implied in compatibility with the EIS assessment, revealing that it corresponded to the stakeholders' perceptions about the impacts associated to the disturbances, but they were not frequent. The arguments that the interviewees linked to them were mainly about damage in ecological functions and pollution, indicating that the EIS focused on listing mainly direct impacts. *Change in the pattern of water circulation in the Araçá Bay* for D1 and *disturbance and scarcity of aquatic wildlife* for D2 are examples of these cases. However, the stakeholders also attributed indirect arguments (e.g. lack of urban structure, inevitability of urban development) to some of these impacts, such as *landscape change* and *change in operating conditions of the local road system* for D1. The absence of additional information in the EIS does not allow us to evaluate if these conclusions were guided to the same processes that were considered by the stakeholders to classify these impacts.

Table 10. Matrix of comparison of interviews results and impact list from São Sebastião Port (SSP) environmental impact study (EIS) and additional classification of type of impact equivalence (E0 = No equivalence; E1 = impact and disturbance equivalence; E2 = partial impact equivalence; E3 = equivalent to EIS impact list, but no equivalent to D1 e D2) and corresponding lines of argumentation (✓ = presence – pollution; loss of territory; damage in ecological function; lack of urban infrastructure; influence of political arrangements; inevitability of urban development; cause of the highway duplication) used by stakeholders to evaluate the listed impacts from changes in provision of the ecosystem services (artisanal fishing, culture support, education and research) under the two disturbance scenarios (D1: set up of slabs and pillars; D2: increase in circulation of ships) in the Araçá Bay.

| Impacts from EIS impact list cited in groups interviews     |   | Type of equivalence   | Referring argument line |                       |                                |                              |                                     |  |
|---|---|---|-------------------------|-----------------------|--------------------------------|------------------------------|-------------------------------------|--|
|   |   |   | Pollution               | Loss of territory     | Damage in ecological functions | Lack of urban infrastructure | Influence of political arrangements | Inevitability of the urban development |
| Disturbances  | Set up of slabs and pillars                         | Generating expectations in the community                    | 3                       |                       |                                |                              |                                     | ✓                                      |
|   |   | Change in air quality                                       | 2                       | ✓                     |                                |                              |                                     |  |
|   |   | Increased noise levels                                      | 3                       | ✓                     |                                |                              |                                     |  |
|   |   | Change in the quality of surface water resources            | 3                       | ✓                     |                                |                              |                                     |  |
|   |   | Alteration of the quality of coastal waters                 | 1                       | ✓                     |                                | ✓                            |                                     |  |
|   |   | Change in the pattern of water circulation in the Araçá Bay | 1                       |                       |                                | ✓                            |                                     |  |
|   |   | Changes in sedimentary dynamics in the Araçá Bay interior   | 1                       |                       |                                | ✓                            |                                     |  |
|   |   | Effluent generation   | 1                       | ✓                     |                                | ✓                            |                                     |  |
|   |   | Generation of solid waste                                   | 3                       | ✓                     |                                | ✓                            |                                     |  |
|   |   | Loss of habitats for terrestrial fauna                      | 3                       |                       | ✓                              | ✓                            |                                     | ✓                                      |
|   |   | Disturbance and scarcity of terrestrial wildlife            | 1                       |                       |                                | ✓                            |                                     |  |
|   |   | Degradation of the plant community                          | 1                       |                       | ✓                              | ✓                            |                                     | ✓                                      |
|   |   | Creation of substrate for colonization of benthic organisms | 1                       |                       |                                | ✓                            |                                     |  |
|   |   | Reduction of photosynthetic rates                           | 1                       |                       |                                | ✓                            |                                     |  |
|   |   | Contamination of aquatic environments and organisms         | 3                       | ✓                     |                                | ✓                            |                                     |  |
|   |   | Disturbance and scarcity of aquatic wildlife                | 1                       |                       |                                | ✓                            |                                     |  |
|   |   | Generation of employment and income                         | 3                       |                       | ✓                              |                              | ✓                                   | ✓                                      |
|   |   | <b>Interference with artisanal fisheries</b>                | 1                       |                       | ✓                              |                              | ✓                                   | ✓                                      |
|   |   | Increased demand for housing                                | 3                       |                       | ✓                              |                              | ✓                                   | ✓                                      |
|   |   | Change in the operating conditions of the local road system | 1                       |                       |                                |                              | ✓                                   | ✓                                      |
|   |   | Landscape change  | 1                       |                       | ✓                              | ✓                            | ✓                                   | ✓                                      |
|   |   | Attraction of population                                    | 2                       |                       | ✓                              |                              | ✓                                   | ✓                                      |
|   |   | Social conflicts  | 3                       |                       | ✓                              |                              | ✓                                   | ✓                                      |
|   |   | <b>Interference with traditional culture</b>                | 3                       |                       | ✓                              |                              | ✓                                   | ✓                                      |
|   | Increased demand for public services                | 3   |                         |                       |                                | ✓                            | ✓                                   |  |
|   | Land use changes                                    | 3   |                         | ✓                     |                                | ✓                            | ✓                                   |  |
|   | Degradation of SSP surroundings                     | 2   |                         | ✓                     |                                | ✓                            | ✓                                   |  |
|   | Deprecation of the Historic Center                  | 3   |                         | ✓                     |                                | ✓                            | ✓                                   |  |
|   | Interference with recreation and tourism activities | 3   |                         | ✓                     |                                |                              | ✓                                   |  |
|   | Increase in circulation of ships                    | Change in air quality                                       | 1                       | ✓                     |                                |                              |                                     |  |
|   |   | Increased noise levels                                      | 1                       | ✓                     |                                |                              |                                     | ✓                                      |
|   |   | Change in the quality of surface water resources            | 3                       | ✓                     |                                |                              |                                     |  |
|   |   | Alteration of the quality of coastal waters                 | 1                       | ✓                     |                                | ✓                            |                                     |  |
| Generation of solid waste                                   |   | 3   | ✓                       |                       |                                |                              |                                     |  |
| Contamination of aquatic environments and organisms         |   | 3   | ✓                       |                       | ✓                              |                              |                                     |  |
| Disturbance and scarcity of aquatic wildlife                |   | 1   |                         | ✓                     | ✓                              |                              |                                     |  |
| Risk of invasion of environments by exotic organisms        |   | 3   |                         |                       | ✓                              |                              |                                     |  |
| <b>Interference with artisanal fisheries</b>                |   | 2   |                         | ✓                     |                                | ✓                            | ✓                                   |  |
| Change in the operating conditions of the local road system |   | 2   |                         |                       |                                | ✓                            | ✓                                   |  |
| Landscape change  |   | 2   |                         | ✓                     |                                | ✓                            | ✓                                   |  |
| Generation of odors   |   | 2   | ✓                       |                       |                                |                              |                                     |  |
| <b>Interference with traditional culture</b>                |   | 3   |                         | ✓                     |                                | ✓                            | ✓                                   |  |
| Interference with recreation and tourism activities         |   | 3   |                         | ✓                     |                                |                              | ✓                                   |  |
| Risk of collision with vessels                              |   | 1   |                         | No argument assigned. |                                |                              |                                     |  |

## 5 DISCUSSION

### 5.1 Evidences on differences among stakeholders in environmental impact assessment (*hypothesis 1*)

#### 5.1.1 Group characterization

Urban and industrial growth has commonly isolated local residents from the coastline in detriment of development projects that enhance leisure or transportation services for external users (CLARK, 1996; DIEGUES, 1999) and fail in providing appropriate locational alternatives for coastal dwellers (MCGRANAHAN et al., 2007). Although urban, social and environmental changes have greatly altered the shape of the Araçá Bay in the last decades (MANI-PERES et al., 2016) and influenced its environmental composition and quality (SANTOS & TURRA, 2017), as far as possible, the bay remained as a transitional territory suitable for the permanence of a local community (MANI-PERES et al., 2016) and for the accomplishment of several use activities (AMARAL et al., 2015). The experience of being merged with (and overlapped by) São Sebastião downtown and urban development projects (e.g., SSP) was fundamental to the stakeholders to recognize land use conflicts and processes associated to them.

As assured by numerous studies (JACKSON et al., 2001; LOTZE & WORM, 2008; BENDOR, 2009; QUÉTIER & LAVOREL, 2011), temporal dynamics are key elements to estimate the state of socioecological properties and improve assessment methods, especially if they comprise Local and Traditional Ecological Knowledge (LEK and TEK) (USHER, 2000; JACKSON et al., 2001; LOTZE & WORM, 2008; LAVIDES et al., 2010; MANI-PERES, 2013; ANDRADE, 2015). Our design of different groups itself naturally privileged individuals with long-term relationships with the Araçá Bay, which helped refine and balance the evaluation of local features. Our study reinforce the premise that selecting proper stakeholders who are aware of local processes – even if they have experienced them for different periods of time – is critical to ensure the representativeness of several dimensions of a socioecological system (SES) (USHER, 2000; JENTOFT, 2007; DURHAN et al., 2014; ÜRGE-VORSATZ et al., 2017), as will be discussed latter.

Temporal ties with a territory can further assert spatial appropriation (RAFFESTIN, 2015). Historically, *caiçara* members have strong bonds with their territory of use, gathering concomitantly cultural and work activities (DIEGUES, 1983; ADAMS, 2000a; DIEGUES, 2012). This kind of specific *value* supported the separation of groups based on the activities they perform in the Araçá Bay. Fishing, vessel housing, trade and boat repair were uses performed by Local Direct Users and Guardians, frequently attached to sense of place and identity behaviors. Such practices reinforced cultural self-recognition and LEK (USHER, 2000), useful to detect environmental trends (BERKES et al., 2007) as previously acknowledged by Mani-Peres (2013; 2016) in the Araçá Bay.

The area that the expanded SPP intended to occupy could conflict with the cultural uses cited above. This motivated some residents to spoke out in favor of their interests, officially originating the group of Guardians, who recognized that social participation and preservation are also uses they perform at the bay. It was precisely this engagement and statement that differed Guardians from Local Direct Users. By participating on decision-making arenas, Guardians were capable to rework their LEK with experiences from managers and Researchers, becoming aware of risks and how to access and use them, which may have stimulated their understanding of local processes, as seen in similar cases reported in the literature (FANKHAUSER & TOL, 1997; DOLAN & WALKER, 2006). Social participation and networking can unlock access to a broader view of the conflict (REED, 2008; PETERSON, 2011), improving transparency and accountability (KAPLAN & MCCAY, 2004), enhancing social learning (XAVIER, 2017), and promoting social empowerment by adding information and stimulus from multi-stakeholders' interactions (BUCKLAND & RAHMAN, 1999; SHEPHERD, 2008; HAGE et al., 2010; KITTINGER et al., 2014; COLVIN et al., 2016).

This exchange of information also benefited Researchers. Although divided between longstanding connections and sub-contacts with local dynamics and events, they were often included within management processes in the northern coast of São Paulo state (including the licensing of the SSP), which balanced their involvement with other stakeholders. However, even though the Araçá Bay has been used to produce prolific and abundant scientific research (AMARAL et al., 2010; AMARAL et al., 2015), Researchers' limitations in communicating and permuting the results of their

studies (GRILLI, 2017) harmed the establishment of trust and interactivity agreements between them and the local groups, rising their dissimilarity in assessing impacts.

The natural features of the Araçá Bay (e.g. coastal protection, biodiversity) that benefited the activities performed by LDU, G and R, did not control uses practiced by Local Indirect Users, as expected. LIU were not unrelated to local conflicts, because they are part of the local community and also benefited from the welfare promoted by the ecosystem services (e.g., recreation, landscape appreciation) threatened by the SSP expansion. However, they did not establish a cultural or work relationship with the bay and did not feel impelled to participate in decision-making processes, mostly because they did not recognize themselves as an appropriate group to deal with this issue.

Groups inner specificities validated differences among them and set an initial picture about land use patterns and processes that guided the functioning of the Araçá Bay. Local Direct Users and Guardians formed a subgroup united by cultural and subsistence activities, but differed from each other because Guardians participated on decision arenas on which Researchers were often present. Researchers have studied ecological processes to which all groups interact, however, they did not established ties with the place and with local residents. Local Indirect Users were not unattached from the Araçá Bay, but they were the more distant group, because they have no cultural and work ties with the place. Temporal and spatial scales of interaction were important for this comprehension, as accurately attested by Adger (2006) and Wilbanks (2006). Based on these groups profiles it was possible to identify if they could produce different assessments about changes in the provision of key ecosystem services in the Araçá Bay. Yet, we expected that LIU would present a distinct interpretation of the actual and impact scenarios in relation to the other groups, as will be discussed below.

### 5.1.2 Current and disturbance scenarios

People, ecosystem services, activities performed and impacts in the Araçá Bay are all connected according to its stakeholders. Different and responsive ways of interpreting them within the scenarios were fundamental to apprehend the heterogeneity of social and ecological values from local processes and to validate hypothesis 1.

Changes in the natural flow of resource provision (POST & LUNDIN, 1996; SHERMAN, 2014) due to human interventions in almost all biological systems of the planet (BIERMANN et al., 2009) promoted the use of scenarios to estimate

environmental transformations (WAYLEN et al., 2015). Since personal interests are not disassociated from the perception of risks and their consequences, intended or unintended (USHER, 2000; BIERMANN et al., 2009), such technic has been used to assess coherent future evaluations (HOOPER et al., 2016) about consequences of changes in SES (BERKOUT & HERTIN, 2002; MIETZNER & REGER, 2004), frequently associated with “development” (DIEGUES, 1997). In this context, models that assess multi-scale processes have been valued to project people in the territory (MA, 2003; DOLAN & WALKER, 2006; REID et al., 2006), design spatial planning policies (CONWAY & LATHROP, 2005) and address natural resources management solutions (QUÉTIER & LAVOREL, 2011; LATERRA et al., 2012; WAYLEN et al., 2015; PLDS/ARAÇÁ, 2016).

Assessing the changes in the Araçá Bay, the stakeholders had no other reference for comparison beside the chosen ecosystem services and disturbances scenarios. This encouraged the emergence of subjective and indirect motivations and the differences among groups became more evident. The groups were more comfortable in discussing ecosystem services related to uses they perform or interact, so it was natural that temporal and spatial scales – controlled by individual perceptions – were evoked. Since artisanal fishing, culture support and education and research are important benefits and central uses of the Araçá Bay (CARRILHO, 2016; PLDS/ARAÇÁ, 2016), different experiences with them could inevitably influence groups’ answers. However, the Araçá Bay capability to contain these ES because of its local specificities (e.g., spatial dimension, traditional practices, habitat diversity, biosiversity) was in general commonly recognized by all stakeholders. So, they had the sensitivity to size the ES in the appropriate scale to capture local changes.

Particularly in the current scenario, the ecosystem services were fundamental to evidence differences among the groups. All groups often recognized artisanal fishing and culture support as tied-ES, due to their connection with *caiçara* culture (MANIPERES et al., 2016). But behavioral and social factors that attended to the daily uses performed by LDU and G influenced their perceptions and greatest ranks in the assessments of these two ES. The same reasoning was applied to R and the ecosystem service of education and research. Academically considered an open-air laboratory, the Araçá Bay is currently one of the places that most concentrates scientists and studies in Brazil (AMARAL et al, 2010). And, although LDU, G and R did not present significant differences from each other on the assessment of education and research, local residents

frequently perceived it as something distant, mysterious and detached of the bay territory. The contrasting assessment of LIU was an evidence of it.

We noticed that the interaction to the place was important for the groups to recognize the presence of the ecosystem services. However, in order to recognize the importance and scope of the artisanal fishing, culture support and education and research in Araçá Bay, it was determinant that the groups had cultural or work links with ecosystem services or with stakeholders related to them, as discussed by Kochnowe et al. (2015) and Mouchet et al. (2017). Therefore, by not being particularly attached to any of the ES and activities most often linked to them, Local Indirect Users presented the lowest rating of the ES and differed from the other groups, both in the current and disturbance scenarios.

The groups perceived that the set up of slabs and pillars was a threat to the provision of the ES. By placing the ecosystem services into the future scenario, the groups checked the maintenance of their use activities and ties with the Araçá Bay, which required that they situated themselves in the possibility of threat. Welfare references and the desire to maintain or return to a “more natural” state (KOCHNOWE et al., 2015) appeared in the decreased provisions of artisanal fishing and culture support for all groups. It was especially strengthened by a strong sense of place and LEK of LDU and G.

Thus, Local Ecological Knowledge was relevant to the scenario assessment, because it can provide a broader and deeper understanding of changes in the baseline conditions (DIEGUES, 1997; USHER, 2000; BERKES et al., 2007). Intuitively, local users, covered by a comprehensive interpretation of local environmental processes, see changes more often, for longer and with different point of views (USHER, 2000), all natural indicators similar to what is valued in science, but reflecting experiences of current and previous generations (BERKES et al., 2007), which was perceived in the LDU and G assessments. Researchers also recognized significant differences in the provision of the artisanal fishing and culture support in the context of change, indicating a possible convergence of LEK and scientific data on which they based their assessments, both responsive to processes and patterns of the Araçá Bay. Even not socially or culturally affected by changes in the provision of both ES, Researchers were capable to infer the ability of the local community in coping with the threat, as observed by Dolan & Walker (2006).

However, in the assignment of impacts attributes of artisanal fishing and culture support and in the argumentation patterns were possible to notice the group's different ways of interpreting the ES availability. Most Researchers used arguments about direct consequences and frequently inferred about impacts of indirect scope. Otherwise, LIU, LDU and G (in different levels) attributed impacts of indirect scope to this disturbance scenario, but they brought several indirect arguments to justify their choice. It evidenced that the groups accessed different processes of interpretation of the disturbance scenario.

As well as local beneficiaries felt more direct impacts and changes in provision of artisanal fishing and culture support, Researchers experienced it for the rating of education and research (their work and main use activity) and this was not common among all groups. Again, by not fully comprehending the interdependency of the education and research activities and the natural features of the Araçá Bay, local residents identified a potential change in the occurrence of this ES, but they did not know how to dimension the consequences in the same way the researchers did, which was evidenced by the variation in assigned impacts attributes. Moreover, this ES did not seem to be closely linked to social and urban problems, which contributed to its different interpretation from the others ecosystem services that experience this influence.

The lack of understanding or information about how the ecosystem services are distributed and influenced in the territory of the Araçá Bay was especially what prevented LIU from assessing significant changes in the ES provisions. LIU only experimented impacts in the physical space of the Araçá Bay that can damage the leisure activities they benefit, but these perceptions are not enough to cover more complex socioecological processes. The Araçá Bay is not widely recognized or used by its leisure attributes. In our interpretation, recreational uses *per se* did not embrace a broader comprehension of impacts from the SSP structure. These results counterpose conclusions from Plieninger et al. (2013), whose work indicated that recreational uses were particularly powerful to improve the assessment and management of ecosystem services and species in German.

In the assessment of the disturbance scenario 2, the groups continued to have different interpretations from each other, but their appraisals depended on the ES considered. Indeed, for Guardians and Researchers, the second disturb intensified their assessments because evoked a cumulative interpretation of changes and impacts. It is

natural that environmental transformations that are oblique through the ecosystem services, uses and people, and fluid in space and time scales, produce synergistic and cumulative impacts (REID et al., 2006). However, to capture them in a context of urbanization and land use change require a specific spatial appropriation that considers the apprehension of regulations and processes at the local level (CONWAY & LATHROP, 2005). Our analysis can not explicitly establish direct causal relationships between the disturbances, but G and R assessments and resembling patterns of impacts attributes suggest that the ES analyzed could be impacted from common vectors of change, as also considered by Mouchet et al. (2017).

Surprisingly, LDU did not follow the same pattern as Guardians and Researchers. Since the ships that arrive in SSP do not have enough draft to enter the Araçá Bay, they maintain a safety distance, which for several members of LDU group means that the ships do not have the chance to occupy the territory of use of the Araçá Bay, something that the structure of slabs and pillars has. Lack of resources to reach deeper fishing grounds and informal rules of use of the São Sebastião Channel already limit the interaction between LDU and the ships. Even attributing mainly impacts of direct scope, in their perceptions, the distance from the Araçá Bay to the channel may be sufficient for the non-existence of a spatial influence in the ES, which was shared by LIU.

In general, LIU observed no influence of the disturbance scenario 2 in all ES, attributing even an increase and a positive impact to the education and research. This perception may be based on an expectation of incentive for this type of activity on compensatory strategies, but served to confirm that the scope of interaction of LIU is distant from education and research (and possibly from artisanal fishing and culture support too), which certainly contributed to difference them from the other groups.

Here we corroborated Usher (2000) that inferred that environmental assessments are challenging to all types of stakeholders, even if Local, Traditional and Scientific Ecological Knowledge support them. Local users have a mental image of what is normal and expected on a continuous time scale (BERKES et al., 2007) including the functioning of urban developments that are already part of the SES (RUIZ-LUNA & BERLANGA-ROBLES, 2003). In regions where industrialization and urbanization cause profound social change, as previously perceived for the Araçá Bay, knowledge can be inhibited to be widely diversified and shared among local residents (USHER, 2000). Especially in these cases, the collaboration between stakeholders is

crucial to aggregate a wider range of information and experience to understand and predict ecosystem changes (BERKES et al., 2007; BALFORS et al., 2016), evidence trade-offs (MOUCHET et al., 2017) and offer solutions (RUIZ-LUNA & BERLANGA-ROBLES, 2003; BIERMANN et al., 2009).

In the Araçá Bay, the natural configuration of people enabled for co-management is a particularity that was not appreciated in public hearings or other policy arenas during the SSP expansion EIA process (CARMO, 2016; FEITAL, 2016). This prevented the information and LEK available from being considered (USHER, 2000), which neglect the relevance of cultural values, such as identity and sense of place (PLIENINGER et al., 2013). However, these were the conditions that aroused Researchers interests in studying the place and propelled local residents in forming Guardians group.

Among all groups, guardians were equipped with the perceptions of a local user, cultural motivations, notions of political arrangements, contact with urban issues and managers and access to scientific data, only possible because of their representativeness and actions. In the presence of a group of people publicly involved in discussing the conflict – such as guardians –, consulting them may bring a comprehensive and representative understanding of the local uses and users.

We concluded that there were differences in the groups' assessments of the ecosystem services in the current and in the disturbances scenarios (D1 and D2). Among the scenarios, the groups were more sensible in assessing changes from the set up of slabs and pillars, because such disturbance conflicts with the stakeholders' use and appropriation of space in the Araçá Bay. Among ecosystem services, the scores, impact attributes and arguments ascertained differences in the assessment of education and research from the assessment of artisanal fishing and culture support (understood as tied-ES). Among groups, differences in the type of relationship with the Araçá Bay, explored in the characterization of groups, led to different interpretations about the ecosystem services and disturbance scenarios, which strengthened the differences between LIU and the other groups and corroborated hypothesis 1.

## **5.2 Evidences of ecosystem-based management in the improvement of marine environmental impact assessment (*hypothesis 2*)**

The stakeholders assessed broader, synergetic and indirect impacts of disturbance scenarios in the Araçá Bay than the EIS of the SSP expansion. The stakeholders' interpretation about local socioecological processes, sources of impacts and cause and effect relationships were especially attested by the arguments aroused by the stakeholders (i.e., the “whys”). These evidences reinforced the importance of consulting different stakeholders to support a robust impact assessment, corroborating hypothesis 2.

The growing interests in assess and enhance quality and health of ocean and coastal ecosystems (HALPERN et al., 2017; RAYMOND et al., 2017) is parallel to the need for management strategies that embrace humans and ecological properties as an integrated system (LOTZE et al., 2006; CHAPIN et al., 2009). Recognizing the prolific natural capital, ecosystem services and human dimensions of the environments (MOLDAN et al., 2012; RAYMOND et al., 2017), it is easy to understand why the assessment of potential impacts should not be restricted to single challenges or components (RAYMOND et al., 2017).

The scenery of judicialization and conflict that involved the interrupted expansion of the São Sebastião Port had previously indicated that there were inconsistencies between the assessment of impacts presented by the EIS and by the local stakeholders (CARMO, 2016; FEITAL, 2016; SANTOS & TURRA, 2017; TURRA et al., 2017). Our specific choice of the analytical components (i.e., stakeholders, ecosystem services and scenarios) was intentional and we presumed that they would intersect in any kind of comparison on the effect of the development in the bay. Nevertheless, the EIS did not properly predict changes from the set up of slabs and pillars and the increase in circulation of ships in the provision of artisanal fishing, culture support and education and research.

We did not anticipate the stakeholders' assessment of additional impacts, but they were fundamental to ground our findings, especially supported by the argumentation patterns. The ES naturally stimulated perceptions about processes of environmental quality and welfare that comprise the territory transversely. That is why arguments about urban and social problems appeared. Nonetheless, even recognizing its insertion into the economy and landscape of São Sebastião municipality (SÃO PAULO, 2011), the SSP did not address land use and urbanization conflicts.

In both disturbances scenarios, the impacts were underexploited in the EIS and did not express the stakeholders' main concerns about the changes in the Araçá Bay –

especially indirect ones –, a typical issue of such analyses (ÜRGE-VORSATZ et al., 2017) and opposite to a robust assessment (HOOPER et al., 2016). The overlap of impacts assessed by stakeholders in both disturbances scenarios also evidenced the coupling and synergy of the changes. It is worth emphasizing that the impacts that were identified for both scenarios were mainly related to changes in the urban infrastructure. We suppose that the basic premise of considering people as part of ecological systems was not respected in the EIS analysis. As coastal zone resilience is strongly linked to ecosystem functioning, macroeconomic, ocean health, social equity and welfare (ADGER et al., 2005; MA, 2005; HALPERN et al., 2017; ÜRGE-VORSATZ et al., 2017), such attributes of the Araçá Bay should not have been disregarded in the EIA process.

The purpose behind the test of hypothesis 2 was to evidence that disturbances, resources, ecosystem services and people of a socioecological system are interconnected by intricate cause and effect relationships and processes, inherent of complex governance systems (BIERMANN et al., 2009). At the local level, community-based interpretations about environmental changes and needs help to frame scientific and management interventions, grounding decision making and adaptive capacity building (DOLAN & WALKER, 2006; MCGRANAHAN et al., 2007). At the same time, local knowledge systems and social engagement (USHER, 2000; BERKES et al., 2007) foster the interaction and learning of different stakeholders (XAVIER, 2017) and contribute with a fair and equitable environmental impact assessment (HOOPER et al., 2016).

Even so, it is important to highlight that perceptions can not replace all data collection and analysis required to attest the feasibility of a project in an environmental impact assessment. However, the act of consulting stakeholders itself is a more licit and embracing process than the evaluation of socioecological changes based on socioeconomic diagnoses from secondary sources, as stated in hypothesis 1. Although there are always diffuse interests involved (RAYMOND et al., 2017), the inclusion and involvement of people that drive changes and manage them are crucial to overcome the tendency of producing abstract and inaccurate assessments that compromise the EIA effectiveness (BIERMANN et al., 2009; PLIENINGER et al., 2013; GENELETTI, 2016a; HOOPER et al., 2016).

Ideally, for any assessment or decision, distinguishing impacts and benefits from multiple sources justify analytical, political and mitigation purposes that include

human externalities (ÜRGE-VORSATZ et al., 2017). In our study case we were not able to assess all the disturbances from the SSP expansion, nor all the ES provided by the Araçá Bay. However, EIA processes should consider all these components to certify the feasibility of development projects. Integrated approaches, as showed here for EBM, are the nearest solutions to safeguard that conservation and development goals can co-exist, include multiple users, ecological processes and social values (MA, 2005; IFC, 2012a; WORLD BANK, 2013; EPA, 2013; UNEP, 2014; BENNET et al., 2015; BALFORS et al., 2016; GENELETTI, 2016b; MANDLE & TALLIS, 2016). Respecting socioecological processes, licensing instruments may become more coherent, robust and perhaps even resource saving, because the subjectivity that involves the consult of stakeholders can guide an objective and responsive quantitative data collection for all EIA's phases and decision-making. We especially recommend that these suggestions be incorporated in the *scoping* phase of EIA, to avoid integration problems from the project design (SCABIN, et al., 2015).

After testing and corroborating the hypotheses of this research, we advocate that the role of ecosystem-based management is to link impacts and stakeholders, functioning as a multi-scale strategy that provides information from several sources and enable a suitable decision making in environmental impact assessments. Particularly in coastal zones, the different stakeholders must be considered and encouraged to strengthen their local communities by participating socially and valuing cultural values, forms of knowledge and use of the territory, to be able to request that any process or development that can change satisfactory conditions of environmental quality and human well-being be understood and discussed with a rationale, practical and fair purpose. In this context, EBM, materialized as ecosystem processes and services, have proved to be an useful tool to assess independent, cumulative and synergistic impacts from direct or indirect sources. The promising applicability of this technique has a vast potential to qualify environmental impact assessment in Araçá Bay and elsewhere.

## 6 CONCLUSIONS

Our findings advance the understanding of the role of Ecosystem-Based Management (EBM) in processes of marine Environmental Impact Assessment (EIA), by appraising the perceptions of different stakeholders that have experienced the judicialized and contested licensing process of the São Sebastião Port (SSP) expansion – currently suspended.

Stakeholders who had a closer, deeper and more engaged relationship with the Araçá Bay had more comprehensive perceptions about changes in the availability of artisanal fishing, culture support and education and research due to the set up of slabs and pillars and the increase of circulation of ships from the intended SSP expansion. This was a result of greater sense of place, access to Local, Traditional and Scientific Ecological Knowledge and opportunities to social participation.

The perceptions of the stakeholders reflected trade-offs of the local conflict and detained different forms of knowledge, behaviors and functions valuable for resource and land management. Such perceptions provided a wider and more integrated assessment of impacts in the provision of the ecosystem services than the Environmental Impact Study of SSP expansion.

We concluded that more participative, harmonic, integrated, resource saving and less judicialized assessments can be provided by EBM approaches and are well-suited for all phases of EIA, especially the scoping. Respecting the intrinsic variability of coastal zones and its role as a socioecological system meets with the use of EBM as a strong framework to improve the effectiveness of EIA.

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## 8 APPENDICES

### 8.1 APPENDIX 1 – Authorization from Ethics Committee (Plataforma Brasil)

**Research title:** Ecosystem-Based Management as a tool for Environmental Impact Assessment: a case study on the project of expansion of São Sebastião Port, SP\*

**Leading researcher:** Mariana Martins De Andrade

**Version:** 1

**CAAE:** 72213317.0.0000.5464

**Submitted in:** 05/31/2017

**Proponent Institution:** University of São Paulo

**Status of the Project Version:** Approved

**Current Location of the Project Version:** Leading researcher

\* Title posteriorly adjusted to “Empirical evidence of the role of Ecosystem-Based Management in qualifying Marine Environmental Impact Assessment”.

|  |  |  |
|--|--|--|
|   | USP - INSTITUTO DE<br>BIOCIÊNCIAS DA<br>UNIVERSIDADE DE SÃO  |  |
| <b>COMPROVANTE DE ENVIO DO PROJETO</b>   |  |  |
| <b>DADOS DO PROJETO DE PESQUISA</b>  |  |  |
| <b>Título da Pesquisa:</b>   | MANEJO BASEADO EM ECOSISTEMAS COMO FERRAMENTA PARA AVALIAÇÃO DE IMPACTO AMBIENTAL: UM ESTUDO DE CASO SOBRE O PROJETO DE EXPANSÃO DO PORTO DE SÃO SEBASTIÃO, SP |  |
| <b>Pesquisador:</b>  | MARIANA MARTINS DE ANDRADE   |  |
| <b>Versão:</b>   | 1  |  |
| <b>CAAE:</b>   | 72213317.0.0000.5464   |  |
| <b>Instituição Proponente:</b>   | Universidade São Paulo   |  |
| <b>DADOS DO COMPROVANTE</b>  |  |  |
| <b>Número do Comprovante:</b>  | 084602/2017  |  |
| <b>Patrocinador Principal:</b>   | FUND COORD DE APERFEICOAMENTO DE PESSOAL DE NIVEL  |  |
| <p>Informamos que o projeto MANEJO BASEADO EM ECOSISTEMAS COMO FERRAMENTA PARA AVALIAÇÃO DE IMPACTO AMBIENTAL: UM ESTUDO DE CASO SOBRE O PROJETO DE EXPANSÃO DO PORTO DE SÃO SEBASTIÃO, SP que tem como pesquisador responsável MARIANA MARTINS DE ANDRADE, foi recebido para análise ética no CEP USP - Instituto de Biociências da Universidade de São Paulo - IBUSP em 31/07/2017 às 10:44.</p> |  |  |
| <p><b>Endereço:</b> Rua do Matão, Travessa 14, nº 321<br/> <b>Bairro:</b> Butantã <b>CEP:</b> 05.508-090<br/> <b>UF:</b> SP <b>Município:</b> SAO PAULO<br/> <b>Telefone:</b> (11)3091-8761 <b>E-mail:</b> cepibusp@ib.usp.br</p>  |  |  |

## 8.2 APPENDIX 2 – Term of consent used in the interviews

### TERM OF CONSENT

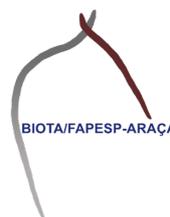
This research has an exclusively scientific purpose and it was spontaneously accepted by the interviewee, who can give up at any moment, even without any reason, simply by informing in the most convenient way his/her choice. As a volunteer and without financial interest, you will not be entitled to any remuneration. The data related to you will be confidential and private, and the result disclosure will only aim possible benefits obtained by the research, and you will be able to request information during all its phases, including its following publication.

Name: Mr. / Mrs. \_\_\_\_\_

I declare that I was informed about the research **“Empirical evidence of the role of Ecosystem-Based Management in qualifying Marine Environmental Impact Assessment”** (included in the Biota-Araçá/FAPESP Project: “Biodiversity and functioning of a subtropical coastal ecosystem: subsidies for integrated management”, Module 10: Integrated Management); conducted by the Laboratory of Marine Management, Ecology and Conservation of the Department of Biological Oceanography, Oceanographic Institute, University of São Paulo.

São Paulo, \_\_\_\_\_ of 2017

\_\_\_\_\_  
(Signature of agreement)







## 8.5 APPENDIX 5 – Samples of stakeholders speeches according to the lines of argumentation (“whys”)

| Argument                       | Group (number of stakeholders who cited it) | Speeches samples   |
|--------------------------------|---|--|
| Loss of territory              | LIU (n=4)                                   | <i>"Putting the slab you will extinguish this population that performs the artisanal fishing, because they will not have where to fish, and once you do not have that part of the mangrove, you will only have the channel and the costs to fish."</i>   |
|                                | LDU (n=10)                                  | <i>"It's important for us, right, especially for us, caiçaras, we do not have more space, we have our boats to pull [to enclose], the only space we have is this one. That is, if Araçá is gone it will be difficult for us."</i>  |
|                                | G (n=8)                                     | <i>"It's a conflict... very big, especially for fishing. They may have to... they will end up leaving their channel region and to go out to sea. They will be expelled from their places, right?"</i>  |
|                                | R (n=9)                                     | <i>"It will remain a smaller corridor for the fisherman to explore his product, it is obvious to me that it will impact the resource too, right? Because ... it ... its distribution decreases and he [the fisherman] continues to extract at the same intensity, there comes an hour that goes... there is a possibility of exhausting..."</i>  |
| Pollution                      | LIU (n=8)                                   | <i>"The fishermen they do not talk so much, right, but depending on the area that is taken, I think it will harm them, right, and beyond that I think the more it enlarges [the SSP], the more pollution inside, right?"</i>   |
|                                | LDU (n=8)                                   | <i>"Everywhere sewage accumulates in here, because the bay, right, it is a backwater, right, here it comes and accumulates."</i>   |
|                                | G (n=9)                                     | <i>"Because if you expand [the SSP] it here... you have an increasing depth and if the depth is increasing you enter to the channel stream, which is a deep channel, that would greatly improve the situation of any waste, or problem, or any impact that the port could generate. Which I do not think it's good, but at least would minimize [the pollution with] the speed of the waters. Anything you do here, once this area is very shallow, it will produce a direct impact on the mangrove, right?"</i> |
|                                | R (n=7)                                     | <i>"It [the pollution] may imply mainly in the ... ship washing, exchange of fuel, some [chemical] leakage even if small... once Araçá is small too, if a ship leans there in the Port today and spill, I do not know, about 500L, right, like... for a huge ship it does not mean anything 500L of fuel, the tide increasing can carry all this to Araçá... it can be a very big loss."</i>   |
| Damage to ecological functions | LIU (n=3)                                   | <i>"And there's another important thing about the mangrove, it's not just fishing, it's the nursery too, and you're putting the slab you're still damaging this nursery, a lot of fish come to reproduce in the mangrove, fishes, birds, and doing it here you are condemning those fishes that will leave, right, they will seek for another areas for their spawn, thus leaving population caiçara helpless. Only those who have a fishing boat and fishing nets will be able to continue in this branch."</i> |
|                                | LDU (n=6)                                   | <i>"It is nonsense, where is the light for the ... the illumination for the animals? Of course, it will come some robalos [fish], some other fishes, they can infiltrate and they can even, how can I say ... almost start a new creation, but what about the others [species]? Everybody dies. So some predators will come, but that's all."</i>  |
|                                | G (n=10)                                    | <i>"Oh, it's like I told you... it's seasonal. So, if you have the slabs, there will have no</i>   |

|                                     |           |  |
|-------------------------------------|-----------|--|
|                                     |           | <i>sun, so fatally many species will die.. The shrimp... it comes, it comes, but it survives from plankton, small plants, little animals, I do not know what, and then if there is no sun, it will die."</i>   |
|                                     | R (n=10)  | <i>"It will end in the sense of the primordial source of these transformation process that exists in function of the union of organic matter and the sun to provide a productivity there will end, right, then that will no longer exist that source of food there."</i>   |
| Lack of urban infrastructure        | LIU (n=4) | <i>"São Sebastião does not have a structure, (...), so it is not enough to expand the Port, it has to have a structure, sanitation, you have to have a ... a master plan that really works here in the city, right? a ... a project of expansion of the municipality, also, of the structure, understood?" E7</i>  |
|                                     | LDU (n=6) | <i>"Here, the population was small, the population of São Sebastião suddenly grew in such a way that people were surprised, right, the very fast growth... then when they [foreign workers] come, it will be even more. So, you can not unravel, it will be a... will drown the traffic, drown everything, everyone drowned, both maritime and terrestrial"</i>  |
|                                     | G (n=8)   | <i>"The Port is important for the city? It is, but how can we have a port that dialogues with the society and understands its needs? How can it has a beneficial and positive relationship with the community where it belongs? I think this is the proposal, then... the port needs to grow, to expand, but how can it grow without affecting the communities, the community around, right, the community where it is inserted, right? We have to think about development, where there is also social gain."</i>  |
|                                     | R (n=3)   | <i>"São Sebastião, it is a typical of the city that should have a growth plan for the next 100 years, not 3 years, but 100 years... in 10 years, this area could grow, and there we could produce infrastructure for here and we could allow only be some thousand inhabitants to occupy, (...) and when it becomes full, we will start to grow in another place, right, that could remain temporally preserved... because then you have time to study the place in 10 years and when it will be explored, you already have all the knowledge of the area, for ... what to have to do ... how could it be mitigated... "</i> |
| Influence of political arrangements | LIU (n=2) | <i>"From the moment you start, it's... Like State issues, if you have a house and they need to cross a road through your house, if you do not sell your house, you do not leave there, you're impeding progress and you will be obliged to leave."</i>   |
|                                     | LDU (n=4) | <i>"You realize that people have that hope that it [the SSP expansion] does not happen, but we know that State... State is State, right, it can do everything, we see it around... there are people who still resist, but a lot of people think it's going to be this just like this, it will be difficult."</i>   |
|                                     | G (n=9)   | <i>"There is already a big fight between the residents and those interested in using the place as an enterprise. The city has an interest, the State government has an interest. They [SSP] say they will provide jobs, but they do not care about the environment, you know how it is, they want progress."</i>   |
|                                     | R (n=4)   | <i>"Neither the managers know how to talk to us nor do we know how to talk to the managers, so if you establish a wall, they have opinions, we have opinions, and you think, and there is a conversation of opinions while the knowledge that would be necessary to provide this background is underestimated, as if our opinion were more important than knowledge."</i>  |
| Inevitability of urban development  | LIU (n=5) | <i>"Many things have changed in the course of time, now about the improvement, we do not know, because progress also brings bad things, right? It's good from on side, but it's not on the other side, because nature is very shaken by it, right? It's like this."</i>  |

|                                  |           |  |
|----------------------------------|-----------|--|
|                                  | LDU (n=6) | <i>"To expand the port is a natural thing, it has to increase because the ... is ... progress, sometimes these enterprises... right, the progress itself always hurts a little, but you can soften it... you can have an enterprise, you can have an extension of the Port once you also preserve."</i>  |
|                                  | G (n=4)   | <i>"So they are only dealing with the progress, development, in a precipitated way, without a contingency plan, without thinking about the local population today as it is, without thinking about the risk factors, without thinking about all these details, right? Is there a structure for the population today? Can I talk about sustainability? Can I think about the next generations? How am I going to leave it to the next generations, being that ... (...) Are the big projects coming? And with that there is the migration, right? There are new people coming, so they have very complicated issues... it's an area of environmental conflict, indeed."</i> |
|                                  | R (n=2)   | <i>"São Sebastião will grow, the port will eventually grow, if it is not São Sebastião it is going to be Ubatuba, if it is not Ubatuba it is Bertioga [near cities]. There is pre-salt, there are activities, do not grow up it is even cruel, do not grow indicates that the local people can not prosper because if they thrive they will consume more, if they consume more they will need more infrastructure, if they will need more infrastructure, things should grow."</i>   |
| Cause of the highway duplication | LIU (n=4) | <i>"Of course everything in excess hurts, right? When this new highway gets ready, we do not know what the city will be like. But ... there's room for everything, right?"</i>   |
|                                  | LDU (n=6) | <i>"The road was not made for nothing, you know, it is a lot of money invested, right?"</i>  |
|                                  | G (n=3)   | <i>"So all these big expansions, in an extremely small area, look, we have an extremely small area and it's like this is a big city, because you have the Transpetro terminal, you have the port, you want to build public marinas, then you will have the container terminals, (...) you have trucks coming by, you have a big highway passing behind you (...) they are blowing all this part of behind the city."</i>   |
|                                  | R (n=0)   | –  |

## 8.6 APPENDIX 6 – Original impact list of impacts of the Environmental Impact Assessment of the São Sebastião Port expansion (SÃO PAULO, 2011)

| N° | Impact list  |
|----|--|
| 1  | Generating expectations in the community                                 |
| 2  | Air quality change   |
| 3  | Increased noise levels   |
| 4  | Raising vibration levels   |
| 5  | Induction of erosion and silting processes                               |
| 6  | Changes in the quality of surface water resources                        |
| 7  | Alteration of the quality of groundwater resources                       |
| 8  | Alteration of soil quality   |
| 9  | Change in the quality of coastal waters                                  |
| 10 | Alteration of the runoff regime  |
| 11 | Changes in the water circulation pattern in Araçá Bay                    |
| 12 | Alteration of the sedimentary dynamics in the interior of Araçá Bay      |
| 13 | Effluent generation  |
| 14 | Generation of solid waste  |
| 15 | Suppression of vegetation  |
| 16 | Loss of habitat for terrestrial fauna                                    |
| 17 | Disruption and extinction of terrestrial fauna                           |
| 18 | Attraction and proliferation of vectors, pests and anthropogenic fauna   |
| 19 | Degradation of the plant community                                       |
| 20 | Loss of terrestrial fauna individuals                                    |
| 21 | Creation of favorable conditions for the establishment of mangrove       |
| 22 | Elimination or alteration of aquatic habitats                            |
| 23 | Creation of substrates for colonization by benthic organisms             |
| 24 | Reduction of photosynthetic rates  |
| 25 | Contamination of aquatic environments and organisms                      |
| 26 | Disruption and extinction of aquatic fauna                               |
| 27 | Altering the composition of fauna and flora                              |
| 28 | Risk of Invasion of Environments by Exotic Organisms                     |
| 29 | Shading of coastal environments  |
| 30 | Generation of employment and income                                      |
| 31 | Interference with artisanal fisheries                                    |
| 32 | Reduction of employment  |
| 33 | Increasing demand for housing  |
| 34 | Real estate market dynamics  |
| 35 | Change in operating conditions of the local road system                  |
| 36 | Changing the landscape   |
| 37 | Animation of economic activity   |
| 38 | Increase in tax revenues   |
| 39 | Generating odors   |
| 40 | Attraction population  |
| 41 | Social conflicts   |
| 42 | Dissemination of infectious diseases                                     |
| 43 | Interference with traditional culture                                    |
| 44 | Increase in demand for public services                                   |
| 45 | Development of port support infrastructure                               |
| 46 | Changes in land use  |
| 47 | Degradation of the Porto environment                                     |
| 48 | Characterization of the Historic Center                                  |
| 49 | Increased demand for parking areas and support for truck drivers         |
| 50 | Interference in the regional road system and increased risk of accidents |
| 51 | Risk of collision with vessels   |
| 52 | Interference with leisure and tourism activities                         |

