ENVIRONMENTAL IMPACT ASSESSMENT UNDER AN ECOSYSTEM APPROACH: THE SÃO SEBASTIÃO HARBOR EXPANSION PROJECT

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Introduction

Impacts on natural ecosystems by human activities are becoming increasingly perceived by society, and nowadays not a single marine ecosystem is free from signs of anthropogenic impacts (HALPERN et al., 2008). This phenomenon is called Anthropocene (MONASTERSKY, 2015), which is the most recent geological period in Earth's history, when human actions began to have a significant global impact on the climate and the functioning of ecosystems. A broad and strategically diverse movement has emerged in this context to counteract these pressures and promote sustainable development (HOGAN & VIEIRA, 1995). For instance, the Environmental Impact

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Assessment (EIA) is a process incorporated into decision-making processes on potentially polluting or otherwise damaging enterprises, which allows for negotiations to reduce environmental impacts (MORGAN, 2012). However, the effectiveness of EIAs is still under scrutiny (SÁNCHEZ, 1993; LI, 2008; CARMO, 2013, 2016), and proposals to improve the process are ongoing (CARMO, 2016, BORIONI et al, 2017). One way to qualify the EIA, still incipient in Brazil, is the application of the ecosystem approach (MEA, 2003; GENELETTI, 2016).

We present here a critical analysis of an EIA process that highlights the strategic importance of the ecosystem approach. First, some shortcomings of the EIA process in Brazil that could be addressed by ecosystem approaches are discussed. Subsequently, the expansion project of the Port of São Sebastião (São Paulo, Brazil), considering its background and characteristics, is presented, with emphasis on the environmental conflicts that led to its judicialization and the effective involvement of several actors in its discussion. In this context and in order to understand the structure, functioning, biodiversity, and importance of Araçá Bay (the location of the planned port expansion), the Biota/Araçá Thematic Project (FAPESP) was realized as a concentrated effort by researchers from different scientific and research institutions and thematic areas.

In the context described above, we made an analysis of the potential impacts from the installation and operation steps of this project, considering the understanding of the oceanographic processes and possible effects on the human well-being caused by the undermining of provided ecosystem services. The environmental feasibility of the project was compared to the analysis presented in the Environmental Impact Statement evaluated by the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) to support the environmental license application. Finally, we reflected on the implications of the ecosystem approach incorporation in the EIA in Brazil.

Limitations of the EIA process in Brazil

The EIA is a common tool, used globally, to evaluate potential impacts on ecosystem integrity and functioning (MORGAN, 2012). In Brazil, it is provided by the National Environmental Policy (Law No. 6.938 / 1981) and is an essential step for the implementation of enterprises and activities that are potentially polluting, damaging, or use natural resources. Its objective is to allow human activities to have their expected environmental impacts identified and their environmental costs internalized, in order to support decision making and to attain environmental sustainability.

In Brazil, limiting the application of EIA only at the project or developments level, as provided for in National Environmental Council (Conselho Nacional do Meio Ambiente - CONAMA) Resolution No. 01/1986 (GLASSOM & SALVADOR, 2000), compromises its effectiveness, since the process does not take into account the affected region's ecosystems. Although the evaluation of cumulative and synergistic impacts with other public enterprises and policies is cited in the aforementioned legislation, a systematic and adequate evaluation has not been carried out (LEGASPE, 2012; TEIXEIRA, 2013). The situation is aggravated by the fact that projects licensed by different governmental spheres can coexist for the same location, and their integration is precarious.

The individualized analysis of each project leads to its dissociation from the socio-environmental reality of the region, where different enterprises, human activities, public policies and ecosystem processes coexist. This condition compromises both the quality and relevance of the studies presented, and may impede an effective determination of the environmental viability of the developments (CARMO, 2016).

The fragmented and reductionist view of project licensing begins with the scoping phase of the environmental impact studies, materialized in the Terms of Reference (TR) in Brazil. The Inter-ministerial Ordinance No. 60/2015 defines the TR as a "document prepared by the environmental agency that establishes the necessary content of the studies to be presented in the EIA process" referring to the detailing of these in specific TRs. However, such TRs are standardized in the legislation annexes, leaving little room for the specificities necessary for a more local, integrated and functional approach.

According to the Federal Public Prosecutor's Office (MPF, 2004), the TR should be a guiding document to ensure compliance not only with the guidelines of CONAMA Resolution No. 01/86, but also with specific guidelines of the project and the socio-environmental characteristics and particularities of its location. That is, such a document should take into account the structure and functioning of a region, not a standardization of issues -as has occurred-, especially after the issuance of IBAMA Ordinances No. 419/2011 and No. 60/2015. Both ordinances encouraged a standardization of these procedures, taking into account both the pressure already being exerted on environmental licensing in the light of the tight deadlines for creating TRs, and under the pretext of streamlining the general EIA process (CARMO, 2013).

Furthermore, the environmental characterization and diagnosis proposed in the TRs, and realized in the Environmental Impact Statements, make it difficult to directly identify the impacting actions of the project. In fact, the operational division between analysis of physical, biotic and socioeconomic (or anthropic) environments, provided in CONAMA Resolution No. 01/86, generated studies with different scopes and depths that are not integrated (CARMO, 2016). Thus, bulky documents are prepared, with much information that is difficult to interpreted, hampering the qualitative and quantitative analysis of potential impacts of a development or enterprise.

The EIA can be improved by using the ecosystem approach, since it advocates the understanding of processes, direct and indirect cause-effect relationships between physical, biotic and socioeconomic aspects and the understanding that human activities can compromise services and the benefits provided by ecosystems (GENELETTI, 2016).

Ecosystem approach

The ecosystem approach is based on the premise that human and non-human populations should be seen and analyzed in the context of the ecosystems in which they (both) live (SARTORI & MONTEIRO, 2010). This integrated view demands knowledge drawing from virtually every area and/or discipline of science. Notably, it demands knowing the relationships between human systems and the environments that support

them. The Millennium Ecosystem Assessment (MEA, 2003, 2005) stands out, being a framework which aims to determine the importance of ecosystems for human well-being and establish the scientific basis for their sustainable use (MEA, 2005). This global assessment considers the concept of ecosystem services to understand the relationships between ecosystems and human well-being, thus demanding the understanding of ecosystem processes and functions.

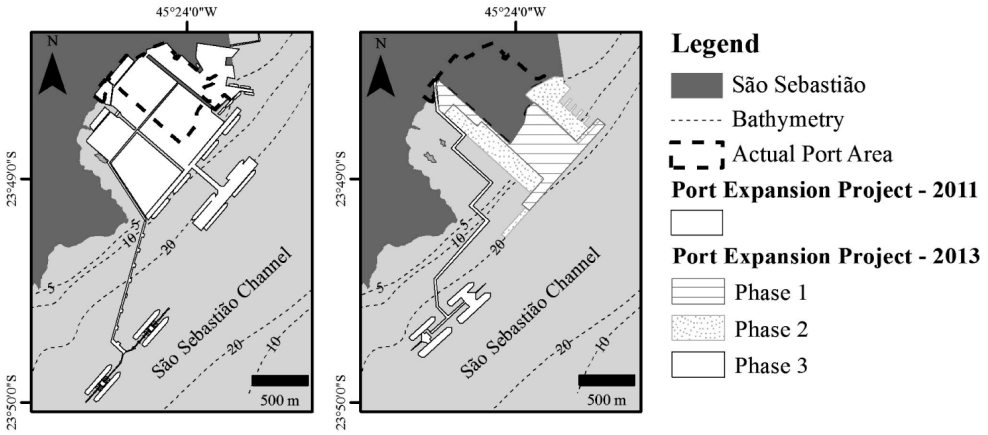
Following MEA (2003), there has been a marked increase in studies on ecosystem services (MARTINEZ-HARMS et al., 2015). Among them, applications of ecosystem services into environmental policies (WITTMER & GUNDIMEDA, 2010) and, more recently, environmental impact assessments (GENELETTI, 2016) can be highligthed. Currently, the contribution of the ecosystem approach to environmental management and decision-making is widely recognized in the literature (e.g. COSTANZA et al., 2014; DAILY et al., 2009; FOLEY et al., 2005; GROOT et al., 2010; TALLIS & POLASKI, 2009).

Simplified approaches, such as the Drives, Pressures, State, Welfare and Response method (DPSWR) (COOPER, 2013), help to understand the relationships between ecosystems and their benefits to human well-being. However, such approaches are often hidden or ignored in decision making (COSTANZA et al., 2014), while there is a need to make them explicit. In order to exemplify this specific approach, the DPSWR model was applied in the EIA process related to the expansion project of the Port of São Sebastião, presented below.

The expansion project of the Port of São Sebastião

The construction of the Port of São Sebastião started in 1936, and was inaugurated in 1955 (MANI-PERES et al., 2016). After the expansion from 1987 to 1989, in 2004, the government of the State of São Paulo and Companhia Docas de São Sebastião (CDSS) started a new EIA process within IBAMA aiming at a new expansion (CDSS, 2011; MANI-PERES et al., 2016). Changes were made in the initial project over time (CDSS, 2011, Public Civil Action No. 0000398-59.2014.403.6135), generating a proposal with a total occupation area of around 1.2 million m^2 (CDSS, 2011), with a landfill of about 82% of Araçá Bay (Figure 1). During the licensing process, the expansion of the retro area was altered with the construction of a concrete slab, over 34% of Araçá Bay, supported by about 17,000 piles (CDSS, 2013; Figure 1). This new arrangement foresaw its interconnection with the future road contour (Contour of Caraguatatuba and São Sebastião) leading to construction of the Tamoios Highway, which is under duplication.

Figure 1 – Port of São Sebastião expansion project proposed in the Environmental Impact Assessment prepared in 2011 (left) and its adaptation in 2013 (right). System of Coordinates: WGS 1984; Projection: Mercator; Data source: Earth and bathymetry: I3Geo / MMA (accessed February 2017); Expansion Project - 2011: Directive Plan of the Municipality of São Sebastião and CDSS (2011); Expansion Project - 2013: CDSS (2013). (Adaptaded by Luciana Y. Xavier).



In December 2013, IBAMA issued the Preliminary License No. 474/2013 (PL, Licença Prévia, in Portuguese) for phases 1 and 2 of the project (Figure 1) (CDSS, 2013); However, the Federal Public Prosecutor's Office (MPF) and the Public Prosecutor's Office of the State of São Paulo (MPE), jointly recommended the suspension of the PL. This recommendation was disregarded by IBAMA and after a broad discussion between civil organizations, researchers and MPF and MPE, the license was judicialized by the Public Civil Action No. 0000398-59.2014.403.6135, with an injunction request filed against IBAMA and Companhia Docas de São Sebastião. In June 2014, the Federal Court granted the injunction to suspend the effects of PL and determined that amendments were to be made in the presented studies. Following continued appeals by the defendants, in April 2016, a judicial decision was issued in the first instance, conditioning the issuance of a new license to the reviewed Environmental Impact Statement (EIS). The new EIS should contain at least a thorough analysis of the locational and technological alternatives. These alternatives would the intervention in Araçá Bay from potential cumulative and synergistic impacts originating from other mega-developments in progress along the Northern Coast of the state of São Paulo, such as land access routes to the Port of São Sebastião, land use and occupation, housing and basic sanitation. This decision was based on a report prepared by researchers from the Biota/Araçá Project and Center of Marine Biology of the University of São Paulo in response to the consultation from MPE about the possible effects of the port expansion in Araçá Bay.

Methodological approach

The method used in this study was the documentary analysis and the critical discussion of the expansion project of the Port of São Sebastião by experts from several areas of knowledge. The specialists took into account the qualitative environmental impacts generated by developments on ecosystem services and benefits of Araçá Bay to the society. This analysis considered the DPSI/WR framework (COOPER, 2013) as a structuring axis. Using this structure, it was possible to identify the impacting activities or drivers (D), the subsequent pressure(s) (P) generated, what exactly is affected (S, state), how it is affected (I, impacts on the physical and biotic environments) and what are the negative ecological outcomes and benefits to society (W, welfare). Responses (R) were not included in the analysis since they refer to mitigation measures that should be proposed by the port proponent. In this manner, the analysis of the São Sebastião Port expansion project was based on potentially impacting actions (ALBUQUERQUE, 2013) and the effects on ecosystem services identified in the region (CARRILHO, 2016), summarized in a conceptual map (Figure 2). The development was analyzed considering its implementation and operation phases.

Synthesis of the impacts the expansion of the Port of São Sebastião may cause to Araçá Bay

Impacts during the installation phase

In this phase, several impacting actions were identified, such as implementation of the landfill, insertion of prefabricated piles, use of structures to support these operations in shallow areas, such as rafts, tripods or towers, and installation of the concrete slab, the piping system and mooring berths, and the loss of materials during operations caused by the movement of cranes, trucks and workers.

These actions will generate direct and indirect impacts on the Araçá Bay and its surroundings, due to the re-suspension and movement of sediments during the installation of the piles and concrete base plates. Mangrove remnants will be affected by changes in sediment type and deposition (sedimentation). The latter is also affected by changes in hydrodynamics in the bay generated by the presence of the piles.

As a consequence, habitat alteration or destruction and subsequent increases in mortality are expected where the sediment would be removed. The higher sediment availability, re-suspended and moved by the construction or by the local hydrodynamics, will lead to an increase in water turbidity, reducing light penetration and so severely affecting photosynthesis. Pollutants such as heavy metals, polycyclic aromatic hydrocarbons (PAHs) and persistent organic pollutants (POPs), compartmentalized in the sediment and unavailable to biota, would thus become bio-available. The area occupied by piles will reduce the area available for colonization by non-consolidated bottom organisms, while increasing the area available to hard-substrate species and possibly invasive species already recorded in the area, also with serious consequences. Additionally, the piles and

slab installation will cause sediment compaction and movement due to the excavation and construction supporting structures. These activities will generate solid waste and effluents, such as cargo and fuel oil from trucks, cranes and ferries, in addition to the overflow of concrete. In conjunction with increased artificial lighting and noise level, these activities will disturb the original environment and pose severe impacts on biota. Thus, areas are lost and the environment is altered or destroyed in the location directly affected by the development, as well as in adjacent localities.

Once installed, the piles will constitute vertical physical barriers while the slab will consitute both a vertical (reducing the flow of water, materials and organisms along the bay) and a horizontal barrier (reducing wind-induced mixing and light incidence in the water column and sediment). The barriers will change water movement and bottom morphology, as well as the total volume of water in the bay. Mobility of organisms and water exchange between the channel and the bay will be reduced, and the barriers created by the mooring berths will lead to an increased water residence time inside the bay.

As a consequence of the piles and slab, attenuation of currents and wave orbital velocity are expected, especially in the shallower areas and under the slab, leading to a reduction in sediment transport, spatial and temporal heterogeneity of the sediment (in mid-term), exchange of organic particles, gases, nutrients and organisms between the channel and the bay, and the oxygenation of the sediment and water column. Due to the reduction in dynamics, deposition of fine sediment, particulate organic matter and pollutants will increase, especially in the shallow area of the bay and under the slab, leading in turn to retention of terrigenous material and water table outcropping. The turbulence generated around the piles will cause localized areas of erosion and siltation, further promoting an additional change in the morphology of the bay.

It should be noted that a possible modification of the inlet of Mãe Isabel stream, main tributary of the region, will modify the hydrodynamics of its lower course, altering the sedimentary composition of its inlet and the bay itself. Disruptions on mangrove cores and on primary production by macroalgae, seagrasses and microalgae in the non-consolidated sediment and in the water column will also be evident.

Impacts during the operation phase

Impacts of the operation phase include traffic and berthing of ships and vessels, considering the increase in frequency and tonnage, pipeline operation and movement of cranes and trucks for cargo operations.

Ship operation will amplify the sediment's movement and re-suspension. Berthed ships suggest the worsening of solid and liquid waste generation, including fuel oil or cargo leaks. It is important to highlight the difficulty to contain potential spills in the São Sebastião Channel, due to its intense and highly variable hydrodynamics. Moreover, the chronic contamination scenario is inherent to port operations, and has been historically recorded for the region (BÍCEGO, 1988). Large vessels traffic will intensify the transport and invasion of organisms from different coastal regions across the planet to the area of the development. This will be exacerbated in the case of allien opportunistic

species, due to the high availability of artificial consolidated substrate on the surfaces of the supporting piles. Additionally, the new hard substrate will provide habitat for hard-substrate species, which are almost all suspension feeders. These organisms will cause increased bio-deposition of ingested algae, suspended fine particles, and add muddy and organic-rich material to the sediment, causing local burial and/or oxygen depletion. In parallel, there will be an increase in artificial lighting and noise, impacting resident and migratory organisms.

Loss of ecosystem services and benefits to society

The changes described in the physical and biotic environment will have profound consequences for the Araçá Bay ecosystem and its direct and indirect influence areas, including the São Sebastião Channel and surroundings. The loss of benefits to society provided by the Araçá Bay ecosystem services will take different forms.

Increased turbidity during the installation and operation phases, together with the reduction of light incidence caused by the large concrete slab, will compromise water purification services provided by organisms and the local hydrodynamics in addition to the provision of food for the region's fauna, which in turn will affect local fishery production. Water purification service by the primary producers corresponds to the utilisation of atmospheric carbon and nutrients that reach the bay from mainland and the São Sebastião Channel, especially by sewage dumps. Primary producers rely on light for photosynthesis, which generates carbon to be consumed by other organisms in the food web, which will also consume the organic matter that also enters and accumulate in the bay. Without light, these processes and this service cease to exist, leading to the accumulation of organic matter and nutrients in the sediment and to changes in its biota.

Due to the combination of organic matter mineralization by (aerobic) bacteria and much lower photosynthetic oxygen production due to the extensive shading of the bay, oxygen will become depleted locally, causing widespread anoxia. This effect will be greatly aggravated by the reduction of the water volume exchanged with the channel. Subsequently, there will be the consumption of organic matter by anaerobic bacteria, releasing gases such as methane and hydrogen sulfide, severely impacting the local biota. The unpleasant odors of these gases, and their potential toxicity in higher concentrations, will make the environment unhealthy, directly impacting the port area residents and employees.

These gases also contribute to the atmospheric heat retention and, thus, the installation and operation of the port will increase greenhouse gas emissions by the decomposition of the organic matter under the slab. The intensification of burning of the bunker (heavy fuel oil), caused by the increase in size and frequency of the ship fleet, will also increase the gases emmissions and reduce local air quality. Impairment of primary production and environmental quality due to eutrophication and toxic gases may lead to a collapse of local biota, affecting food production (fish) in the bay and surrounding areas. These impacts will also occur in areas not directly covered by the slab within the bay, where food capture will be prevented, both by its border effect and hydrodynamic and sedimentary changes. These factors will also lead, directly and indirectly, to the

degradation and "coastal squeeze" of mangrove remnants and to severe disturbance of the Araçá Bay ecosystem. Thus, the impact of the port expansion on natural fish stocks will be dramatic and irreversible, affecting traditional/subsistence fishing and aggravating the socio-economic condition of this fragile sector of society, whose manifestation and cultural perpetuation depend on the relationship with the sea and its resources.

Additionally, there is the effect on the biota of organic (e.g. petroleum derivatives) and inorganic pollutants (e.g. heavy metals), inherent to port activity, which may lead to mortality of sensitive organisms. This mortality and displacement may in turn benefit species tolerant to extreme and degraded conditions, both native and invasive. The surviving, but contaminated organisms will enter the food web and so pass on the pollutants to other animals and humans when consumed. In summary, the changes planned for the expansion of the Port of São Sebastião will generate large and irreversible impacts on the maintenance of health and food security for society.

The collapse of biological communities will also be critical to processes that maintain local diversity and those benefits deriving from it. Araçá Bay can be understood as a discrete space unit since most of the benthic organisms do not move directly with other similar environments. Thus, for an organism or species to colonize this type of environment, it must migrate or succeed in dispersing its larvae and juveniles. Such connectivity is crucial to genetic flow and genetic variability and also increases the resilience or capacity to assimilate impacts without compromising its functionality.

The degradation and transformation of the characteristics of Araçá Bay will have profound and irreversible consequences for the organisms that depend on it as a connection point to other areas. That is, the impacts will affect species and populations that today have a geographic distribution far beyond the São Sebastião Channel and the Northern Coast of São Paulo itself. This effect can be illustrated by the migratory birds that use Araçá Bay as a resting and feeding area and by the fish that reproduce there, grow and then go to adjacent areas. The ecological impairment of the bay will increase the ecological fragmentation of regions near the Northern Coast of São Paulo, leading to the macro-scale reduction of genetic connection processes between populations.

In addition, biodiversity changes in the bay and its surroundings will impact the service of future benefits to society. The quantitatively recorded biodiversity in Araçá Bay counts among the highest for the entire Brazilian coast (AMARAL et al. 2016). Its reduction will potentially lead to losses of biotechnology prospecting, that is, the search for new bioactive compounds and biotechnological processes (drugs, cosmetics, food etc.). The more than 1400 species recorded, plus hundreds of new species for science, and 16 threatened species, are the result of the great diversity of habitats in the bay. This set of conditions enables Araçá Bay to sustain the accomplishment of scientific and educational activities. The research and teaching tradition in the area, facilitated by the existence of the Center of Marine Biology of the University of São Paulo CEBIMar/USP for 60 years, have made Araçá Bay one of the most studied environments on the Brazilian coast. The accumulation of knowledge (AMARAL et al., 2010; CARRILHO, 2016) is of fundamental importance for environmental changes' effects studies, and there are not many environments in the Brazilian coast capable of providing these parameters.

The Araçá Bay provides other benefits to society that will also be eliminated by the expansion of the Port of São Sebastião. One of them is its use by the fishermen and even residents of distant districts, such as the city center of São Sebastião and Ilhabela. Because it is sheltered, the bay has ideal conditions for mooring and sheltering small boats used by fishermen. With the hydrodynamic changes, the areas planned in the EIS to function as a navigation channel for these users will likely be subject to gradual silting. In addition, the occupation of the space now available by the expansion of the Port will not allow to keep small vessels sheltered in the bay. The impossibility of sheltering the boats in an adequate and free place can contribute to the end of the activities of the traditional fishermen who use that space, causing socio-economic and cultural damages.

Other social benefits are related to leisure and recreation uses of the bay by the surrounding residents. The traditional canoe race, held annually in June among the fishermen of the region, is famous. The loss of these services has several consequences, including a decrease in quality of life due to lack of leisure options. This service is associated with another one, called scenic beauty. Araçá Bay is a beautiful area, both by its own features and the landscape that can be seen from it. The presence of an extensive tidal plain, a rare environment on the coast of the state of São Paulo, presents remarkable changes in scenery with the changing tides throughout the day. In general, the bay has different purposes, that form the cultural heritage of the Municipality of São Sebastião, contributing to the sense of place of the inhabitants of the surroundings, the Caiçara cultural identity, their quality of life and good social relationships.

Assessment of the Environmental Impact Statement deficiencies and considerations about the viability of the development

The scenarios presented in the EIS indicate the low environmental viability of the development in consequence of the impacts it presents. Both Araçá Bay and its surroundings belong to different marine protected areas: the Marine Protection Area of the North Coast of São Paulo, the Municipal Marine Protection Area of Alcatrazes and Relevant Ecological Interest Area of CEBIMar. Araçá Bay also harbor species threatened with extinction.

In order to discuss the environmental viability of the development, it is essential first to understand the dynamic aspect of the marine environment, being aware that changes in a given locality directly and indirectly influence other areas, sometimes distant and apparently disconnected. This is the case of ship anchoring in an area near the southern entrance of the São Sebastião Channel and the port itself. Ship anchoring may be a source of solid wastes in downstream areas such as the Tupinambás Ecological Station and Alcatrazes Wildlife Refugee not foreseen in the EIS.

An integrated analysis is the basis for understanding the joint and cumulative effects of the development. Thus, from the presented analysis, it is understood that any intervention, anywhere in the bay, including the region ahead of its opening (mooring berths of phase 1), will lead to severe and perhaps irreversible impacts on the surrounding ecosystems.

Araçá Bay acts as a reactor, transforming matter and energy into products that, when exported to the surrounding environment, play a crucial role for human society. The health of the local marine environment has been historically affected by various human interventions. Thus, the cumulative impacts resulting from the expansion project of the Port of São Sebastião have a much greater degradation potential than could be expected in an isolated analysis of the development, as presented in the EIS. An example would be oil spills that reach the area under the slab, where removal would not be possible due to inaccessibility. In this case, the impacts of volatilization of oil derivatives will last for a prolonged period, persistently affecting both the already scarce diversity of species that would still exist in the area as well as the local human population. Another example of synergic effect is the demographic increase caused by the new roads that will lead to an increase in population and irregular occupation. In a scenario of greater pressure on public utilities, such as an effective sewage collection and treatment in the region, an increase the quality of water in the region expected.

The proposed expansion of the Port of São Sebastião is environmentally unfeasible, also in light of predicted Climate Change effects. These projected changes, such as the increase in frequency and magnitude of high energy oceanographic events (storms and undertows), rising of the relative sea level, rising water temperatures, ocean acidification, among others, will have a cumulative effect on impacts described above. Storms and sea level rise will affect stability of the port and shiping activities. Another interaction not addressed by the EIS, are the secondary climate change effects, that will cause even more drastic effects on the biota and human occupations at the site and its surroundings (CARMO, 2016).

The comparison of the results presented here with the environmental impact study prepared for the EIA process that supported the preliminary license granted by IBAMA shows differences in relation to the identified impacts. The EIS listed 50 impacts (CDSS, 2011) while the present study listed 29 (Figure 2). The fragmentation of impacts can be a distortion that allows the strategy to classify a greater number of items as low magnitude and/or reversible. Thus, the analysis of the EIS in the licensing process was more permissive. The study argues that direct impacts on the physical and biotic environments would commonly be observed in the implementation of port terminals and piers. Moreover, the EIS states that these impacts would mainly be concentrated during the construction period (changes in noise levels, air, water and soil quality, erosion and sedimentation processes, suppression of vegetation and disturbance of fauna, loss/alteration of habitats for terrestrial and aquatic wildlife). Thus, these impacts were all assessed as having low to medium relevance and being predominantly temporary (CDSS, 2011, P. 98). This result stands in contrast with the present analysis concluding that the impacts will have great spatial and/or temporal magnitude and will be, in general, irreversible, leading to the collapse of this environment.

From the differences between traditional EIA approaches and those based on ecosystems, it is important to mention the method used to define the relevant environmental aspects in relation to the impacts of the (proposed) development. The approach presented here followed Albuquerque (2013), who carried out a study in the Araçá Bay

region to define the relevant environmental aspects of the site. The EIS presented defined such aspects mainly from the experience of the team in similar projects conducted in other environments (CPEA, 2011, p. 95), thus disregarding local oceanographic, environmental and social processes.

After receiving the EIS, IBAMA requested 31 requirements to be submitted by the entrepreneur. IBAMA verified that 20 of these requirements were fully met, 10 were partially met or considered "in progress" and one was not met. IBAMA's final conclusion was that there were impediments to the issuance of the Preliminary License. These impediments did not allow drawing conclusions about the viability of the entire development, leading to the situation in which licenses could be issued only for phases 1 and 2. Further complements would be required in order to analyze the environmental feasibility of phases 3 and 4 of the project. This constitutes a deliberate fragmentation of the EIA process, a practice that is technically unjustifiable and not supported by legislation. Nonetheless, there is precedent for such a situation, granting the license for the installation of the Belo Monte dam construction site by IBAMA in 2011. However, this practice conflicts with an integrated and systemic view of the environment.

The issuance of fragmented licenses with pending environmental studies or compliance with conditions, has led to lawsuits and stoppages of the process, both in the case of Belo Monte (CARMO, 2013) and of the Port of São Sebastião. This demands a refinement of the overall licensing process and requires a improvement of its technical quality that must be focused on the specificities of the development and the ecosystem under analysis.

Considerations on the implications of the ecosystem approach for the EIA process

The results presented here bring to light some reflections about the current EIA process of developments related to the environment. Current practices, despite their important role in mitigating impacts and improving many of the projects presented, do not seem adequate to address the current reality of many large development projects. Consequently, there is more intense political pressure to accelerate the issuance of environmental licenses (CARMO, 2016). In fact, a World Bank report (2008), in dealing with the procedures adopted for the EIA in Brazil, stated that there is a need for greater transparency, publicity and agility in presenting the results to society and to define the requirements to be met by the entrepreneurs. On the other hand, changes would be more easily implemented in Brazil if they were independent of legal actions, given the political divergences that surround the discussions about EIA in the country (FONSECA et al. 2017).

The ecosystem approach in the EIA emerges as a viable alternative to address such challenges, as well as those related to biodiversity loss and climate change. As discussed in Europe and North America (GENELETTI, 2016), the opportunity to integrate this approach into the EISs of individual development projects would be advantageous to facilitate the analysis of cumulative and synergistic impacts (EUROPEAN UNION,

2013). Emerging development policies and the loaning criteria enforced by international agencies have now demanded consideration of ecosystem services in mitigating environmental impacts (TALLIS et al. 2015). The Ecosystem Approach should preferably be adopted because of the scoping of the Terms of Reference. This requires a structural change in the implementation of the EIA, that should emphasize the definition phase of environmental studies, which would be more efficient and involve a greater and better technical discussion (BORIONI et al, 2017).

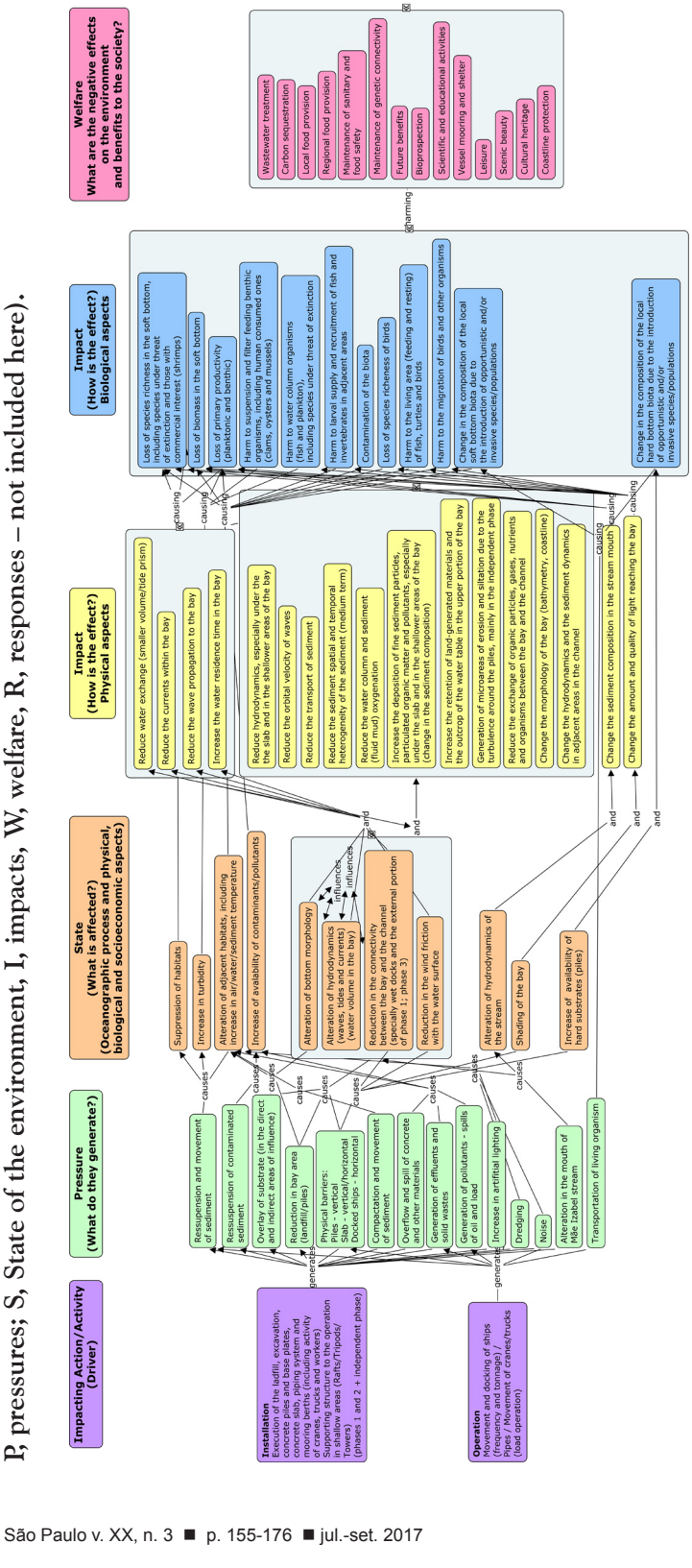
In addition, the fragmentation of environmental impact studies into physical, biotic and socio-economic analyzes is not effective in terms of cost, time and quality of diagnosis and analysis. This is especially true in the case of cumulative and synergistic impacts and/or issues that require multidisciplinary integration of both direct and indirect impacts (BAKER & SCOTT, 2013).

The ecosystem approach is a more transparent and logical process that allows a more objective impact assessment, which can be better understood by the various actors involved. The analyzed EIS (for the Araçá Bay case) profoundly underestimated the magnitude and relevance of the impacts assessed, which has contributed to the rejection of the project from most of the actors involved. Thus, in addition to providing greater agility in the administrative process, the ecosystem approach may lead to a smaller probability of future challenges and judicializations.

The rejection from the involved actors can decrease considerably with more integrated measures. This is especially true in conflicts involving coastal developments, which are complex and multidimensional in nature (cf. SUMAN, 2001), comprising issues of territorial planning, urban and industrial development, conflicts over conservation of the environment, tourism and economic development. These conflicts seem to result from fragile institutional arrangements for the management of resources and fragmented decision-making processes (SUMAN, 2001). Thus, integration strategies, as advocated by the ecosystem-based approach, are seen as necessary. In this context, the importance of broadening the social participation and control in the scoping phase of the environmental studies (CARMO, 2016) is highlighted. The social participation allows for the anticipation of issues and aspects, which are normally presented only when public hearings are efficiently held.

The present case study illustrates that it is possible to make the EIA process less bureaucratic, more participative and better directed, using an evidence-based approach, which is feasible to be implemented, without any changes in the current legislation. More importantly, the results show how the engagement of the various actors, especially academia, can contribute for positive changes in environmental decision making.

Figure 2 – Summary of the impacts caused by the proposed expansion of the Port of São Sebastião, organized in the form of a concept map in *CMAP tools software*. The São Sebastião Port expansion project was analyzed based on potentially impacting actions of phases 1, 2 and 3 (independent phase), during the port installation and operation steps, in oceanographic processes and ecosystem services that could be impacted considering the DPSI/WR analytical structure (COOPER, 2013; D, drivers, P, pressures; S, State of the environment, I, impacts, W, welfare, R, responses – not included here).



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ENVIRONMENTAL IMPACT ASSESSMENT UNDER AN ECOSYSTEM APPROACH: THE SÃO SEBASTIÃO HARBOR EXPANSION PROJECT

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***Resumo*:** A Avaliação de Impacto Ambiental (AIA) visa analisar a viabilidade ambiental de empreendimentos, mas exibe problemas que comprometem sua qualidade, como a visão fragmentada, tecnocrática e positivista com que os estudos são realizados. O aprimoramento das AIAs pode beneficiar-se da abordagem ecossistêmica, quando leva em conta os processos e serviços ecossistêmicos afetados. O presente trabalho aplicou essa abordagem ao projeto de expansão do Porto de São Sebastião (São Paulo, Brasil), cuja AIA foi questionada judicialmente, utilizando análise documental e discussão por especialistas. Diferentemente do reportado na AIA, a análise dos processos oceanográficos evidenciou impactos diretos e indiretos nos serviços e benefícios ecossistêmicos, de grande magnitude e/ou irreversíveis. Essa análise permitiu o aprofundamento da compreensão dos efeitos do projeto de expansão do porto nos componentes e processos ambientais (hidrodinâmica, dinâmica sedimentar e biodiversidade) e também no bem-estar humano, evidenciando os benefícios do uso da abordagem ecossistêmica aplicada.

***Palavras-chave*:** Política ambiental, Gerenciamento Costeiro, Sustentabilidade, Conservação Marinha, AIA.

***Abstract*:** The Environmental Impact Assessment (EIA) aims to analyze the environmental viability of projects, but exhibits problems that compromise its quality, such as the fragmented, technocratic and positivist vision. The prediction of environmental impacts can be improved using the ecosystem approach, considering the processes and the ecosystem

services affected. The present work applied this approach in the expansion project of the Port of São Sebastião (São Paulo, Brazil), in which the EIA was judicially questioned, based on documental analysis and discussion by specialists. Unlike foreseen in the EIA, the analysis of oceanographic processes showed direct and indirect impacts on ecosystem services and benefits, irreversible and/or of great magnitude. The analysis also allowed an improvement to the comprehension not only on the effects on the environmental components and processes (hydrodynamics, sediment dynamics and biodiversity), but also on human well-being, evidencing the benefits of applying the ecosystem approach in the EIA.

***Keywords*:** Environmental Policy, Coastal Management, Sustainability, Marine Conservation, EIA.

***Abstract*:** La Evaluación de Impacto Ambiental (EIA) busca analizar la viabilidad ambiental de emprendimientos económicos, no obstante muestra problemas que comprometen su calidad, como su visión fragmentada, tecnocrática y positivista. El mejoramiento de las EIAs se puede beneficiar del enfoque ecosistémico, al considerar los procesos y servicios ecosistémicos afectados. El presente trabajo aplicó este enfoque en el proyecto de expansión del Puerto de São Sebastião (São Paulo, Brasil), cuya EIA fue cuestionada judicialmente, utilizando análisis documental y discusión por especialistas. A diferencia de los señalado por la EIA, el análisis de los procesos oceanográficos evidenció impactos directos e indirectos en los servicios y beneficios ecosistémicos, de gran magnitud y/o irreversibles. Este análisis permitió una mejor comprensión de los efectos del proyecto de expansión del puerto en componentes y procesos ambientales (hidrodinámica, dinámica de sedimentos y biodiversidad) y en el bienestar humano, colocando en evidencia los beneficios del uso del enfoque ecosistémico.

***Palabras clave*:** Política Ambiental, Gestión Costera. Sostenibilidad, Conservación Marina, EIA.