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Evaluating ten years of management effectiveness in a mangrove protected area

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ABSTRACT

Creating protected areas (PAs) intended to counteract the effects of human activities on the environment is a significant step towards conserving coastal and marine ecosystems. Various countries have introduced legal mechanisms to create and manage their important ecosystems, such as mangroves. Despite the significance of evaluating the effectiveness of PAs, literature on the topic is scarce, especially pertaining to the mangrove ecosystems. Therefore, the present study intended to evaluate the management of a PA located in northeastern Brazil throughout the first decade of the current century (2003, 2006, and 2012). The management of the PA was considered inadequate, and the level of efficacy even declined progressively, although a slight improvement was recorded in 2006. The respective levels of effectiveness were 35%, 50%, and 15% for 2003, 2006, and 2012. The improvement recorded in 2006 was attributed to a new management plan and the ensuing environmental actions, such as monitoring and management programs, PA zoning, and others. The worst management performance was indicated for the following assessment parameters, namely, administrative matters (public administration), biogeographic characteristics, and threats. One of the main reasons for the low management effectiveness is that the mangrove PA is located in an urban area of one the most densely populated cities in Brazil, namely, Fortaleza, (7786 inhabitant/km^2). The location has led to an increase in the number of threats to the PA and has strongly influenced the biogeographic characteristics. The urbanization in and around the area has resulted in the PA being isolated, with no connection to other ecosystems through ecological corridors. Both direct measures and strategic planning are required to facilitate continuous improvement of the management effectiveness of PAs. This strategy is imperative in countries with tropical ecosystems characterized by significant biodiversity, which is vulnerable to anthropogenic effects.

1. Introduction

The recognized ecological and economic importance of mangrove ecosystems has been discussed and emphasized in various studies (Badola et al., 2012; Uddin et al., 2013; Barbier, 2014). Mangrove forests contain natural resources and ecosystem services of immense value to people and the environment (Carney et al., 2014; Giri et al., 2015). These include fisheries, forest products, pollution abatement, carbon storage, nursery habitats, and coastal protection against natural disasters, such as tsunami and cyclones. However, as mangrove ecosystems could be located close to urbanized areas, anthropogenic activities, such as the continuous discharge of contaminated water, could influence these systems detrimentally. Such negative influences are particularly prevalent in the developing countries of South America, Asia, and Africa. The conservation of mangrove forests is currently a significant environmental challenge and the creation of effective strategies to

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promote such conservation is therefore urgently needed (Roy, 2014).

The current rate of mangrove deforestation is 150,000 ha per year, which is ~1% of the global mangrove occurrence. Moreover, this rate has even reached 2–3% annually in some countries. Sixteen percent of the >70 mangrove species are currently under threat (Polidoro et al., 2010). Therefore, it is imperative that these coastal ecosystems are managed effectively and their protection is reinforced. Furthermore, as only 6.9% of mangroves worldwide are located within protected areas (Giri et al., 2010), additional protected areas (PAs) should be urgently delineated in the effort to reduce the rate of loss.

Since the previous century, PAs have been employed in various developing countries to conduct integrated coastal management (ICM). These protected areas are used in the planning and management of most of the popular coastal holiday destinations, islands, and tropical ecosystems, such as mangroves (Satumanatpan et al., 2014). Protected areas can potentially conserve tropical coastal resources and provide social and economic benefits to the local communities. In addition, PAs play an important role in the conservation of biodiversity and the implementation of ambitious multilateral agreements on the environment, such those proposed at the 2010 Convention on Biological Diversity (CBD) (Stoll-Kleemann, 2010; Carranza et al., 2014). However, the percentage of marine and coastal protected areas considered successful or effective with respect to ecological and/or socio-economic factors is debatable (Bennett and Dearden, 2014a). Evaluating the management effectiveness of protected areas has been an ongoing challenge in coastal conservation, mainly in the tropical regions (Gaston et al., 2006; Garces et al., 2013). Management effectiveness evaluation (MEE) has gained global recognition as an important framework to promote the continuous improvement of conservation efforts in protected areas (Addison et al., 2015). However, studies in developing countries on this topic are scarce.

Demarcating of mangrove protected areas is one of the widely adopted approaches to environmental conservation in the tropical areas. The performance of the mangrove PAs can be assessed based on their management effectiveness. Unfortunately, the results of such studies are not easily accessible and have yet to be widely shared among the conservation and scientific communities (Stoll-Kleemann, 2010). Moreover, few studies have examined the qualitative management effectiveness of these important ecosystems in a diachronic manner, e.g., over the course of a decade. Therefore, we have explored this aspect in a mangrove ecosystem located in a high-pressure urban area, namely, the Ceará River estuary in northeastern Brazil. This PA is situated in Fortaleza, the city with the highest demographic density in Brazil (7786 inhabitant/km^2) (IBGE, 2014). At 14.1 km^2, 60% of which is it located in urban zones, the mangrove area of Fortaleza is one of the largest urban mangroves in the world. Fishing and crab harvesting in the mangroves are important economical and subsistence activities for many families (Cavalcante et al., 2009) resident in the area. Despite various environmental laws to protect mangroves in Brazil, this particular ecosystem has been adversely affected by a variety of anthropogenic activities (Santos et al., 2014), such as urbanization and shrimp farming in the coastal zone (Queiroz et al., 2013; Tenório et al., 2015). Systematic studies on the management effectiveness of mangrove protected areas in developing countries are scarce. Brazil presents a particularly interesting instance for environmental policy establishment because of its democratic political system, fast economic growth, recent creation of protected areas in coastal/marine environments, and its importance in the global environment. Therefore, this paper aims to contribute to the scientific debate about management effectiveness in mangrove protected areas by means of a case study in the Ceará River estuary in Brazil.

2. Methods

2.1. Study site

Although the coastline of Brazil extends for more than 10,000 km, only 1.87% of the territorial waters benefit from some form of protection (Magris et al., 2013). Our study area was the EPA (Environmental Protected Area) in the Ceará River estuary, located on the Brazilian northeastern coast (Fig. 1). This tropical estuary has a semi-arid climate and is under threat from multiple contamination sources. The Ceará River basin is one of the three major water sources of the metropolitan area of Fortaleza, the state capital. This basin is under increasing pressure because of the disorderly urban expansion and the erection of numerous illegal constructions that contribute to the deforestation of the mangrove, erosion, and soil siltation, as well as the decline in the quality of the estuarine water. Agriculture and small boat traffic are minor sources of river pollution, whereas untreated sewage, urban drainage, and industrial effluents from electroplating, textiles, plastics, tanneries, and other factories constitute the main sources of contamination (Cavalcante et al., 2009; Nilin et al., 2013).

According to the classification of the Protected Areas National System (Portuguese: *Sistema Nacional de Unidades de Conservação* [*SNUC*]), conservation units (Portuguese: *unidades de conservação* [*UC*]) are a type of protected area (Portuguese: *áreas protegidas* [*PA*]). There are two groups of protected areas, namely, strictly protected areas (or restricted protection) and sustainable-use protected areas (or direct use) (Santos and Schiavetti, 2014). Our study area is located in an EPA that was established by state decree 25.413/1999. The management model is that of sustainable-use protected area, which includes the active participation of several social entities. The area covers 27,45 km^2 and is occupied, inter alia, by indigenous and poor urban communities.

2.2. Data collection and analysis

The methodology of this study comprised three steps, namely, data gathering and selection, field studies, and information analysis. Two different sets of sources were used during data gathering and selection. The first source comprised official data and documentation from the environmental protection agency responsible for the EPA (the state government), planning instruments, environmental legislation, scientific papers, and media material. The other source of information was the answers obtained from a questionnaire circulated to EPA managers in 2003, 2006, and 2012. As regards the questionnaire, we followed the methodology of Cifuentes et al. (2000), adapted from the Rapid Assessment and Prioritization of Protected Areas Management, e.g., RAPPAM protocol (Hockings et al., 2006). This methodology has been implemented in 53 countries, in more than 1600 PAs located in Europe, Asia, Africa, Latin America, and the Caribbean (Leverington et al., 2010). Further adaptations, based on Cook et al. (2014), have been adopted since. The authors (Cook et al., 2014) have recommended that the questions be explicitly formulated with regard to the assessment frame to limit undue influence on the evaluation of the effectiveness.

The questionnaire was organized into ten different groups of questions (management categories), which were further organized into variables and subvariables, called “variable” and “indicator,” respectively (Table 1).

The questions were evaluated and scores were allocated. Based on Cifuentes et al. (2000), evaluation matrices for each category

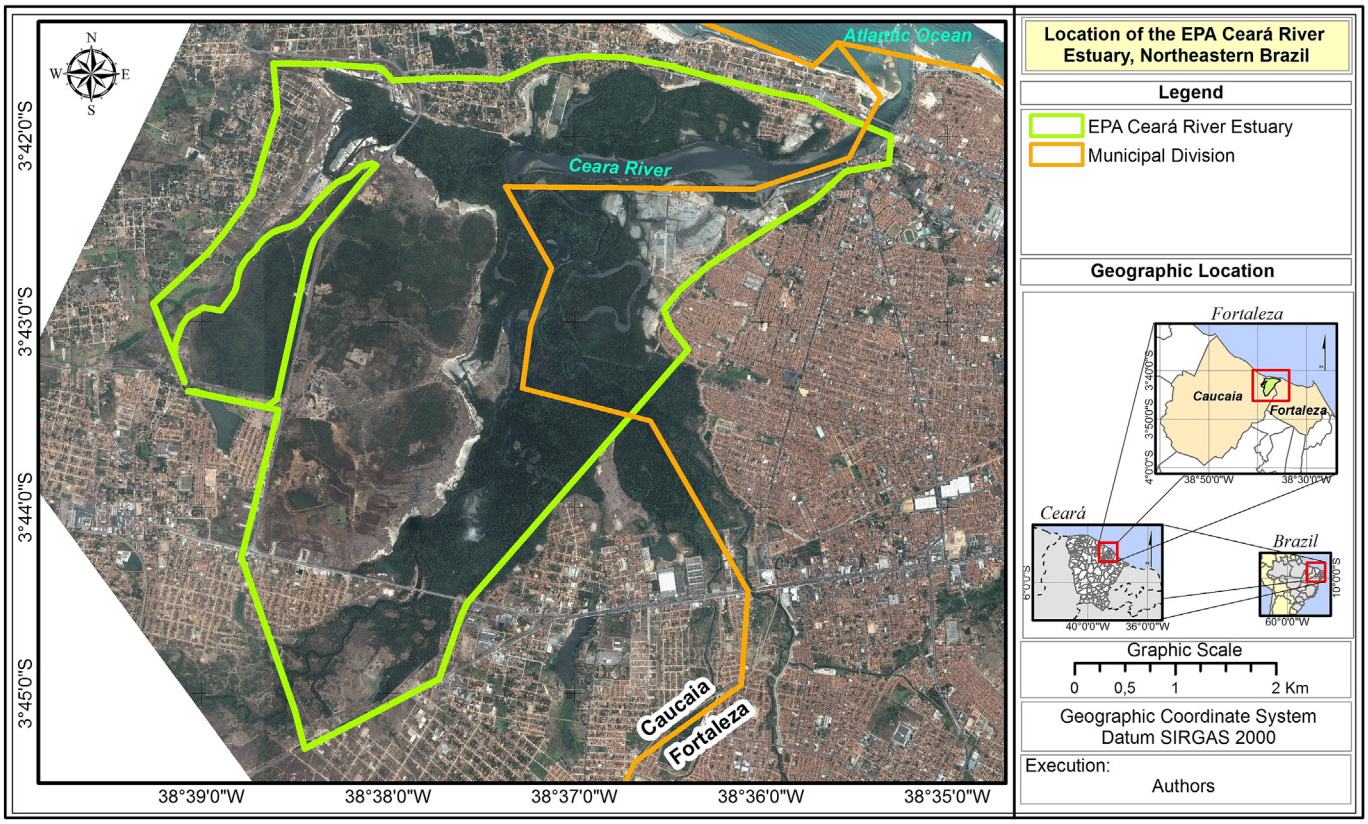

Fig. 1. Location of the EPA Ceará River estuary, northeastern Brazil.

were constructed from the total score, and the arithmetic mean was subsequently calculated for the indicators in each category. The value for each category was obtained by the sum of its respective variables, and this value was contrasted with an optimal scenario in which all the variables had the maximum score. The percentages obtained were classified into concepts ranging from "unsatisfactory" (0–35%), "low satisfactory" (36–50%), "moderately satisfactory" (51–75%), "satisfactory" (76–90%) to "very satisfactory" (91–100%).

Field studies were conducted in and around the PA to verify the environmental systems and to analyze the answers to the questionnaires. Laboratory activities entailed producing cartographic material from the data collected. We employed the ArcGIS 9.3 (ID 837871100535) software and images from the *Quick Bird* satellite (0.60 m spatial resolution) from 2008.

3. Results and discussion

The scores allocated to the effectiveness of the management were 33% in 2003, 50% in 2006, and 15% in 2012, indicating unsatisfactory (incompetent) management of the EPA over a period of ten years (Table 2).

The lowest scores were allocated in the following categories, namely, biogeographic characteristics, administrative, and threats. The low score of the first category was ascribed to the poor delimitation of the area, which excluded a part of the mangrove and the Ceará River mouth (Fig. 2). As regards the administrative category, the problems arose from financing irregularities, the absence of an organogram, and staff shortages. The low score for the threats category derived from environmental effects, such as air, soil, and water contamination, wildfires, advancing urban settlements (Fig. 3), development infrastructure, introduction of exotic species, and the extraction of native flora and fauna.

In their highly debated study on the effects of anthropogenic threats in 93 protected areas, Bruner et al. (2001) have concluded that the majority of parks are successful at stopping land clearing and are—to a lesser degree—effective at mitigating logging, hunting, wildfire, and grazing. However, numerous examples have revealed the inefficiency of these protected areas. In this regard, Nellemann et al. (2007) have found that illegal logging occurred in 37 out of 41 protected areas in Indonesia. Contradictory results have to be carefully compared because of the complexity of studies on management effectiveness. Bruner et al. (2001) have measured the effectiveness of parks in protecting tropical biodiversity; with their study pinpointing various major difficulties in examining the overall effectiveness of protected areas. Numerous PAs are situated in the tropical regions and their effectiveness could vary according to the specific region, IUCN (International Union for Conservation of Nature) category, and the age of the PA. Schiavetti et al. (2013) have found that the size of most of the coastal and marine PAs of Brazil was between 1001 and 1,000,000 ha, which means their EPA category was similar to that of this case study. This management category is less successful in conserving its resources because it allows urban areas and production activities, which could be detrimental to the site, as various human activities are incompatible with conservational goals.

3.1. Administration

As regards the staff allocated to the study area, during the ten years of observation, only managers were appointed, but no supporting team to assist them. In respect of the financial evaluation, the managers have indicated that resources were not transferred to them regularly, and there were no mechanisms to accept external

Table 1
Indicators for the evaluation of management effectiveness in the mangrove protected area (NE Brazil).

Category	Variable	Indicator
Administrative	Personnel	Manager/Technical support/Operative support/Ability to hire additional personnel
	Financial	Operational budget/Accountancy/Financial funding adequacy/Special funding/Ability to manage own financial resources
	Organizational	Files/Organogram/Internal community/Adequacy
	Infrastructure	Tools and personnel/Basic and specific facilities/Salubrity/Security/Limits well defined/Access and signage
Political	Community participation	Relations between the PA and the community
	Intra-institutional support	Main office and administrative system
	Inter-institutional support	
	External support	
Legal	Land tenure	Domains
		Conflicts
	Laws and regulations	Transparency in the application of laws and regulations
	Legislation concerning the creation of the EPA	Validity and adequate legislation
Planning	Management plan (MP)	Existence and quality (experienced staff) of the MP
	Compatibility with other MPs	Personnel responsible for the creation of the MP
	Annual operative plan	Implementation of the MP
	Planning	
	Zoning	
	Limits	
Knowledge	Biological and cartographic information	Information on the culture of local native communities
	Legal/Investigative information	Disclosure of the legal aspects of the PA Information on scientific researches and procedures occurring inside the PA
	Monitoring and feedback	
	Traditional communities	
Management programs	Sketches and layouts	Management and planning personnel Frequency of activities
	Implementation of the planned activities	Program planning
	Coordination	
	Continuity and evaluation of programs	
Biogeo-graphics	Size	Optimal total surface
	Vulnerability	Vulnerability of the species to the disturbances and level of impact
	Shape	Shape and level of fragmentation
	Connectivity	Connectivity and occurrence of ecological corridors
Legal use	Aquaculture	Compatibility of these activities with the use and capacity goals of the PA
	Engineering works (telecommunication)	
	Tourist and entertainment ventures	
	Fishery	
	Transportation	
	Petroleum and gas	
	Services	
Illegal use	Fishery	Occurrence and impact level
	Engineering works	
	Tourist and entertainment ventures	
	Aquaculture	
	Adventure tourism	
	Petroleum and gas	
	Services	
Threats	Contamination	Threat level and effects in the mangrove protected area
	Overfishing	
	Infrastructure for growth and development	
	Introduction of exotic species	
	Flora and fauna extraction	
	Extraction of non-renewable resources	

Source: adapted from Cifuentes et al. (2000) and RAPPAM.

funding (from NGOs, international foundations, universities, and others).

The poor documentation provided by previous administrations continuously affected the running of the EPA. Only in 2006 were the first files containing documentation on planning, results, and reports created. There was no physical office to house the management of the PA, making surveillance and monitoring difficult; consequently, the score for infrastructure was low. Furthermore, the equipment did not meet the demands of the PA. In 2003, the score for administration was only 28% of the total score; moreover, in 2012, it declined sharply to a 8%. The performance of this category was completely unsatisfactory, although there was a short-lived improvement in 2006, when a score of 39% was achieved. This category was allocated some of the worst scores in the entire evaluation process.

In a study on PAs located on the Thailand coast, Satumanatpan et al. (2014) have indicated the vital challenges in developing countries that have to be resolved. These challenges include inefficient intersectoral and intergovernmental collaboration, weak commitment to applying financial discipline and appointing adequate numbers of well-trained staff, weak leadership, law enforcement inefficacy, and limited participation.

3.2. Participative governance and management

In 2003 and 2012, no community councils existed to focus and direct the participation of and support from the inhabitants of the EPA. In contrast, in 2006, the improved result indicated that the social and political mechanisms (local committees, associations, and cooperatives) present were able to engage participants in

Table 2
General score and effectiveness level for each evaluated point.

CATEGORIES	Effectiveness				General score			
	2003	2006	2012	Optimal	2003	2006	2012	Optimal
Administrative	0	1	0	4	4.5	6.25	1.3	16
Political	0	1	1	4	5.5	8	7.5	16
Legal	1	1	1	4	5.5	6	5	12
Planning	0	2	0	4	4	15.7	2	24
Knowledge	0	2	0	4	7	15	5	20
Management programs	2	3	0	4	11	13	1	16
Illegal usage	1	0	0	4	8	8	4	16
Legal usage	1	2	0	4	5	16	1	24
Biogeographic characteristics	1	0	0	4	5	4	2	24
Threats	1	0	0	4	7	5	0	24
Total	**Effectiveness**				**Total**			
	1	**3**	**0**	**4**	**62.5**	**96.95**	**28.8**	**192**
					% from optimal			
					33%	**50%**	**15%**	**100%**

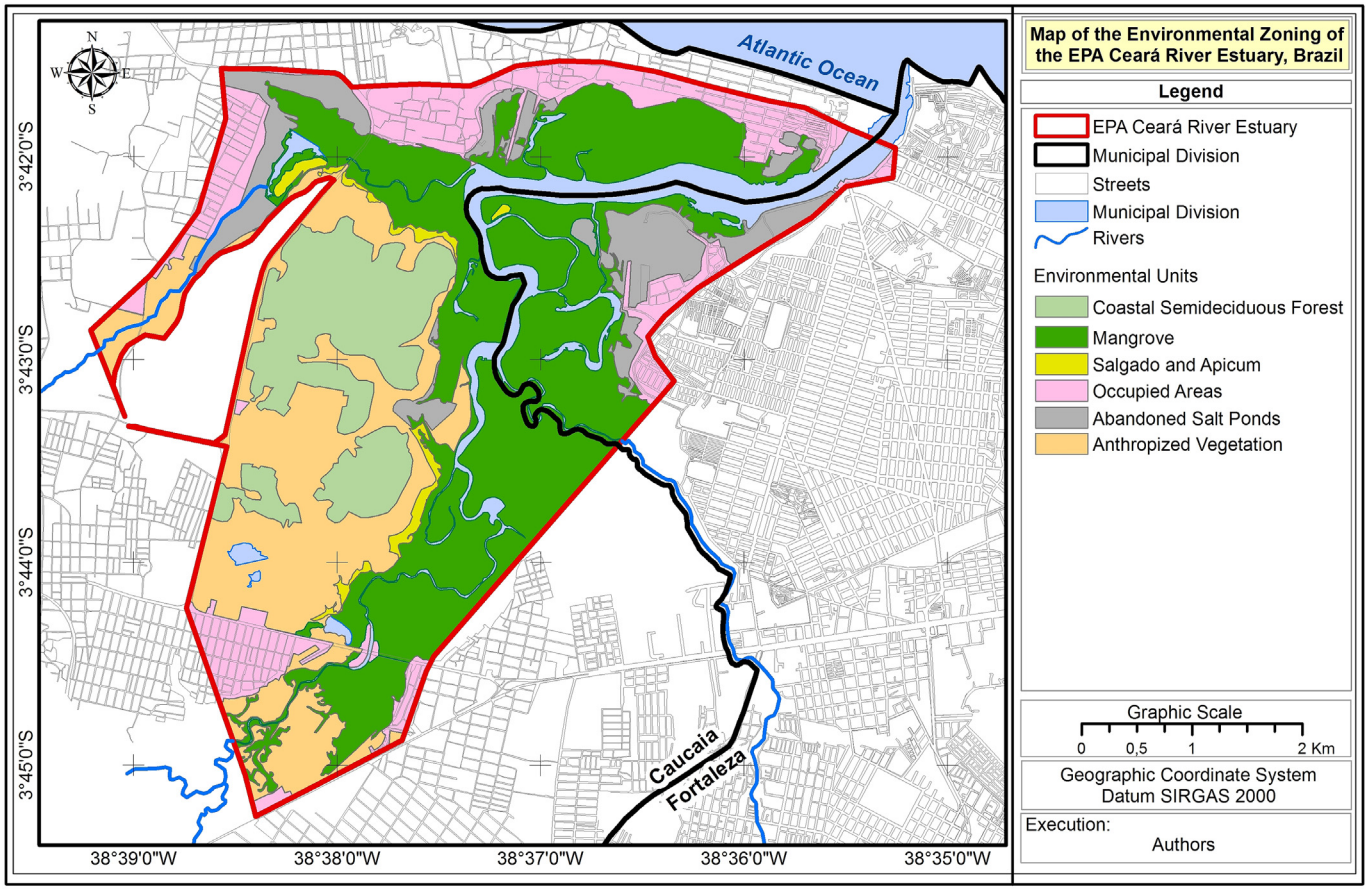

Fig. 2. Map of the environmental zoning of the EPA Ceará River estuary, Brazil.

activities such as environmental education. Bennett and Dearden (2014b) have conducted case studies in marine protected areas in Asia, where the perceptions towards governance and management processes were generally negative. The results of their study showed better relationships between the PA and communities only in 2006, as well as between the management of the PAs and the governmental institutions.

As regards inter-institutional support, we have observed that the jurisdiction and procedures for environmental management were confusing; moreover, they overlapped on the three administrative levels, namely municipal, state, and federal. For example, utility companies installed water and electricity systems at irregular locations in the mangrove areas, without obtaining authorization from the PA management. As regards intra-institutional support, there was no political synergy, as there was no effective support from the central administration. Consequently, the PA was managed independently, as a comprehensive system, without any integration with other governmental structures. The relevant results for 2006 and 2012 were considered somewhat satisfactory at, respectively, 50% and 47% of the optimal. However, the 34% of the optimal achieved for 2003 was deemed unsatisfactory. Although improvement has occurred over the last number of years, it was not

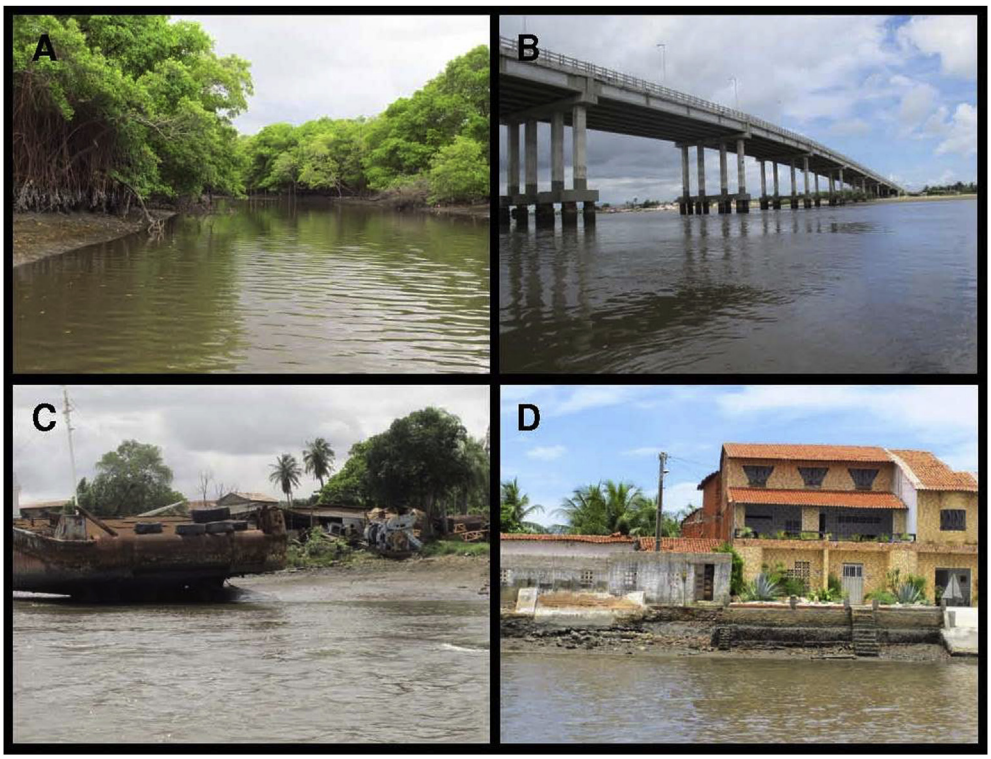

Fig. 3. Environmental effects on the EPA Ceará River estuary. A) Mangrove of the Ceará River plain. B) Bridge over the Ceará River. C) Disorderly industrial use on the Ceará River. D) Advance of urban settlements.

enough to meet the goals of effective management.

Leverington et al. (2008) has recorded over 6300 assessments of management effectiveness from 100 countries. Original data were obtained and analyzed for approximately half of these assessments, and nearly fifty evaluation reports were reviewed. This study indicated that the essential management factors demanding attention were (in descending order) appropriate programs for community benefits and assistance, communication programs, management effectiveness evaluations, natural resource and cultural protection measures, and the involvement of communities and stakeholders.

Research by Dudley et al. (2007), relevant to 330 sites, is regarded as the largest single-methodology study on management effectiveness. The results have indicated the factors that most strongly influenced the sustainability of biodiversity in PAs, namely, law enforcement, access control, resource management, monitoring and evaluation, maintenance of equipment, budget management, and the existence and implementation of annual operational plans.

3.3. Legal aspects

With regard to our study, the data for 2003 and 2012 have shown that less than 35% of the PA had been delimitated. The inadequate demarcation has led to conflict between the environmental protection agency and the local population over the irregular occupation of land, especially in the mangrove permanent preservation areas (PPA). The conflicts had started because of the unplanned advance of urban settlements (see Fig. 3D).

As regards the laws and regulations, in 2003 there was a lack of EPA legislation to regulate the use and exploitation of resources, which led to overlapping and management difficulties. Moreover, there was no management plan at all. The relevant official documentation was only drafted in 2005, but has not been updated since. Some degree of planning and regulating was present in 2006. All the managers have observed that the users of the PA scarcely abided by the laws and regulations. However, a somewhat satisfactory performance was found for this aspect for all three periods.

3.4. Planning

In 2003, no management plan (MP), zoning (delimitation), operations plan, or management board existed. In 2006, with the creation of an MP, the PA area was demarcated and zoning extended, and a management board was established by official decree. However, attempts to carry out the MP largely failed, with less than 35% of the plan being put into practice. In 2006, discrepancies between the MP and the plans of the state and the city were observed. For example, the MP of the PA was incompatible with the housing plan proposed by the Municipal Administration Office that intended to legalize irregular land occupation in the PA. In 2012, despite the existence of an MP, zoning, and legally defined limits, the PA experienced problems related to the updating of legislation and the geographic limits. Consequently, the score of 17% obtained for 2003 for this aspect dropped to a poor 8% in 2012. In 2006, however, a score of 65% was reached, which was a moderately satisfactory standard.

As observed by Muthiga (2009) in a coastal protected area in Kenya, a combination of management inadequacies interacted to limit the ability of PAs to achieve their objectives fully. These inadequacies included overlapping mandates, financial and administrative constraints, and inadequate stakeholder participation.

3.5. Information available to the management

In 2003 and 2012, information on the PA was not only out of date

but also mostly unobtainable. In 2012, no monitoring was conducted because of a lack of funds. Although research was conducted sporadically, it bore no relation to the problems experienced in the PA. No indigenous knowledge was recorded or stored.

In 2006, the information was updated, but there was little dissemination. The PA was monitored, which partially fulfilled the requirements of the MP. Information on the Tapebas (indigenous people from the area) was made known to the coordinators and managers of the PA. The customs and tribal knowledge of these people were promptly registered and employed by the management. It is important to note that although PAs are intended mainly to preserve biodiversity (both in Brazil and globally), they are also important elements in maintaining and improving the living conditions of traditional communities (Ahmad et al., 2012). The performance for 2003 and 2012 was unsatisfactory, and that for 2012 was considered moderately satisfactory.

3.6. Management programs

In 2003, structured management programs were designed; however, these only covered the main activities. In 2006, although these programs did exist, they were poorly structured. However, the data suggest that 90% of the plans were executed during the two periods. No confluence of these activities with any governmental programs occurred, the periodicity was variable, and the intersectoral collaboration through the exchange of data was deficient.

As regards management programs, 2012 differed from the other years. According to the manager, no such programs were executed and no other program was conducted either. The only activities during this period were initiated by the state environmental protection agency, such as *Tree Week* and *Environment Week*. However, nothing specific to the PA was done. Less than 35% of the general and specific activities were put into practice because of a lack of logistics, organization, staff, and support. Since there was no management program in progress, we assumed there was no connection between them. A moderately satisfactory performance of 69% was indicated for 2003, and that for 2006 was 81%, labeled satisfactory. Finally, for 2012 only 6% was achieved, ranking as unsatisfactory.

Management practices in protected areas almost invariably include monitoring and evaluation programs. However, staff often perceive these activities as less important, ascribing higher priority to the general day-to-day activities. It is almost impossible to assess objectively the success of these management activities (Gaston et al., 2006) when no monitoring and evaluation programs are in place.

3.7. Biogeographical characteristics

According to the managers, between 51% and 75% of the total surface of the PA was in an optimal condition during the three periods. Although the area shape is irregular, the PA is undivided. Fig. 2 shows that the PA is isolated and has no connection to other ecosystems by way of ecological corridors, because of the urbanization inside and surrounding the area. The vulnerability of the area was indicated as high, because of the importance of mangrove ecosystem. The assessment indicated that this factor was unsatisfactory during the three observation periods.

A growing body of literature has been emphasizing the need to consider functional networks of protected areas to conserve coastal biodiversity. In contrast, in Brazil, various aspects of such networks, such as goods and ecosystem services (Lavieren and Klaus, 2013; Devitt et al., 2015; Rodríguez-Rodríguez et al., 2015), occurrence, and effectiveness assessments remain incipient, especially in the urban areas. An important dimension of the effectiveness of protected area networks is the role they could play in the physical landscape to conserve the regional and national populations of various common, widespread, and endangered species (Gaston et al., 2006).

3.8. Illegal and legal uses

Various human activities carried out in the PA pose a threat to the mangrove environment. The lack of communication between the different official entities is illustrated by the managers not knowing how many of the structures in the PA have environmental licenses, as these were issued by a different administrative agency. Furthermore, discrepancies occur in relation to other programs, such as the housing programs of the federal administration. In accordance with the PA zoning and management plan, erection of houses is allowed in PPAs and environmental recovery areas (abandoned saline areas). All the periods assessed were found unsatisfactory, only reaching 33%, 33%, and 17%, respectively, for 2003, 2006, and 2012.

As regards legal use of the area, in 2003 and 2012, the activities, such as licensed occupation of the PPA and overexploitation of the resources, were incompatible with the PA objectives. The performance results for 2003 and 2012 were therefore unsatisfactory, while they were moderately satisfactory for 2006.

The coordination of legal frameworks and mandates, various levels of policies, and local rules and regulations is a challenge and, simultaneously, an imperative for facilitating effective management in protected areas. Without a coordinated and harmonized approach from the relevant institutions, conflicting and counterproductive results will continue in PAs (Bennett and Dearden, 2014a).

3.9. Threats

The results showed that all the years ranked as unsatisfactory. The factors with the most prominent effects in the EPA were fauna and flora extraction, human settlements, fires, and contamination risks. However, possibly, these effects could be reversed. In 2006 and 2012, the PA managers indicated the advance of human settlements as a threat to the conservation of natural resources.

Leverington et al. (2008) have identified the most serious threats in the protected areas, namely, hunting, fishing, logging, wood harvesting, gathering of non-timber forest products, recreational activities, and activities conducted on adjacent land. Despite the ecological and economic importance of this site in northeastern Brazil, this PA has suffered considerable degradation because of contamination from intense and continuous industrial and domestic activities (Cavalcante et al., 2009). A previous ecotoxicological study in this estuary conducted by Nilin et al. (2007) has indicated that surface water samples collected at the inner portion of the estuary were toxic. The index of geo-accumulation indicated metal enrichment in the Ceará River sediment, mainly at the inner sites, ranged from moderate to strong contamination by Al, Cu, Cr, and Zn (Nilin et al., 2013).

The present research employed the efficiency measures from the perspective of the role of management actors, and not from that of the other stakeholders. This is a common approach in various research papers and, therefore, is considered to have scientific validity (Leverington et al., 2010; Cook et al., 2014; Vokou et al., 2014). Furthermore, to eliminate any bias in the results, we have analyzed documents to assess 10 different management criteria (Table 1) and we have provided field/cartographic maps to check the biogeographic aspects. Field activities and cartographic mapping were employed to analyze the anthropogenic effects, as well

as the criteria for the proposed questionnaire. In addition, this methodological approach has utilized objective criteria, such as the existence and proper categorization of management documents (plans, minutes of meetings, reports, and others), as well as environmental monitoring studies for the years evaluated (2003, 2006, and 2012).

In conclusion, an analysis of the data of the last ten years clearly indicated that the management of the PA was unsatisfactory. The PA had to contend with significant problems, caused mostly by disorderly urban growth. Presently, there are no guarantees for the long-term conservation of the environmental quality and biodiversity in the mangrove. In such circumstances, it would be difficult to meet the goals of the PA. Generally, the political will to establish protected areas appears to be stronger than the will to manage them. The creation of protected areas can be considered a public relations exploit that focuses attention on the politicians involved. However, financial and human resources, planning, and efficient environmental management are required to manage these areas properly. Moreover, an understanding of environmental challenges and their causes is required. It is known that the establishment and expansion of PAs in developing countries were often not based on the appropriate technical and scientific criteria, but resulted from economic pressure by foreign agents (Macedo et al., 2013). The findings of this study have indicated that the management effectiveness goals of the mangrove protected area have been met only partially. However, our present concern is how to utilize these results for further improvement of the management process to foster the creation of more successful PAs in the future, mainly in the developing countries.

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