ASSESSMENT OF THE CURRENT STATUS OF MANGROVES IN BRAZIL

INSTITUTO BIOMA BRASIL
Wetlands INTERNATIONAL
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FOREWORD

Mangroves are among the most diverse and awe-inspiring ecosystems on the planet. They play an essential role as nurseries of life, contribute to climate regulation, and provide livelihoods for thousands of families along the Brazilian coast. Understanding their extent, conservation status, and challenges is key to guiding public policies and integrated coastal management actions.

This document, prepared by the BiomaBrasil Institute under consultancy from Wetlands International Brazil/Mupan – Women in Action in the Pantanal, with support from the Wetlands International Global Office, presents a comprehensive and up-to-date analysis of the state of mangroves in Brazil. Bringing together scientific, cartographic, and legislative data, the study offers a detailed overview of the variability of mangrove ecosystems along the Brazilian coastline, highlighting their functional aspects, ecosystem services, threats, and conservation priorities.

The publication provides an integrated view of mangroves as living systems in constant transformation — influenced by climatic, hydrological, ecological, and human factors — and underscores the importance of approaches that bridge science, public policy, and social participation.

The study brings together solid scientific evidence and practical recommendations, engaging with local and national perspectives as well as global conservation goals. In doing so, it stands as a key reference to guide policies and to inspire coordinated actions for the maintenance of coastal and marine ecosystems, framed within a wetscape perspective in which mangroves play a crucial role.

Wetlands International Brazil/Mupan's mission is to promote the sustainable management of wetland ecosystems and the well-being of the communities that depend on them. In this context, the present work reinforces our commitment to coastal and marine conservation, highlighting the role of technical and scientific knowledge and collaboration among institutions, communities, and governments in building integrated solutions to the country's environmental challenges.

We hope this report contributes to strengthening the recognition of the ecological, economic, and social value of mangroves and helps expand effective actions for their conservation across Brazil.

Rafaela Danielli Nicola

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Technical-scientific Director of Mupan - Women in Action in the Pantanal

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CONTENT

LEAD

1.STATUS OF MANGROVES IN BRAZIL

The mangrove forest is discontinuos along approximately 90% of the Brazilian coast, extending from far northern region of Amapá State (Oiapoque, 04°26'N) to Santa Catarina State (Laguna, 28°30'S). This range reaches the southernmost latitudinal limit of mangrove forest distribution in the Western South Atlantic. Taking to account the large extension of Brazil's coastline and the structural responses of mangrove ecosystem to diverse coastal physiographies, oceanographic condition, geomorphological and climatic/meteorological features, Schaeffer-Novelli et al. (1990) proposed the division of Brazilian mangroves into eight distinct segments. Given that Brazil possesses the second-largest mangrove area in the world, its mangroves hold significant global relevance in terms of blue carbon sequestration and storage. Aboveground biomass in Brazilian mangroves accounts for approximately 7.3% of the global carbon stock in mangrove vegetation, while soil organic carbon contributes about 6.5% to the global mangrove soil carbon stock.

2. ECOSYSTEM SERVICES AND MANGROVE

Mangrove ecosystems are linked to numerous ecosystem services, delivering multiple benefits that enhance their potential impact on improving the quality of life in coastal communities. Their relevance is particularly evident in terms of biodiversity conservation, the sustainability of small-scale fisheries, and community-based tourism across various regions of the country.

3. THREATS AND PRIORITIES FOR MANGROVE CONSERVATION IN BRAZIL

In recent years, there has been a noticeable trend of mangrove forest decline along the Brazilian coastline. Brazilian mangroves have decreased in area by approximately 2%, equivalent to around 110 km², over the past two decades. The IUCN Red List of Ecosystems provides key insights into the structural and functional attributes of ecosystems across three distinct biogeographic regions. **North Brazil Shelf:** Despite extensive mangrove coverage in this region, the degree of disturbance remains relatively low. Nevertheless, expanding road networks, overfishing, and the conversion of mangrove areas into agricultural and aquaculture zones present ongoing threats. Oil spills pose a serious hazard to mangrove ecosystems; yet, pressure for further oil and gas development—particularly in the Equatorial Margin—continues to rise. **Tropical Southwestern Atlantic:** This region faces multiple drivers of mangrove degradation and loss, including shrimp farming, unsustainable resource exploitation, and pollution from domestic, industrial, and agricultural sources. Two major events exacerbated environmental challenges here: the Fundão dam disaster in 2015 and an extensive oil spill off the Northeastern coast in late August 2019. **Warm Temperate Southwestern Atlantic:** It encompasses Brazil's most densely populated coastal zones, with several cities exceeding seven million residents. Local communities contend with numerous socio-environmental conflicts, including wind energy development, real estate speculation, neglect of civil and political rights, violations of economic, social, cultural and environmental rights, privatization of land and territories, and the impacts of tourism infrastructure.

4. CONSERVATION AND SUSTAINABLE MANAGEMENT OF BRAZIL'S MANGROVE ECOSYSTEMS

Disorderly coastal land occupation driven by real estate speculation, along with environmental degradation and biodiversity loss, are key barriers to effective conservation and integrated coastal zone management. These challenges pose significant threats to equitable and inclusive livelihoods for local communities, particularly in light of the lack of consolidated fisheries statistics, which hampers the development of effective public policies. Ecological restoration of mangrove forests emerges as a potential solution—provided it goes beyond mere seedling planting and aims to reestablish altered hydrological and topographic conditions. Active community engagement is essential.

5. NATIONAL POLICY CONTEXT AND LEGAL FRAMEWORK

Brazil's environmental legislation safeguards mangrove ecosystems through various legal instruments, notably the 1988 Federal Constitution, which designates them as 'national heritage,' and Federal Law No. 11,428/2006, which classifies mangroves as permanent preservation areas (APPs) throughout their extent. Given that approximately 90% of Brazilian mangroves are located within Conservation Units, Federal Law No. 9,985/2000—establishing the National System of Nature Conservation Units (SNUC)—is also of significant relevance, despite ongoing challenges related to the management and enforcement of protections in these areas. Additionally, it is worth highlighting the National Program for the Conservation and Sustainable Use of Brazil's Mangroves (ProManguezal), launched in 2024.

6. MAPPING KEY STAKEHOLDERS AND THEIR ROLE

Numerous universities, non-governmental organizations (NGOs), and community associations are actively engaged in the conservation of Brazil's mangrove ecosystems, focusing on community mobilization, biodiversity preservation, environmental education, ecological restoration, community-based tourism, and scientific research. In addition, many quilombola, Indigenous, and fishing communities continue to defend their territories, although they often remain marginalized and lack institutional support. This underscores Brazil's significant potential to secure funding for mangrove conservation initiatives.

1

STATUS OF MANGROVES IN BRAZIL

1.STATUS OF MANGROVES IN BRAZIL

1.1 MANGROVE ECOSYSTEMS VARIABILITY ALONG THE BRAZILIAN COASTLINE

In Portuguese the word "mangue" is used to underline a floristically diverse group of tropical trees that, although belonging to botanical families that present no taxonomic association to each other, share similar physiological features. The word "manguezal" or "mangal" describes forest communities or the ecosystem, where plant, animal and microorganism populations interact by occupying the mangrove area and its physical (abiotic) environment. Soffiati -Netto (1996) suggested that the Portuguese word "*mangue*" possibly derives from the word "*mangle*" of Caribbean or Arawak origin (indigenous peoples from Northern South America), in his book, "A human vision of Brazilian mangroves through the ages".

The mangrove forest is not continuous along the Brazilian coast, and it goes from far Northern Amapá State (Oiapoque, 04°26'N) to Santa Catarina State (Laguna, 28°30'S). It meets the Southern latitudinal limit of mangrove forests distribution in the Western South Atlantic (CINTRÓN-MOLERO and SCHAEFFER-NOVELLI, 1981; SCHAEFFER-NOVELLI, et al. 1990; SOARES et al, 2012). The mangrove species in Brazil, namely, are *Avicennia germinans* (L.) Stearn, *Avicennia schaueriana Stapf* & Leechm., *Laguncularia racemosa* (L.) Gaertn. f., *Rhizophora harrisonii Leechman*, *Rhizophora mangle L*., and *Rhizophora racemosa* G. F. Mayer.

In Brazil, the northern limit of the distribution of mangrove species is in Amapá State, and the southern boundary varies according to the species. From the northernmost portion of Brazil, Rhizophora harrisonii and *R. racemosa* occur until Maranhão State, and Avicennia germinans occurs until Rio de Janeiro State. The state of Santa Catarina is the southern limit of occurrence of *A. schaueriana, L. racemosa*, and *R. mangle* (BERNINI et al. 2023).

According to Schaeffer-Novelli et al. (2000), mangrove forests are widely distributed along approximately 90% of the Brazilian coast, and it is often limited to sheltered intertidal environments, mudflats, mainly to larger coastal indentations, such as bays, estuaries and protected by coastal barriers or barrier islands, and to coastal lagoons subjected to frequent tidal flooding and saline intrusions. Mangrove forests are discontinuously found along the coast from 04° 26' 12" N, in Amapá State, on the Amazonian Equatorial Coast, to its latitudinal limit at 28° 30'S in Laguna, Santa Catarina State (VALE et al., 2023).

This large latitudinal amplitude allows mangroves to find several favorable environments to be colonized where they can develop and persist. The coast of Rio Grande do Sul State, where unfavorable climatic factors interact with physiography factors to create oligohaline environments that inhibit and prevent mangrove forests' establishment (CINTRÓN-MOLERO; SCHAEFFER-NOVELLI, 2019). Schaeffer-Novelli et al. (1990) proposed 8 segments related to analyses of the ecosystem's structural responses regarding Brazilian mangroves (Figure 1).

Segment I:

From Cabo Orange (04°30'N) to Cabo Norte (01°40'N). Humid climate with mean rainfall of 3.250 mm. Large tidal ranges and high river flows seem to compensate the dry season, which lasts from July to December. Potential evapotranspiration close to 1.300 mm/year.

Segment II:

From Cabo Norte (01°40'N) to Ponta Curuçá (00°36'S). Humid climate with mean rainfall of 2.900 mm/year. The dry season lasts approximately 4 months. Estimated potential evapotranspiration is 1.600 mm.

Segment III:

From Ponta Curuçá (00°36'S) to Ponta Mangues Secos (02°15'S). Humid climate with rainfall ranging from 2.000 to 2.500 mm/year. The dry season can last from 1 to 6 months. Potential evapotranspiration ranging from 1.400 to 1.500 mm/year.

Segment IV:

From Ponta Mangues Secos (02°15'S) to Cabo Calcanhar (05°08'S). Dry climate with a long and prevalent dry season. Mean yearly rainfall of 1.250 mm, which is lower than the potential evapotranspiration (1.500-1.600 mm).

Segment V:

From Cabo Heel (05°08'S) to Recôncavo Baiano (13°00'S). Dry climate with well-defined seasonality. Yearly rainfall ranging from 1.100 to 1.500 mm, which is equals to, or lower than, the estimated evapotranspiration (1.400 mm). The dry season lasts from 3 to 6 months.

Segment VI:

From Recôncavo Baiano (13°00'S) to Cabo Frio (23°00'S). Mean yearly rainfall of 1.200 mm/year, which is similar to the potential evapotranspiration value (1.180 mm/year), there is no dry season. Higher rainfall in summer, and it decreases towards the stretch's Southern limit. Cabo Frio is close to the cold upwelling waters and it gives rise to strong winds, which contributes to the region's dry climate.

Segment VII:

From Cabo Frio (23°00'S) to Torres (29°20'S). Rainfall increases from 1.090 mm/year in Rio de Janeiro to 1.400 mm/year in Torres, and moves Southwards. Higher rainfall amounts are observed close to Serra do Mar, towards the coastline. Potential evapotranspiration is close to 1.000 mm/year. There is excess water availability throughout the segment.

Segment VIII:

From Torres (29°20'S) to Chuí (33°35'S). This coastal segment exclusively comprises exposed straight beaches and low dune systems in front of a broad sandy Quaternary coastal plain. Mean yearly temperature is <20°C; mean yearly thermal amplitude is >10°C. Rainfall (1.500 mm.year-1) is higher than evapotranspiration (1.000 mm.year-1). The mean tidal amplitude is 0.22 m; spring tide amplitude is 0.24 m.

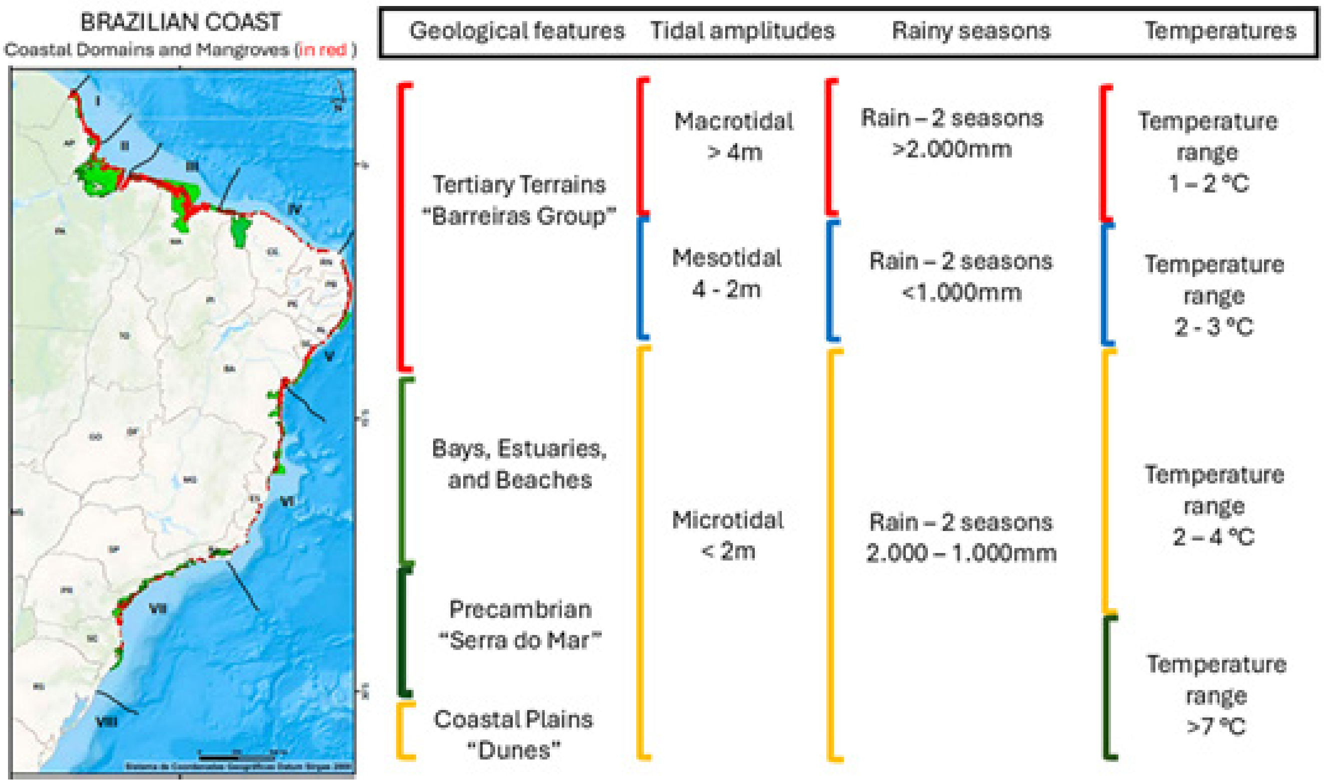

Figure 1 - The eight segments in the Brazilian coast (Schaeffer-Novelli et al., 1990), based on the presence of mangrove ecosystems from segments I to VII.

Mangrove's structural characteristics along the Brazilian coastline reflects the environment physiography (Schaeffer-Novelli et al., 1990). Similarly, mangroves are supported by oceanographic patterns and oceanic processes described by Sherman et al. (1990).

Figure 2 shows the Brazilian coast and its Territorial Sea boundaries, the continental shelf break and the Exclusive Economic Zone. The boundaries are also represented by the Large Marine Ecosystems (LME) classification and to the coastal segments (SCHAEFFER-NOVELLI et al, 2000).

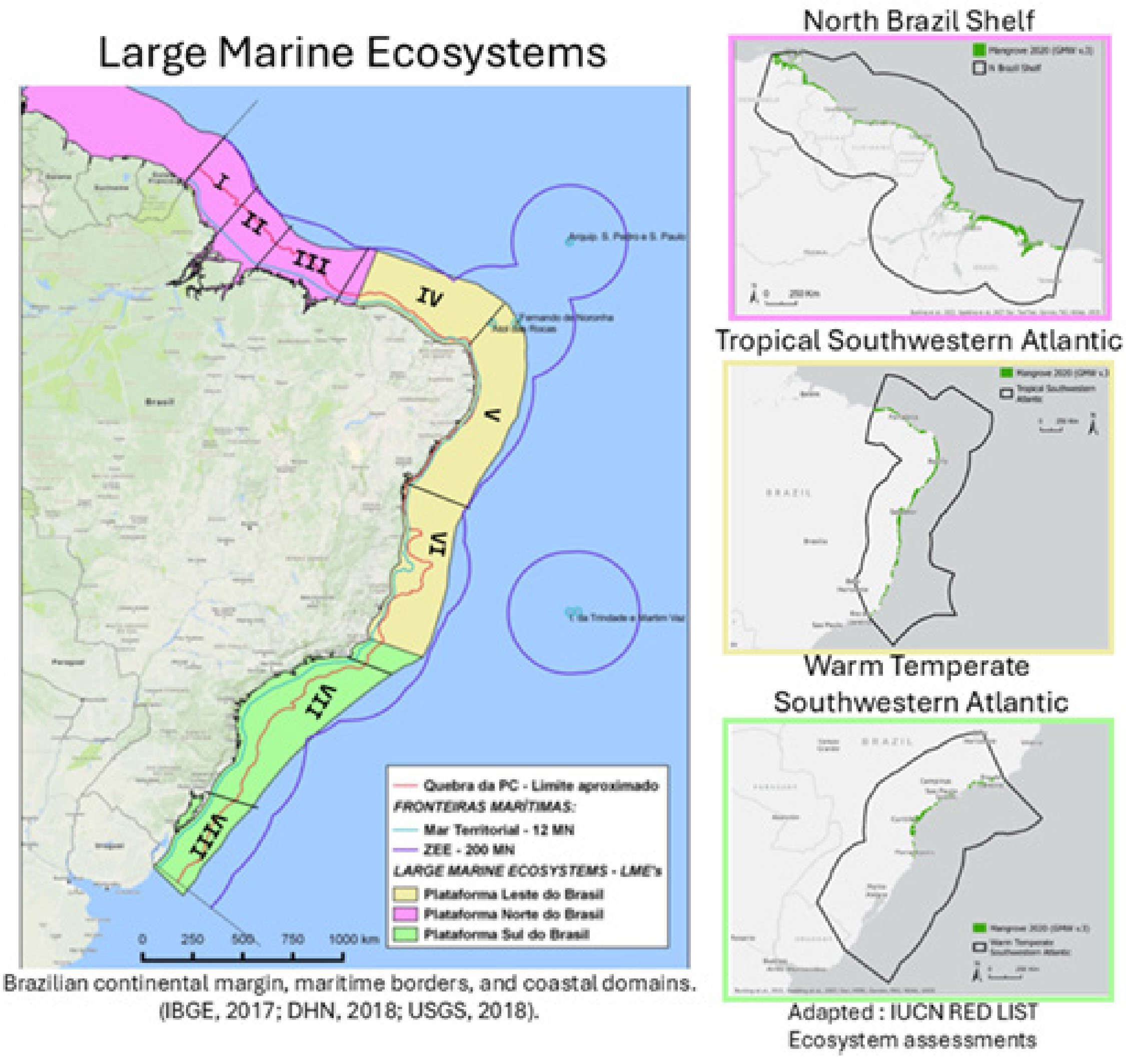

Figure 2 – The blue line draws the Brazilian Territorial Sea boundaries; continental shelf break is in red and the Exclusive Economic Zone is in purple. The three LMEs covering the Brazilian coast were to the right and they were presented as Marine Provinces of the World (MEOW) by the IUCN Red List Ecosystem report. The Northern Brazil Shelf is highlighted in pink (adapted from Fernandes et al., 2025), Tropical Southwestern Atlantic is in yellow (adapted from Ximenes et al. 2024 a) and Warm Temperate Southwestern Atlantic is highlighted in green (adapted from Ximenes et al. 2025).

Mangroves reflects the environmental conditions of the almost 7.000 km of the Brazilian coastline from Amapá to Santa Catarina, which presents distinct coastline physiography, oceanographic, geomorphological and climatic/meteorological features. The Northern coastline stands out for its large tidal range, means annual high rainfall and low thermal amplitude; whereas the Southern one accounts for smaller tidal range, mean annual lower rainfall and higher thermal amplitude.

1.1.1. Functional aspects of Brazilian mangroves

According to the Atlas of the Brazilian Mangroves (ICMBIO, 2018), the Northern region is the home to more than 80% of Brazilian mangroves, besides accounting for significant aboveground-biomass values (Figure 3). Brazilian mangroves also stand out in comparison to other biomes (ROVAI, et al, 2022) (Figure 4).

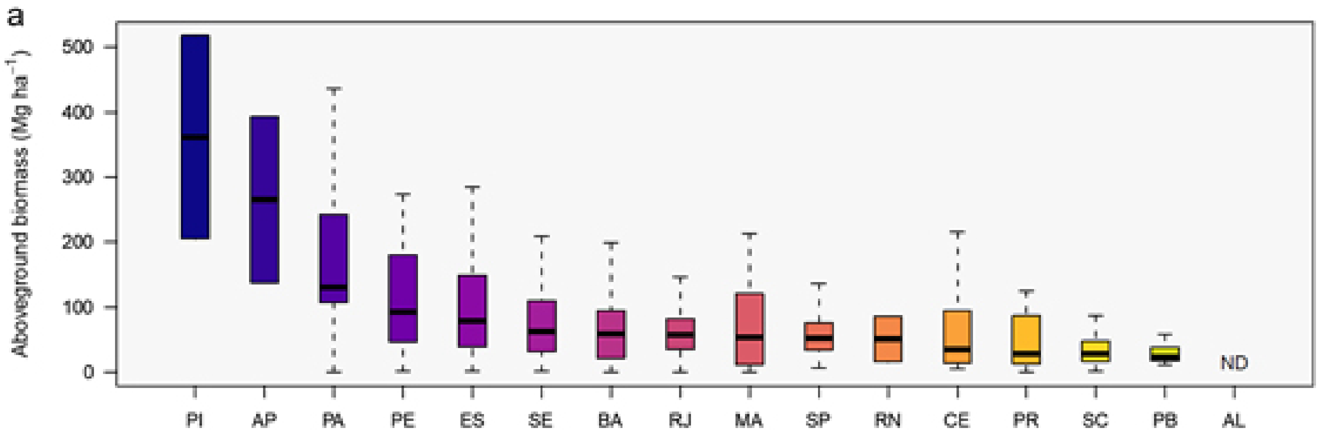

Figure 3 - Aboveground Biomass Estimate (Mg.ha-1) per Brazilian state (ROVAI et al 2022).

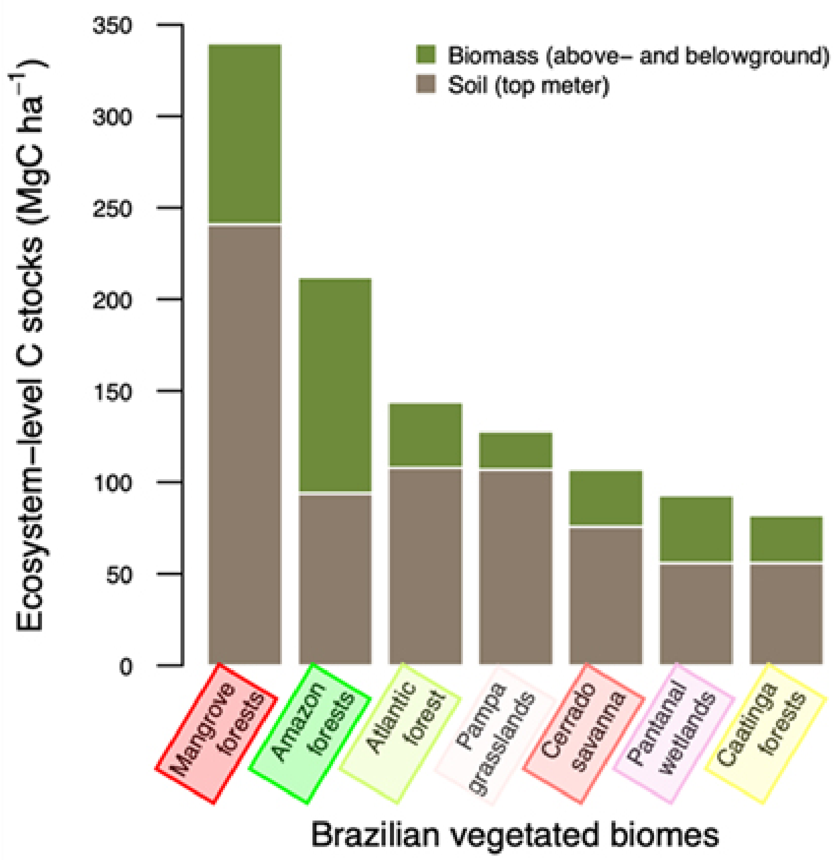

Figure 4 – Estimates of carbon stock (Mg.ha-1) in Brazilian biomes' aboveground and soil biomass (ROVAI et al 2022).

Taking to account the large extension of Brazil's coastline, and the fact that it has the second largest mangrove area in the world, it is possible stating that Brazilian mangroves have outstanding global importance when it comes to blue carbon sequestration and storage (CINTRÓN-MOLERO et al., 2023).

Aboveground biomass values recorded for Brazilian mangroves range from 25.3 to 284.8 $Mg.ha^{-1}$ (95.8 $Mg.ha^{-1}$, on average), and it corresponds to 7.3% of the global carbon stock in mangrove aboveground biomass (ROVAI et al. 2016).

Brazilian mangroves' net primary production (litterfall production) ranges from 3.79 to 16.97 $Mg.ha^{-1}.year^{-1}$ (10.92 $Mg.ha^{-1}.year^{-1}$, on average). This total corresponds to estimated yearly rate of carbon removal from the atmosphere of 4 Tg of Carbon or of 30% of the Neotropical region's litterfall production (RIBEIRO et al. 2019).

Organic carbon stock in the soil ranges from 72.1 to 388.3 $MgC.ha^{-1}$ (240.4 $MgC.ha^{-1}$, on average), and it corresponds to 6.5% of its global stock (ROVAI et al. 2018).

According to the modeling carried out by Rovai et al. (2016), high tidal ranges, high mean annual temperatures, abundant rainfall and low evapotranspiration potential contribute to achieving high biomass values in mangroves, at latitudinal scales. These parameters have significant influence on the amount of biomass found in mangrove forests, although they vary along the Brazilian coast. Consequently, mangroves located in different coastal segments (Segments I-VII) also present varying carbon storage values for aerial and soil biomass, and for their carbon sequestration from the atmosphere (CINTRÓN-MOLERO et al., 2023).

Thus, higher aerial biomass values are predicted for mangroves located at low latitudes influenced by macrotidal tides and inserted in deltaic environments (Segments I–III). Lower aerial biomass values are found in mangroves located in environments dominated by tides or waves, or on arid coasts, as Southern latitudes increase (Segments IV and VII). The lowest soil organic carbon values are estimated for mangroves located in deltaic and macrotidal environments (Segments I–III) and in arid environments (Segment IV), whereas higher soil organic carbon values are estimated for coastlines dominated by tides and waves (Segments V–VII). Finally, lower litterfall production, which is indicative of carbon sequestration from the atmosphere, was predicted for mangroves subjected to both lower winter temperatures and reduced tidal range (Segment VII), as well as to lower yearly rainfall and river discharge (Segment IV). (CINTRÓN-MOLERO et al., 2023).

Brazil has a vast coastline with physiographic, ecological, climatic, oceanographic, socioeconomic and cultural/religious differences. The next level of analysis applied to this ecosystem was achieved after featuring the coastal physiography, and coastal-oceanic patterns and processes linked to mangroves' structure and function. Those are the large wetland landscapes (JUNK, NUNES DA CUNHA, 2024) that acts as part of the wetland environment itself, the focus of concern for management and public policy propositions when looking for sustainable bio-socioeconomic purposes.

1.2. BRAZIL: COASTAL-MARINE SYSTEM

1.2.1 Large Coastal Wetscapes

Large coastal wetlands, also called "coastal wetlands" or "wetscapes", are ecosystems or groups of well-connected macrohabitats (JUNK, NUNES DA CUNHA, 2024) characteristic of specific coastal segments at the interface between terrestrial ecosystems, and tropical and temperate coastal marine waters subjected to predictable long-term pulses. These wetscapes are of paramount importance at the time to address climate, biodiversity and water availability crises (JUNK, NUNES DA CUNHA, 2024). These environments are true biodiversity hotspots, besides being highly efficient carbon sinks, since they fix and store atmospheric CO_2, and are powerful to reduce greenhouse gas emissions in the atmosphere.

The interaction between large wetland landscapes and coastal wetlands along the Brazilian coast are essential for landscapes' ecology, biodiversity and for the socioeconomic aspects of associated communities (SCHAEFFER-NOVELLI et al., 2024). These wetscapes can be used characterize each of them by their volume of river discharges, by they coastal complexes as bays, estuaries, barrier islands and other ecosystems, such as the Amazon River Estuary and its Mangroves/AM, São Marcos and São José bays /MA, the São Francisco River AL/SE, Todos os Santos Bay/BA, Paranaguá Bay/PR and Patos Lagoon /RS (SCHAEFFER-NOVELLI et al 2024b).

Brazilian coastal Wetlands (WLs) stand out in the Coastal-Marine System for their interrelations, since they meet different profiles, physical and biotic features, and processes that make them special "life houses" in each portion of the Brazilian coast.

1.2.2 Climate and its influence on Brazilian mangroves' latitudinal occurrence

Temperature is a key factor influencing the spatial configuration of mangroves along their entire range, including apicum zones (also known as bar flats or salt flats).Typical mangrove plant species are mostly tropical and they do not tolerate frost. Laguna (28°30'S), which is the Southern border of mangroves bathed by the Southern Atlantic Ocean, is located in an estuary found less than 100 km North from Patos-Mirim Lagoon System (PMLS), which is a hydrological complex that extends itself along the coast, from 30°30'S to Chuí (33°45'S), on the Brazilian border with Uruguay. Assumingly, climate change could increase temperatures and favor mangroves' expansion to Southern areas, as well as their invasion in salt marshes (CINTRÓN-MOLERO; SCHAEFFER-NOVELLI, 2019).

The presence of a northward-flowing longshore current in Brazil has been seen as critical factor limiting southward dispersal into what appears to be a suitable barrier lagoon habitat. Assumingly, the combination of interacting factors limits mangrove ecosystems' southward expansion (CINTRÓN-MOLERO; SCHAEFFER-NOVELLI, 2019) (Figure 5).

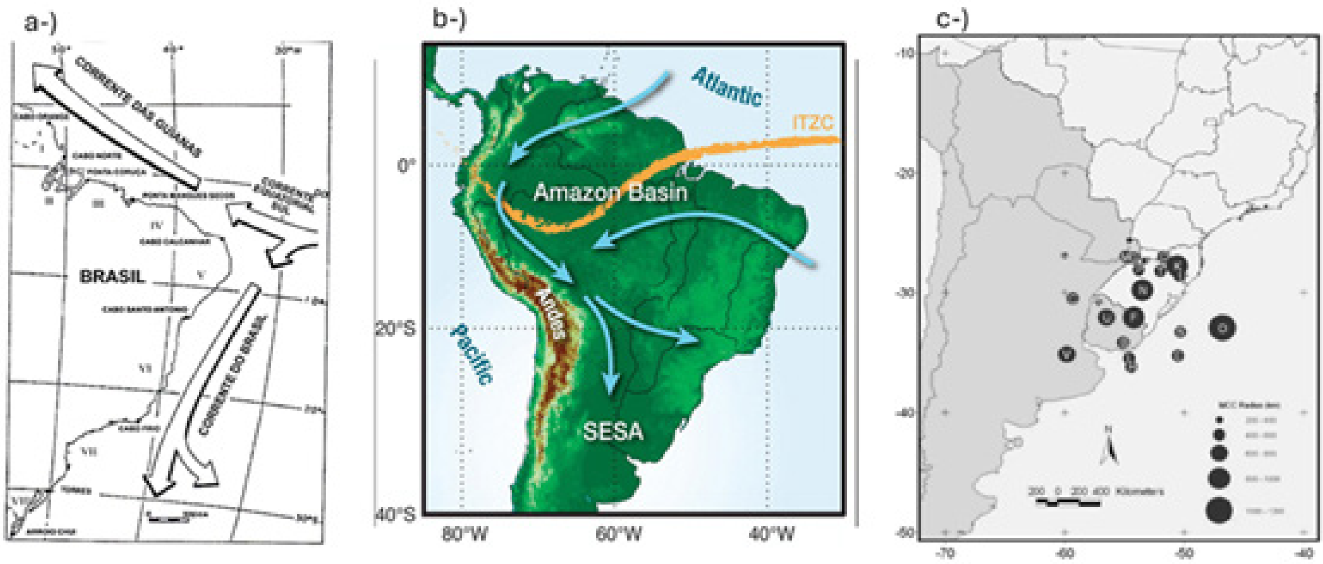

Figure 5 – (a-) Image of marine currents acting in the Brazilian coast. (b-) main features of the South American Monsoon System (SAM) and of the Southeast South America (SESA). (c-) Geometric centers' location of MCCs affecting Rio Grande do Sul State, from October to December 2003. MCCs = Mesoscale Convective Complex Events

The flying rivers highlighted in Figure 5 by blue arrows as the main moisture transport pathways play key role in regulating the extension and development of coastal systems such as mangroves and salt marshes, near their Southern border along the Brazilian Coast. This is one of the most distinctive features of the South American hydrology (CINTRÓN-MOLERO; SCHAEFFER-NOVELLI, 2019).

2

MANGROVES' RELEVANCE FOR NATURE, LOCAL COMMUNITIES AND FOR THE BRAZILIAN ECONOMY

2. MANGROVES' RELEVANCE FOR NATURE, LOCAL COMMUNITIES AND FOR THE BRAZILIAN ECONOMY

2.1 ECOSYSTEM SERVICES AND MANGROVE

Mangroves are important to both provide ecosystem services and support livelihoods, worldwide. Modeling studies have estimated yearly abundance of over 700 billion juvenile fish and invertebrates living in mangroves. Although early life phases do not represent economic or biomass gains, results often point out the importance of conserving mangroves to support fish stocks and fishery. This process further strengthens their defenses, besides improving their conservation and restoration (ZU ERMGASSEN et al., 2025).

Mangroves, throughout their extension, provide valuable ecosystem services to society. These services are distributed into the four categories established by Millennium Ecosystem Assessment (MEA, 2003). Almeida and Coelho-Jr (2018) highlighted the following services:

Provision – food production, raw-material supply, genetic resources/gene bank, biochemical compounds;

Regulation – climate and microclimate, water, erosion control and sediment retention, atmospheric particles' retention, biological control, CO2 fixation/removal from the atmosphere, pollination, infiltration and storm-water runoff, aquifer recharge, disease proliferation prevention, geotechnical stability (natural disaster prevention), wind protection, barrier to tide advance/coastline stability, dune fixation;

Support – water supply, soil formation, nutrient cycling, seed dispersal, landscape connectivity, biodiversity maintenance, biomass export;

Cultural – recreation, ecotourism, educational value, spiritual and religious values, scenic beauty and landscape conservation.

Many of the herein provided ecosystem services can be more relevant than others, depending on the analysis context. Fishing and tourism, for example, are easily understood by most of the population, and they account for new job positions and income along the whole Brazilian coast. Biological filtering, sediment retention and flood control ecosystem services also stand out for their importance in urban mangroves. Finally, cultural ecosystem services related to mangrove traditions, such as that in the Cananéia-Iguape-Paranaguá Estuarine-Lagoon Complex, in Todos os Santos Bay and in many other traditional communities spread along the coast of Pará and Maranhão states (ALMEIDA; COELHO-JR, 2018).

According to FAO (2020), the mean production of extractive fishing in Brazilian coastal and marine regions, between 2010 and 2019, remained close to 524 thousand tons/year. Unfortunately, these data have not been updated; therefore, it is an element of concern for both fishery management and guidelines that suggest lack of sustainability (BPBES, 2024). Furthermore, fishery production focuses artisanal fishing, mainly in Northern and Northeastern Brazil. Based on previous estimates, there are approximately 1 million fishermen on the Brazilian coast, and almost 65% of them live in five states, namely: Pará (24.3%), Maranhão (16.8%), Bahia (12.1%), Amazonas (8.1%) and Santa Catarina (3.4%). Except for Santa Catarina, the other states shelter huge mangrove areas (Table 1). (DIAS-NETO; DIAS, 2015).

Table 1 – Mangrove area per state and coverage rate. Source: Ministry of Environment (MMA, 2018) (MMA, 2028)

COASTAL STATES	AREA (KM²)	MANGROVE PER STATE (%)
AMAPÁ	2268,95	16.22
PARA	3905,89	27.92
MARANHÃO	5054,90	36.13
PIAUÍ	55,50	0.40
CEARÁ	195,18	1.40
RIO GRANDE DO NORTE	135,35	0.97
PARAÍBA	125,65	0.90
PERNAMBUCO	171,72	1.23
ALAGOAS	55,35	0.40
SERGIPE	265,44	1.90
BAHIA	899,32	6.43
ESPÍRITO SANTO	79,72	0.57
RIO DE JANEIRO	137,80	0.99
SÃO PAULO	222,87	1.59
PARANÁ	311,99	2.23
SANTA CATARINA	104,01	0.74
RIO GRANDE DO SUL	-	-

Traditional communities are the main actors in Sustainable Use Conservation Units in Brazil, mainly on the Northern coast. Federal CUs' management in Brazil is carried out by Chico Mendes Institute for Biodiversity Conservation (ICMBio). However, coastal biodiversity management by coastal communities refers to the coordinated stewardship and sustainable use of sociobiodiversity resources at the community level, carried out by various sociocultural groups that comprise Indigenous Peoples and Traditional Communities. These groups identify themselves as indigenous, quilombolas, people of 'terreiros', caiçaras, marine extractors, islanders and artisanal fishermen who stand out in the marine-coastal zone among collective identities recognized by Decree 8.750/16, which established the National Council of Traditional Peoples and Communities (CNPCT) (BEBPES, 2025). Although mangroves are fishing territories given their role in maintaining coastal-marine biodiversity, it still need specific regulations to this activity. Estimates show that 70% to 80% of economically important species use mangrove ecosystems at least once in their life cycle.

It is worth noticing that global economic ecosystem services' assessments mostly see mangroves as subset of other coastal ecosystems. This strategy seems to be misguided, mainly in large-scale studies, due to the risk for overlapping several other ecosystem types and for likely leading to double counting (QUEIROZ et al., 2023).

Furthermore, methods and tools adopted to value ecosystem services often adopt material criteria unsuitable for symbolic and cultural values. Artisanal fishermen communities can provide higher value to mangroves due to the creation and maintenance of social relationships, personal satisfaction and even to physical and mental relaxation, mainly at local contexts. Therefore, this sociocultural dimension should also be taken into consideration by decision-makers aimed at addressing the challenges faced by mangrove conservation projects (QUEIROZ et al., 2017).

2.1.1 CRAB'S PRODUCTIVE CHAIN

Mangrove crab catching is one of the most notable uses of this ecosystem. Crab *Ucides cordatus* (mangrove crab) is perhaps the most important and emblematic representative of the mangrove fauna in Brazil. Its importance is depicted in the coat of arms of some municipalities (Figures 6 and 7).

Figures 6 and 7 - Coat of Arms of Marcação (Piauí) and São Caetano de Odivelas (Pará).

Protection is crucial to ecosystem's functioning and for the subsistence of traditional communities. Overall, "command-control" regulations have been adopted to set the "closed season", to prohibit the capturing, transport and sales during the reproductive migration period of crabs (commonly referred to as the "andada" period), when crustaceans move through the mangroves in search of mating and to lay their eggs.

Andada period is not uniform along the Brazilian coast, so local/regional environmental agencies talk and share knowledge with crab gatherers in order to better define the closed seasons.

According to economic aspects, crab extractivism is encouraged by easy access to mangroves, predictability, low capture costs, good market acceptance, production autonomy and by lack of economic alternatives (GLASSER, DIELE, 2004). Despite pilot studies focused on crab gathering industrialization, "crab legs" and "crab meat" remain as the most prominent products (ASSAD et al., 2014). The transportation of live crabs to large consumer markets results in significant mortality, with estimated losses ranging from 40% to 60% throughout the supply chain (MOTA, 2007). Delta do Parnaíba and RESEX, in Maranhão and Pará States, respectively, are the main crustacean capture points, but the captured animals are sold in very distant consumer markets.


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2.1.2 COMMUNITY-BASED TOURISM

Community-Based Tourism (CBT) is the tourism organization form whose specific cultural and socio-environmental experiences are prevailing. It is associated with generating complementary financial income, and is seen as resistance to pressure on cultural territories. Also known by its acronym CBT (TBC, in Portuguese), this distinguish kind of tourism is organized for, and by, indigenous peoples and traditional communities. It demands several local involvement levels in its planning and management (BPBES, 2024).

CBT emerged in Latin America back in the 1980s. It is associated with "community rural tourism" and with incentives by the Inter-American Development Bank. CBT aims to meet the international demand of tourists concerned with preserving the environment and communities' diversity. Brazil has experienced the heterogeneity of CBT initiatives, and it impaired the process to come up with a widely accepted definition of it. In any case, endogenous features and autonomous tourism management (self-management) prevail as attempt to diversify local production systems managed by communities themselves (SANSOLO; BURSZTYN, 2009; MALDONADO, 2009).

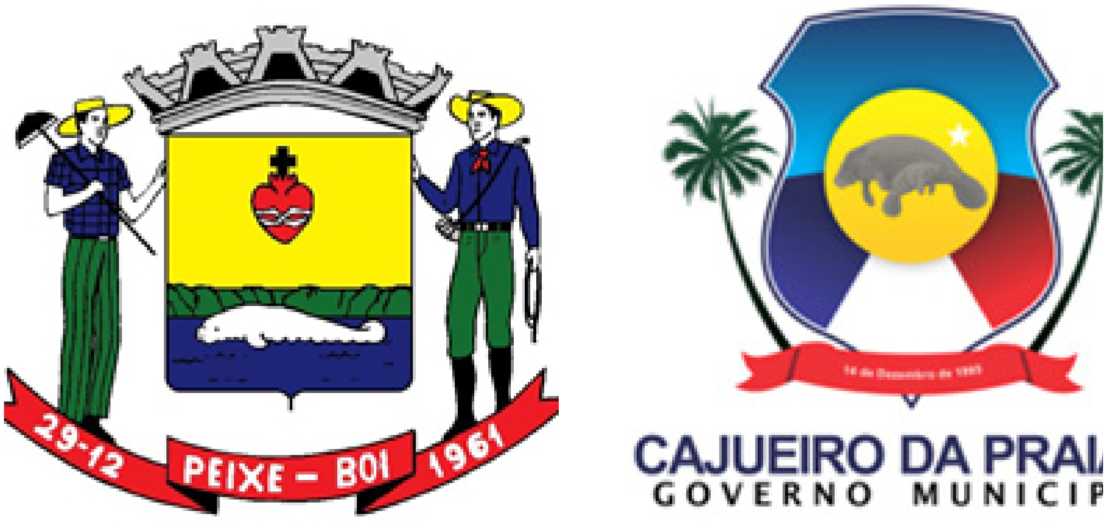
An important bibliometric review has shown theoretical gaps yet to be explored at CBT research scope, mainly in the governance, participation, trading, promotion, outspread and marketing dimensions (GRACIANO; HOLANDA, 2020). These authors state that the CBT knowledge remains on its initial growth stage, and it only counts on few experts. Furthermore, the analyzed studies were limited to report the existing obstacles for CBT management due to internal community conflicts and to distrust with external agents. Despite pointing towards good governance as a possible solution to these obstacles, there are no methodological proposals for them.

Community-based tourism is featured by collective management, transparency in resources' use and allocation, and by the leading role of the involved communities. Local ways of life and culture also become some of the main incentives for tourism activity promotion (BPBES, 2024).

Unfortunately, there is no official record of many fishermen, shellfish gatherers, quilombolas and indigenous people groups that have turned the community-based tourism into their main activity or into activity to complete their family income. The federal government created a platform in 2022 to house these initiatives, but, unfortunately, it has not been updated. Only 4 out of the universe of 62 registers are related to some activity developed in mangroves (MINISTRY OF TOURISM, 2022). Network and cooperatives' structuring has already been tested along the Brazilian coast, but it showed short-lived viability. Sometimes, networks make communities dependent and reduce their internal autonomy.

Fortunately, there are successful examples of traditional coastal communities seeking to achieve sustainable tourism and local culture appreciation, such as the Tucum Network, in Ceará State. This network has also given visibility to social struggles for land and territorial rights. The Tucum Network brings together at least 11 experiences in 9 municipalities along its coastal stretch. Some of them are located inside protected areas for sustainable use, such as Prainha do Canto Verde Extractive Reserve.

There are also good isolated experiences in Saco do Mamanguá (Parati-Rio de Janeiro), Cananéia (São Paulo) and Porto de Pedras (Alagoas). The community in Porto de Pedras has organized itself to promote CBT by involving boat drivers and artisans in it, by offering raft trips to observe the 'manatee' and its habitat in Tatuamunha River. This species has been highlighted in the coat of arms of some municipalities given its importance (Figures 8 and 9). Furthermore, tourism aimed at observing some fauna species associated with the mangrove ecosystem has widespread, such as the case of observing gray dolphins, seahorses, scarlet ibises, migratory birds, among others. Many of these species are conservation flagship species.

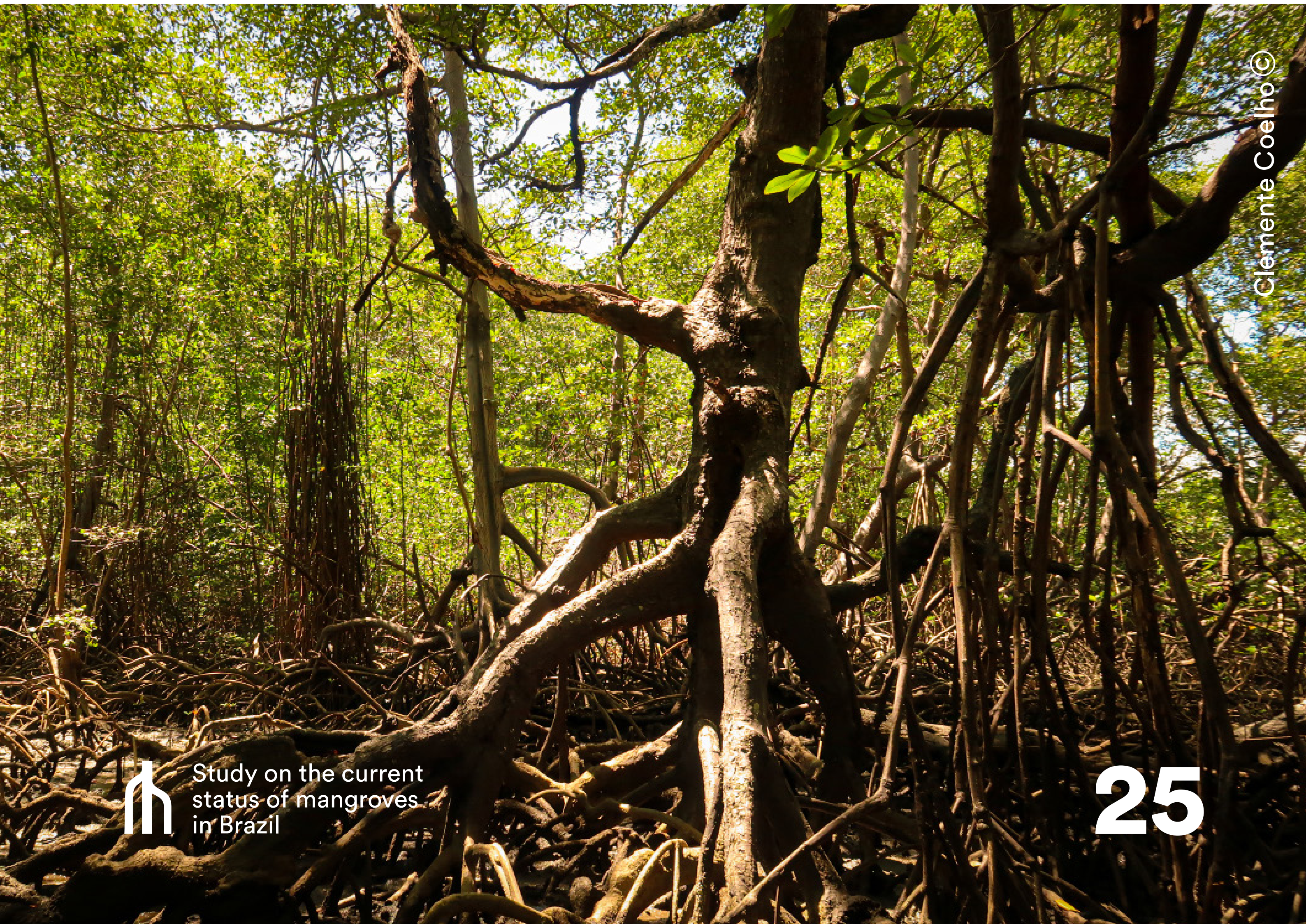


Figures 6 and 7 - Coat of Arms of Marcação (Piauí) and São Caetano de Odivelas (Pará).

2.1.3 OTHER ECOSYSTEM SERVICES

It is also urgent highlighting mangrove ecosystem services and port activities, which are so emblematic of the Brazilian economy, and influences directly mangroves. A systematic review carried out in the last 20 years showed the prevalence of studies focused on regulatory services, such as nutrient cycling, carbon sequestration, storm protection and coastline stabilization. These studies were followed by those aimed at provision and support services (RIBEIRO et al., 2024). It turns out that port dredging, including access routes' deepening, recovery and improvement, still demands efficient environmental management of dredged materials. It takes into account the monitoring of biotic and abiotic elements, treatments and other coastal zone socioeconomic factors, as well as all its use and occupation dynamics (CASTRO; ALMEIDA, 2012). These port activities' synergistic effects end up compromising many ecosystem services, mainly fishing, tourism and leisure activities, which echo on cultural aspects. Thus, conflicts have been multiplying in the main Brazilian ports (CASTRO ALMEIDA, 2012). Therefore, mangroves' conservation favors environmental management in port areas and the effective sharing of ecosystem services and other benefits.

Urban mangroves provide important benefits to society. The most notable of them lies on their ability to filter and incorporate some nutrients from domestic waste into plant biomass.



3 THREATS AND PRIORITIES FOR MANGROVE CONSERVATION IN BRAZIL

3. THREATS AND PRIORITIES FOR MANGROVE CONSERVATION IN BRAZIL

3.1 THREATS TO MANGROVES

There has been a trend towards mangrove forest areas' decrease on the Brazilian coast in recent years. According to data from the Global Mangrove Watch (GMW) collection v 3.0, there was decrease by 59.85 km² in these areas between 1996 and 2020 (BUNTING et al., 2022). MapBiomas (DINIZ et al., 2019) has shown that Brazilian mangroves have reduced their area by approximately 2% (approx. 110 km²) in the last 20 years (2001-2021). These changes in mangroves' vegetation cover on the Brazilian coast are related to natural transitions, most of all, to anthropogenic origin losses, with emphasis on urban and port infrastructure, fishing industry, changes in land use, agriculture and aquaculture/saliculture. Furthermore, a more detailed analysis allows observing that urban pollution, logging, oil spills, hydrological changes, sewage dumping, invasive species, tree cutting, overfishing and other threats to biodiversity affect mangroves and compromise their ecosystem services.

Climate change and other multiple negative anthropogenic impacts acting in ecosystems or even in large functional wetland units (wetland) have resulted in food and water insecurity, and on the loss of biodiversity, ecosystem services and human lives. Proactive mitigation and adaptation actions are needed to correct severe shortage of effective and efficient public policies focused on sustainable management. As society, actions must be inclusive; focus Indigenous Populations, Quilombolas and Traditional Communities; and, simultaneously, develop collaborative and reciprocal learning strategies for socio-biodiversity conservation.

During a long participatory process (September 2019 to February 2021), many stakeholders from society helped diagnosing the main socio-environmental challenges posed on the Brazilian coast during a long participatory process in order to develop the Coastal Zone Pedagogical Political Project (PPPZCM) in partnership with the Brazilian Navy. Results allowed systematizing 14 categories, with emphasis on "disorderly occupation and real estate speculation" and on "environmental degradation and biodiversity loss". A second block of categories highlighted "low effectiveness and/or lack of public policies and management", as well as "low sanitation scope". These four categories had similar weight in different Brazilian regions, except for the Northern region, which strongly highlighted "low effectiveness and/or lack of public policies and management" (RAYMUNDO et al., 2021). Since then, there has been time to reflect on and to highlight problems that were not noticeable at that time.

Mangroves are affected by impacts from more distant regions, whether by domestic or industrial waste discharges. It is known that Rio Doce Continental Shelf sediments are highly contaminated by arsenic; moderately contaminated by chromium, nickel, zinc and lead; and enriched with rare earth elements. It is so, because of the strong influence of material brought by Rio Doce after Fundão and Mariana Dams' collapse (CAGNIN, 2018). Therefore, fishing was prohibited and it led to numerous socio-environmental challenges because fishermen were removed from their work activity, which caused intergenerational issues and their breaking with their own cultural traditions, including their ties with the mangroves.

3.2 THE IUCN RED LIST ECOSYSTEM ASSESSMENT

In 2024 and 2025, IUCN carried out a global mangrove ecosystem assessment based on its Red List Ecosystems methodology. The aim of this assessment was to highlight and discuss mangrove conservation importance and the risks of this ecosystem's collapse given the threats of anthropogenic and environmental origin.

To assess and compare mangrove areas globally, the spatial framework of Marine Ecoregions and Provinces of the World (MEOW), as defined by Spalding et al. (2007), was adopted. It also aligns with the Large Marine Ecosystem framework proposed by Sherman et al., (1990). Which was further applied to mangroves ecosystems in Brasil by Schaeffer-Novelli et al. (1990). This spatial scale also encompasses the 'coastal wetland landscapes' outlined by JUNK & NUNES DA CUNHA, 2024. Ecoregions were defined to represent biogeographic patterns across the entire coastal marine biota, rather than just to mangrove systems.

Brazilian mangroves were analyzed based on the Global Mangrove Watch (GMW) dataset, which was used to outline this ecosystem's features in each of the three corresponding MEOWs, namely: Warm Temperate Southwestern Atlantic, Tropical Southwestern Atlantic and North Brazil Shelf. All of them were classified as "Least Concern", based on the proposed methodology. However, these studies' authors point out several threats that affect mangroves and their surroundings at regional and local level, in addition to predictions and pathways that point towards the mangrove ecosystem degradation in these regions.

3.2.1 NORTH BRAZIL SHELF - NBS

This MEOW presents small disturbance degree in mangrove areas, despite its large coverage. According to Hayashi et al. (2023), less than 1% of the total mangrove forest areas on the Amazonian coast has been converted to other uses. However, roadway system expansion is a risk, it influences land use and affects mangroves in this region. There are 2.024 km of paved highways in Pará and Maranhão states, whereas 17.490 km of unpaved roads make the access to mangroves easier. According to Hayashi et al. (2019), approximately 90% of the anthropogenic impact is felt within a 3 km radius around these roads and it affects the mangroves.

Overfishing and mangroves' conversion into agriculture and aquaculture areas are other threats to this province, since these practices are broadly adopted (ISAAC; FERRARI, 2017). Industrial activities, such as clay and salt mining (SENNA et al., 2002), lead to deforestation, besides producing waste; furthermore, proximity to growing urban centers is the origin for pollution. These activities threaten mangroves, as well as local communities that depend on them for financial income and food security (FREITAS et al., 2013).

Mendes et al. (2024) carried out a study in Caeté River estuary, Bragança City, Pará State, on the Brazilian Amazonian coast, and observed microplastic (MP) abundance in its internal (1.03 items/m^3) and external portions (0.82 items/m^3), which correspond to the most populated areas and to areas accounting for the highest fishing activity, respectively. Pollution by plastic and heavy metals is a significant threat to aquatic systems on the Amazonian coast. The high amounts of macro, meso, micro and nano plastic in the water is closely related to urban development and population growth.

Furthermore, oil extraction and exploration are common activities throughout the Province. However, oil spills pose severe threat on mangrove systems (SILVA JUNIOR, MAGRINI, 2014), but, still, there is strong pressure for oil exploration in this region, mainly for oil and gas exploration in the Equatorial Margin.

3.2.2 TROPICAL SOUTHWESTERN ATLANTIC - TSA

This MEOW extends from Northeastern Brazil through portions of the Southeastern region. Several factors contribute to mangroves' degradation and loss in it, including shrimp farming, urbanization, coastal urban growth, excessive exploitation of natural resources and pollution resulting from domestic, industrial and agricultural activities.

Two significant events in the TSA Province have aggravated some environmental concerns, namely: Fundão dam's collapse in 2015 (TOGNELLA et al., 2020) and an oil spill along the Northeastern coast at late August, 2019 (MAGRIS; GIARRIZZO, 2020). These events had broad biological implications, such as crab population decline, since females showed changes in their fertility period and reduced number of eggs (POFFO et al., 2001).

3.2.3 WARM TEMPERATE SOUTHWESTERN ATLANTIC - WTSA

The WTSA province includes the most populous coastal region in Brazil, where large cities have almost 7 million inhabitants, each. Mangrove forests in this province suffer from severe degradation and loss due to urban expansion, changes in land use and settlement patterns, as well as from other factors like overexploitation and pollution deriving from domestic, industrial and agricultural sources.

These interventions often lead to deforestation, land filling in mangrove areas, erosion, sedimentation, eutrophication and to unpredictable changes in mangrove environments' hydrological regimes (SCHAEFFER-NOVELLI ET AL 2024).

3.3 DEGRADATION FACTORS IN BRAZILIAN MANGROVES

3.3.1. URBAN AND PORT INFRASTRUCTURE

Ports and densely populated areas face chronic pollution issues due to municipal sewage discharges and oil spills caused by nearby shipping.

According to the yearly report by the Program Observing the Rivers, "Portrait of water quality in the Atlantic Forest River basins", which is based on the water quality index (WQI) of 112 monitored rivers, 92.4% of river waters are compromised for direct use, and 17.2% of them have poor or very poor quality, according to CONAMA Resolution 357/05 (Fundação SOS Mata Atlântica, 2025). Results point towards low basic sanitation rates in Brazilian cities.

Almost all main Brazilian capitals within this MEOW are located in coastal environments, and it has driven the broad use of mangrove wood for construction, tannin extraction (red mangrove bark) and charcoal production, since the first urban centers were established. This historical process affects these vital ecosystems' ecological integrity (NETTO; REIS-NETO, 2023)

Mangrove resources in the WTSA region have been used for centuries (NETTO; REIS-NETO, 2023). Urban and port infrastructure advancements in recent decades, as well as the observed increase in the human population, have significantly intensified organic pollutants' accumulation, and garbage and sewage dump in its mangroves.

This issue is quite clear in large urban centers such as Santos, São Vicente, Guarujá and Bertioga municipalities, São Paulo State, as well as in Rio de Janeiro City. Cities located in the WTSA province are among the most densely populated areas along the Brazilian coast. Rio de Janeiro population, for example, is close to 6.2 million inhabitants, according to data from the Brazilian Institute of Geography and Statistics (IBGE, 2022).

Ports and industrial infrastructure expansion still has significant impact on mangrove forests (LACERDA et al., 2002). SUAPE port construction in Pernambuco State and the subsequent implementation of an industrial pole in Recife led to extensive earthmoving and dredging works. These interventions had deep effect on local hydrology, besides causing major changes in, and substantial damage to, the mangrove region (BRAGA, 1989).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In addition to significant threats to local mangrove remnants, ports also pose regional risks on adjacent areas along shipping routes. Increased maritime traffic and associated pollution can lead to habitat degradation and ecosystem service losses that also pose significant risks on regions close to these routes.

As the largest port complex in South America, the Port of Santos serves as a prominent case of industrial and urban development exerting pressure on mangrove ecosystems. This port is located in a protected environment area with significant freshwater inputs and terrigenous sediments. It is also home to a large industrial and urban complex that includes industries in the chemicals, paper, fertilizers, chlorine, styrene and steel sectors (VALE et al., 2023). These industries are major sources of heavy metal pollutants, including mercury, chromium, copper, lead and zinc (SANTOS et al., 2012).

São Sebastião Port has had significant impact on Araçá Bay mangroves over the last century due to a series of activities that have reshaped the region's ecological history (SCHAEFFER NOVELLI ET AL., 2018).

3.3.2. OIL SPILL IMPACTS

Brazil has a long history of oil-related disasters that have had impact on mangrove habitats (LASSALLE et al., 2023). An unprecedented oil spill hit the Brazilian coast in 2019 and it was caused by a single and unknown source (e.g., ship waste or oil leak from a shipwreck). It spread oil along the Brazilian tropical coast and became one of the largest environmental catastrophes in the world, since it caused a series of interconnected socioeconomic and ecological issues (MAGRIS, GIARRIZZO, 2020).

The total of 232 oil-spill occurrences was recorded on the Northern Coast of São Paulo State between 1974 and 2000 (POFFO et al., 2001) due to PETROBRAS Almirante Barroso Maritime Terminal presence, since it received approximately 55% of all oil arriving in the country.

A major oil spill happened off the Brazilian Southeastern coast in October 1983. It severely damaged some 300 hectares of mangrove forests. This hazardous event was caused by a pipeline rupture that released 2.5 million liters of crude oil into the environment (SANTOS et al., 2012).

Risks posed by oil exploration and exploitation on Amazonian marine ecosystems

Attempts have been made to license offshore drilling activities in Block FZA-M-59, since 2013. This block is located 179 km off the coast of Amapá State and 500 km from the mouth of Amazonas River. However, it is essential to consider potential environmental risks affecting areas beyond fixed or delineated boundaries. This is justified by the fact that they host developmental cycles of fish schools belonging to species of high economic importance for the Amazonian Equatorial Margin region, which runs from far Northern Amapá State to Rio Grande do Norte State (Scheffer-Novelli, 2023).

According to IBAMA Technical Opinion N° 128/2023, the Environmental Impact Report (EIR) of this project identifies the area of influence of species threatened by exploitation, such as pink shrimp, pitu, red lobster and manatte and crab. In total, 23 marine mammal species were identified, including whales, porpoises and dolphins, and 2 manatee species. Six of these species are endangered in Brazil, namely: gray dolphin, red dolphin, sperm whale, marine manatee, Amazonian manatee and giant otter (BRASIL, 2023).

The environmental weakness issue in this region is broadened by the presence of admirable mangroves and by other coastal ecosystems, in addition to traditional communities whose relevance is highlighted by connectivity and interdependence between these environments, by the creation of new job positions and income sources, and by guarantee of food security for thousands of families.

In June 17, 2025, The National Petroleum Agency (ANP) put 47 blocks at the mouth of Amazonas River up for auction; 19 blocks were sold, despite a negative report issued by IBAMA, and the pressure from organized civil society and scientists.

3.3.3. AGRICULTURE AND AQUACULTURE

Plantations located upstream these coastal ecosystems account for reducing water amount and quality, as well as for inducing changes in the hydrological balance leading to increased sedimentation, erosion and silting. Sugarcane crops, which are particularly important in Northeastern Brazil, require large amounts of nitrates, other fertilizers, and pesticides. These products are often subjected to inappropriate disposal due to liquid waste produced by plants and pollute watercourses. Rice and sugarcane are the main agricultural products grown in micro-basins located along the coast, and they have negative impact on mangroves (Schaeffer-Novelli et al. 2024).

Significant indirect impacts of shrimp farming—such as the construction of ponds and drainage channels, as well as the discharge of supply waste—in Northeastern Brazil have been linked to alterations in hydrological dynamics and elevated inputs of nutrients and heavy metals, among other environmental effects. (LACERDA et al., 2021). Shrimp farming in the Northeastern region has been widely analyzed and its impacts on the region's mangroves have been described by Meireles et al (2008) as vegetation deforestation, soil sealing, apicum (salt flats) occupation, hydrological changes in estuaries, and changes in the ecosystem's biological and biochemical properties.

3.3.4. DAMS

Freshwater supply excess and/or reduction led to significant changes in estuarine regions and, consequently, in mangroves, which are known to be sensitive to changes in water quality and hydrological processes. Some of the listed hydrological changes can be natural, such as the case of geological formations, falling trees, landslides, sediment accumulation or sand banks in watercourses. They can also be induced by man like watercourses' straightening, channelization, dams, dredging and landfills. Dams deserve urgent attention when it comes to safety due to upstream mining practices, expansion, and to flood control (SCHAEFFER-NOVELLI et al, 2024).

Lacerda (2002) described the rivers' damming water basins on the coast of Ceará State significant impacts on its coastal zone, and they have mainly affected the mangroves.
Fundão Dam faced a catastrophic collapse back in 2015 in the Southeastern region of the Brazilian coast. This dam held approximately 50 million cubic meters of iron mining tailings, which resulted in metal waste dispersion along the Northern coast of Espírito Santo State (ESCOBAR, 2015). This event had significant ecological consequences and mainly affected coastal ecosystems like estuaries and mangroves (TOGNELLA et al., 2021).

3.3.5. EXOTIC SPECIES

The oyster species commonly known as the "ostra-tampinha" (*Sacoostrea cuculata)* is native to the Indo-Pacific and to the Southern and Eastern coasts of Africa. It was first recorded on the Brazilian coast in 2014, in Bertioga region, São Paulo State (GALVÃO et al., 2017). Amaral et al. (2020) recently recorded this exotic species in Rio de Janeiro, Paraná and Santa Catarina states, and in new areas in São Paulo State mostly close to harbor areas.

Eysink et al. (2023) reported the first recorded occurrence of an invasive exotic plant species—native to Indo-Pacific mangroves—in the mangroves of Cubatão municipality, São Paulo state, Brazil. Their study identified *Sonneratia apetala* in this sight, approximately 2 km from Santos City, which houses one of the country's main ports.

3.3.6.CLIMATE CHANGE

Climate change effects on Brazilian mangroves will have severe impact on estuaries and mangroves. These impacts will lead to losses at the 0.89 ha “Sueste Mangrove” (Fernando de Noronha Archipelago), since there is no availability of nearby sources of propagules to restore a unique forest on an oceanic island in the South Atlantic Ocean (personal report by the compiler team).

Small coastal river basins, mainly in Northeastern Brazil, will face flow reduction, increased salinity and, consequently, ecosystem structure reduction.

The Southern and Southeastern coasts are more vulnerable to tropical storms and extreme events. However, high river flows will lead to larger amounts of solid waste, which will be deposited on mangrove banks, or on farther areas where tides can penetrate in. This phenomenon has been often observed in winter, in Recife metropolitan region (Pernambuco State), mainly in Capibaribe River mangroves.

Changes in rainfall

Ellison (2000, 2004) points out that changes in rainfall should have effect on mangrove areas’ growth and extension. It is expected to reach 25% increase in rainfall by 2050, with irregular distribution patterns. There should be growth, propagule survival and mangrove yield decrease in areas known for lower rainfall rates. This scenario will favor their replacement by more tolerant halophytic plants. Therefore, there may be mangroves’ extension and diversity loss. On the other hand, there may be increase in forest zonation diversity and in the growth rates of some mangrove species that may expand their occupation area towards higher rainfall areas. Harty (2004) suggests that, in these cases, mangroves’ ability to compete with the glycophyte vegetation should increase in more internal areas.

Changes in tropical storms’ frequency and intensity

Changes in salinity, flooding rates and sediment input are among the conditions most often observed as tropical storms’ results (ELLISON & STODDART, 1991). These conditions can compromise species’ stability and the composition of mangroves’ vegetation cover (GILMAN et al., 2006). Changes in the coastline can trigger erosion/deposition processes at rates that exceed the resilience of typical mangrove plant species, as well as compromise the ecosystem’s ecological balance (HOPKINSON et al., 2008).

Mean temperature increase

The ecosystem can eventually occupy higher latitudes to the Northern and Southern sides due to temperature increase, but it will always depend on many other factors (FIELD, 1995). However, Woodroffe and Grindrod (1991), and Snedaker (1995), who were cited by McLeod and Slam (2006), argue that extreme climate events linked to low temperatures would limit mangroves’ expansion towards the poles.

The Brazilian coastline's tropical and subtropical latitudinal amplitude allows a whole diversity of physiographic features in places mangroves develop in. Mangrove ecosystems are able to adapt themselves to some degree of variations in abiotic environment conditions in sights they are found in. It means that structural responses are observed in pulses and on decades timeframes at local and regional levels. Climate change, more specifically temperature and mean relative sea level rise, higher CO2 availability, higher rainfall and tropical storms' frequency of recurrence (hurricanes and storms), along with human activities on coastal systems, affect mangroves' ecological balance and, consequently, their sustainability (SCHAEFFER-NOVELLI, 2014).

Increased storm frequency and changes in its current direction and flow, in combination to rising sea levels, could lead to mangrove regression as species migrate inland in search for ideal environmental conditions. It is impossible occupying these spaces due to built-up physical obstacles, and it leads to extensive habitat loss and to the loss of protective and regulatory services provided by mangroves to land-based ecosystems. Furthermore, coastal infrastructure is expected to be found, and it reduces these ecosystems' resilience to additional impacts induced by climate change. Increased frequency of extreme event types is expected to happen. Forecasts have already shown the possibility of climate change producing effects that have impact on mangroves mainly by promoting extreme event excesses and rainfall shortage. This potential future threat is most significant from Ceará State to Santa Catarina State, where mangroves are often unable to migrate inland due to physical obstacles. Although these states are home to only 15% of Brazil's mangroves, they are quite representative of this local context. These areas' loss would be quite significant for such a representativeness; therefore, their buffer zones require extra attention (SCHAEFFER-NOVELLI, 2014).

Mangrove buffer zones can be represented by the apicum when they are located in the innermost portion of the mangrove forest, if one has in mind a cross-sectional line from the watercourse or, alternatively, the ecotone that can be observed between the spring's high tide range and the next ecosystems on the emerged land, which is often featured by different-sized "restingas" (coastal strand ecosystem, sandbanks). The importance of both "apicum" (salt flats) features and the ecotone lies on the fact that the coastline retrogrades in response to increase in the frequency of extreme events (storm surges, for example) and to increase in mean relative sea level when mangrove forests migrate inland and colonize lands that were previously less affected by the mean tides.

3.4. THREATS TO TRADITIONAL FISHING COMMUNITIES

Communities face several conflicts that have impact on their daily lives and sustainability, among them, one finds wind energy projects; real estate speculation; negligence with civil and political rights, as well as with economic, social, cultural and environmental rights; privatization of different areas and territories; and tourism projects (Conselho Pastoral dos Pescadores, 2025).

Conflicts deriving from these activities have led to a series of negative effects, such as deforestation and natural habitats' destruction due to native vegetation removal and to the expansion of eucalyptus monocultures. Fishermen interviewed by "*Pastoral dos Pescadores*" have reported that fish diversity has decreased and that it has compromised aquatic ecosystem health and affected the number of fish available for communities' subsistence. Mangroves' death, as well as water, soil, air and local beaches' pollution and contamination are growing concerns. It is so, because springs, lakes, lagoons, streams and river-drying affect the region's water resources (Conselho Pastoral dos Pescadores, 2025).

The 2019 oil spill off the Brazilian coast, which was the largest environmental disaster at territorial extension in the country's history, had devastating impact on artisanal fishermen. Oil direct and indirect effects have affected people's physical and mental health, harmed families' food and nutritional security, and worsened the fishery consumer market crisis; moreover, its effect is still felt by the local community (Conselho Pastoral dos Pescadores, 2025).

3.5. CURRENT AND PREDICTED CONSERVATION PRIORITIES

3.5.1. THE NATIONAL PROGRAM FOR THE CONSERVATION AND SUSTAINABLE USE OF MANGROVES IN BRAZIL -"PROMANGUEZAL"

The National Program for the Conservation and Sustainable Use of Mangroves in Brazil, also known as "ProManguezal", was launched by Federal Decree N. 12,045/2024. It has some implementation axes to help meeting its conservation and recovery goals, and the sustainable use of biodiversity and ecosystem services associated with mangroves in Brazil.

ProManguezal's six (06) implementation axes comprise (BRASIL, 2024):

I - conserving and recovering mangroves and associated biodiversity;

II - sustainably using natural resources and improving traditional peoples and communities' conditions to produce and trade mangrove resources;

III - reducing socio-environmental vulnerabilities associated with climate change in mangroves;

IV - generating, systematizing and outspreading knowledge about mangroves;

V - training and raising the awareness about mangroves in Brazil;

VI - ProManguezal strengthening and financial sustainability.

ProManguezal has several action lines for each of these six axes. These lines allow highlighting some axes that are more closely related to current and predicted threats and priorities aimed at mangroves' conservation in Brazil, such as creating conservation units, conservation actions aimed at endangered species and at controlling exotic species, implementing ecological restoration projects, actions aimed at controlling anthropic activities that can have negative environmental impact on mangroves and be involved with different social agents (axis I); supporting traditional communities, encouraging the use of native species for income generation; developing community-based tourism, and strengthening networks of women linked to production chains (axis II); producing knowledge about climate change impacts on mangroves and implementing adaptation and mitigation strategies (axis III); promoting geospatial monitoring of mangrove's vegetation cover, encouraging scientific research to support public policies and valuing local communities' traditional knowledge (axis IV); training traditional communities to ensure their participation and social control in decision-making, and environmental education (axis V); and creating financing mechanisms, training traditional communities on how to raise funds and develop economic instruments (axis VI) (BRASIL, 2024).

4

CONSERVATION AND SUSTAINABLE MANAGEMENT OF BRAZIL'S MANGROVE ECOSYSTEMS

4. CONSERVATION AND SUSTAINABLE MANAGEMENT OF BRAZIL'S MANGROVE ECOSYSTEMS

At least 1.200 people from different society sectors pointed out socio-environmental challenges that were systematized into 14 categories as effort to better understand socio-environmental issues and challenges posed on the Political Pedagogical Project for the Coastal and Marine Zone (RAYMUNDO et al., 2021). "Disorderly occupation and real estate speculation" was the most important challenge pointed out by participants at that time. It means lack of planning based on environmental management programs and science, and irregular occupation of PPAs' (Permanent Preservation Areas - mangroves, dunes, restingas, among others); land use conflicts in the territory due to energy, tourism, housing and industry demands, among others; speculation and real estate pressure; condominiums and resorts in inappropriate territories; land grabbing and other land issues.

"*Environmental degradation and biodiversity loss*" are other key issues that demand special attention. They contribute to both general and specific declines in biodiversity, the deterioration of coral reef ecosystems, and the erosion of coastal environmental attributes. Additional impacts include the loss of vegetation cover, reduction in biological diversity, and destruction of natural habitats. These forms of degradation result from logging activities and various types of pollution, including air, soil, and water contamination. Biodiversity is further threatened by hunting, biopiracy, and the illegal trafficking of flora and fauna. Deforestation and use of fire as land-cleaning methods cause significant biodiversity loss, as well. Moreover, the undervaluation of environmental preservation and conservation efforts, coupled with the widespread use of pesticides and monoculture practices, exacerbates the environmental degradation.

It is well known that mangrove ecosystems play important role in the economy of coastal regions due to fishing. However, management efforts are constrained by the absence of production estimates specifically concerning ecosystem-dependent species. The "Uça" crab (*Ucides cordatus*) case is an example of it, for which the only official production bulletin was issued around 2007, based on data collected by IBAMA in 2005. These data were obtained from landing control systems, logbooks, production reports, and statistical sampling (IBAMA, 2007). At that time, mangrove crab production was close to 10.150 tons along the Brazilian coast, with emphasis on Pará and Maranhão states, which accounted for more than 70% of its national production. Production recorded 9.027, 8.534 and 8.607 tons (MPA, 2011) in the following years (2009, 2010 and 2011), respectively.

All bulletins and reports presented deficiencies related to insufficient number of data collectors, lack of productive sector's commitment to provide information and lack of integrated institutional policy aimed at generating national fishing statistics.

Despite initiatives to monitor fishery landings, the country missed consolidated fishery statistics for at least two decades. This information is critical for decision-making on conservation and for guidelines focused on public policies aimed at fishing promotion in Brazil. To a large extent, this process could also compromise Brazil's efforts to achieve SDG 14: "Conserving and ensuring the sustainable use and development of oceans, seas, freshwater bodies and marine resources" by 2030 (SANTOS et al., 2023).


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Ecological restoration of mangroves

Mangrove ecological restoration projects can be an opportunity to apply financial and human resources aimed at restoring the ecosystem in coastal wetscapes.

It is worth noticing that ecological restoration techniques, unlike simply planting seedlings, include interventions aimed at restoring the natural ecological recovery process (SÃO PAULO, 2014).

The ecological restoration process of an altered mangrove must aim at reestablishing the altered hydrological and topographical conditions to make it easier to achieve natural recovery, since it leads to full structural and functional development - as close as possible to the original features (MENGHINI et al., 2018).

The success of a mangrove ecological restoration project critically depends on the involvement of traditional communities from the planning stage through implementation and monitoring. These communities possess the empirical knowledge essential to the project's effectiveness, and have full understanding of the underlying causes of environmental failures.

Mangroves are legally considered Permanent preservation Areas (PPAs in Portuguese) (item VII, art. 4, Federal Law 12.651/2012) (BRASIL, 2012); therefore, any intervention in this ecosystem established in a restoration project must take into consideration the specific provisions in the Brazilian federal and state environmental legislation, as observed in São Paulo State (SMA Resolution 32/2014) (SÃO PAULO, 2014).

5 NATIONAL POLICY CONTEXT AND LEGAL FRAMEWORK

5. NATIONAL POLICY CONTEXT AND LEGAL FRAMEWORK.

The Brazilian environmental legislation safeguards the country's mangrove ecosystems through various legal instruments. From a temporal perspective, the National Environmental Policy (Federal Law No. 6.938/1981) (BRAZIL, 1981) stands out, as it was incorporated into the current Federal Constitution of Brazil, enacted in 1988. The Federal Constitution established a special chapter on the environment (Article 225) (BRASIL, 1988), which directly protects mangrove ecosystems by recognizing the Coastal Zone and the Atlantic Forest as 'national heritage.' Furthermore, Federal Law No. 11.428/2006 (BRASIL, 2006) classifies mangroves as ecosystems associated with the Atlantic Forest biome (ROSARIO; ABUCHAHLA, 2018).

It is important highlighting that Article 225 of the 1988 Federal Constitution provides for the obligation to protect an ecologically balanced environment, since the Brazilian population directly and indirectly uses and depends on natural resources. It also states that the population's health and well-being are intrinsically connected to a healthy environment. Therefore, considering that the 1988 Brazil's Magna Carta (Brazilian supreme), it must always be the very basis for the preparation and improvement of the Brazilian environmental legislation. Furthermore, all infra-constitutional norms must align with its content and guiding principles. In the same year, the National Coastal Management Plan (Federal law N. 7.661/1988) was enacted to guide the rational use of resources in the Coastal Zone, including mangroves (BRASIL, 1988).

In 2002, the National Environmental Council (CONAMA) approved Resolution N. 303, which sets the limits of Permanent preservation Areas and defines mangroves as "coastal ecosystems distributed in low-lying lands subjected to tidal action, formed by recent muddy or sandy mudflats that are mostly associated with a natural vegetation known as mangroves. These ecosystems have fluvial-marine influence typical of silty soils in estuarine regions and discontinuous dispersion along the Brazilian coast, between Amapá and Santa Catarina states". Despite the inconsistencies, this definition was later ratified by Federal Law N. 12.651/2012 (ROSARIO; ABUCHAHLA, 2018).

It is worth mentioning CONAMA Resolution N. 312/2002, which deals with environmental licensing processes in Brazil that can prohibit shrimp farming ventures in mangrove areas. CONAMA Resolution N. 341/2003, in its turn, deals with sustainable tourism development and defines that tourism activities or ventures cannot compromise the mangrove ecosystem. In 2008, the Ministry of the Environment issued Normative Instruction N. 3 to suspend the granting of shrimp farming ventures' approval and authorization to operate in federal conservation units (MMA, 2008) if management plans do not take into consideration the possibility of such ventures (ROSARIO; ABUCHAHLA, 2018).

It is also essential highlighting Federal law N. 12.651/2012, which regulates for the protection of native vegetation in Brazil. this legislation brought serious setbacks in the protection of native Brazilian vegetation compared to the previous framework it (Federal law N. 4.771/1965, also know as Forest Code). This law kept the definition that mangroves are permanent preservation areas (PPAs) throughout their entire extension. These PPAs are defined as "protected area covered or not by native vegetation, and have the environmental function of preserving water resources, the landscape, geological stability and biodiversity, of facilitating the gene flow of fauna and flora, of protecting the soil and ensuring the well-being of human populations" (BRASIL, 2012).

Recently, Federal Decree N. 12.045/2024 provided for the National Program for the Conservation and Sustainable Use of Mangroves in Brazil – "ProManguezal". According to this Federal Decree, ProManguezal "aims the conservation, recovery and sustainable use of biodiversity and ecosystem services associated with the country's mangroves by taking into consideration the various pressures on the ecosystem, including climate change" (BRASIL, 2024).

It is worth noticing that the proposal to create the National Policy for Integrated Management, Conservation and Sustainable Use of the Coastal-Marine System, known as "law of the sea", was approved in May 2025, by the Brazilian Parliament, but it is still waiting for analysis by the Federal Senate. The so called "law of the sea" sets guidelines for the governance of the seas; it seeks integrated management, so that productive-sector activities, such as fishing, oil and gas exploration, mining and energy generation, do not compromise the conservation of coastal and marine ecosystems, including mangroves.

In addition to the Ramsar Convention, other international instruments also protect mangroves, among them, one finds CDB – the Convention on Biological Diversity, CITES - the Convention on International Trade in Endangered Species of Wild Fauna and Flora, UNFCCC - the Framework Convention on Climate Change, and UNCLOS - the United Nations Convention on the Law of the Sea (ROSARIO; ABUCHAHLA, 2018).

Finally, it is essential highlighting the importance of conserving Brazilian mangroves in the National System of Nature Conservation Units (SNUC, in Portuguese) enacted in Brazil by Federal law 9.985/2000 (BRASIL, 2000). It established criteria and standards for the creation, implementation and management of conservation units in the Brazilian territory. Therefore, it enabled the federal, state and municipal governments, as well as the private sector, to act in preserving and conserving the environment.

According to the Brazilian Conservation Units Panel, 3.31% of the marine biome area is within fully protected conservation units, whereas 22.98% of it is classified as sustainable use conservation unit (MMA, 2022)

According to the Brazilian Conservation Units Panel (https://cnuc.mma.gov.br/powerbi), 963,918.22 km² (26.39%) of the Coastal-Marine System is protected by Conservation Units. Brazil has 1.4 million hectares of mangroves along its coastal strip, and approximately 90% of these mangroves are protected by 120 Conservation Units (UCs in Portuguese) in 16 coastal Brazilian states (55 are federal, 46 are state and 19 are municipal conservation units) (MMA, 2024). It covers a tiny area, such as that of the "Sueste Mangrove" at Fernando de Noronha Marine National Park (0.89 ha), but it can also cover areas the size of large cities, such as that of Piratuba Lake Biological Reserve, in Amapá State, which covers 107.454 hectares of mangroves (SCHMIDT, et al, 2023).

However, it is important pointing out that the vast majority of these areas (87.43% of the total area protected in UCs is of the "Sustainable Use" type. It means that fishing and tourism activities are allowed, as long as the main management instrument, the so-called Management Plan, is respected. It reflects their different uses by traditional communities.

Actually, the number of mangroves located in sustainable use conservation units is quite large; they reach 83% of the total area. There are two particularly significant categories among them, namely: Extractive Reserves (Resex in Portuguese) and Environmental Protection Areas (APA, in Portuguese). APAs are more vulnerable to the impact of some socioeconomic activities, such as shrimp farming. Almost all shrimp production ponds are located in sustainable use conservation units (99.9%), mainly in APAs (96.3%) (LEÃO et al., 2018).

A recent study indicates that Conservation Units (UCs) in Brazil contribute to protect mangrove ecosystems, which are consequently less impacted by human activities . However, there is the need for predicting concrete actions in management plans and for strengthening management councils to ensure mangroves' protection (LOPES ET AL, 2025). These authors assessed 25 fully protected federal, state and municipal UCs, but only 72% of them had a Management Plan (only 40% of them mentioned mangroves in UC's creation goals) and 72% had a Management Council. However, this reality is a little better when it comes to federal UCs, whether fully protected or sustainable use ones.

Extractive Reserves (Resex) have been consolidated as one of the main tools to protect traditional fishing territories and sociobiodiversity. They were created to ensure the sustainable use of natural resources by local communities (INSTITUTO LINHA D'ÁGUA, 2024). Recently, discussions have gain momentum regarding the creation of new marine-coastal UCs; with the aim at ensuring another layer of protection for the mangrove ecosystem, and at meeting the needs of fishermen. Rio Formoso RESEX, in Pernambuco State, has been under discussion since mid-2009, but it has definitively entered the creation process after the establishment of public hearings carried out with several society sectors back in 2024. The same happened with Amapá Resex, which has been under discussion since 2005 (Flamã, Bailique, Amapá-Sucuriju and Goiabal).

Canavieiras Marine Resex (BA) is one example of traditional fishing communities' struggle to create a Resex. It was created in 2006 and covers more than 100.000 hectares of coastal-marine ecosystems. This reserve area benefits approximately 8.000 people, including fishermen, shellfish gatherers and quilombola communities. It is a true mosaic of biodiversity, besides representing one of the richest and most varied ecosystems in Brazil. It covers a vast area that encompasses mangroves, marine areas, the Atlantic Forest and Restingas. This reservation unit is refuge for multiple species. It has become a symbol of resistance against real estate speculation and shrimp farming, and its participatory management has strengthened the autonomy of local communities and contributed to ecological balance in the region. However, this achievement is under constant threat, some Bills, such as PL 3068/2015 and PL 2381/21, have already been processed with proposals to turn the Canavieiras Marine Resex into an Environmental Protection Area (EPA), but this category has lower degree of protection and would allow activities responsible for stronger environmental impacts (Instituto Linha D'água, 2024).

Populations located in Sustainable Use Conservation Units are often larger than those living in Full Protection Units, where organisms' capture is prohibited, and it makes environmental conservation in them more challenging due to the higher exploitation of resources (Dourojeanni and Pádua, 2013).

6

MAPPING KEY STAKEHOLDERS AND THEIR ROLE

Table 2 presents a selection of Brazilian initiatives engaged in mangrove conservation. A total of Thirty-seven (37) institutions were selected, 10 of which are higher education institutions (universities), 28 are non-governmental organizations (NGOs) and one community-based association,In terms of geographic scope, 12 are local level, 23 are regional level and 3 are national level. They are distributed in 13 coastal states, namely: 1 in Santa Catarina, 4 in Paraná, 5 in São Paulo, 1 in Rio de Janeiro, 3 in Espírito Santo, 3 in Bahia, 1 in Sergipe, 5 in Alagoas, 2 in Pernambuco, 2 in Paraíba, 5 in Ceará, 3 in Piauí and 1 in Pará. Institutions from Maranhão and Rio Grande do Norte states did not appear in this preliminary research, but it does not imply in lack of institutions working on mangrove conservation in these states. This is only a fraction of Brazil's potential to develop projects, whether financed by government resources or by the private sector.

In total, 5 of the 37 assessed institutions develop Community Articulation Actions, 4 worked with Biodiversity Conservation, 27 focused on Environmental Education, 11 worked with Restoration, 4 worked with Community-Based Tourism and 13 developed Research (mostly University projects).

There is a whole range of communities that come together to defend their fishing territories, but they were not assessed because they seem invisible to research, namely: quilombola, indigenous and fishing communities. Some of them are gathered in associations, others are clandestine and lack legal rights and access to financial resources.

It is essential assessing the existing networks that bring together individual and collective actions by representatives from a wide range of sectors. The “MangueMar Brasil Network”, “Renaman” (National Mangrove Network) and the “Coastal and Marine Zone Political Pedagogical Project Facilitation Network” stand out in Brazil, among others.

TABLE 2 – LIST OF INSTITUTIONS DEDICATED TO MANGROVE CONSERVATION IN BRAZIL

	INSTITUTION	SECTOR	ACTIONS	RANGE
1	Instituto BiomaBrasil	NGO	Research / Environmental Education	National
2	Associação Peixe-Boi	Association	Community-Based Tourism	Local: Porto de Pedras (Alagoas)
3	Associação MarBrasil	NGO	Research / Environmental Education	Regional: Paranaguá estuarine complex (Paraná)
4	Laboratório de Ecologia Costeira e Oceânica – LECO	Federal University of Paraíba	Research / Restoration	Regional: Mamanguape Environmental Protection Area (Paraíba)
5	Laboratório de Estudos em Educação e Meio Ambiente do Recôncavo - LEEMAR	Federal University of Recôncavo da Bahia	Research / Environmental Education	Regional: Todos os Santos Bay (Bahia)
6	Aquasis	NGO	Biodiversity Conservation	Regional: coast of Ceará State
7	TerraMar	NGO	Community articulation	Regional: cost of Ceará State
8	Mangrove Monitoring	Paulista State University	Research / Environmental Education	Regional: Cananéia-Iguape estuarine lagoon complex (São Paulo)
9	Guardiões do Mar e Projeto Uçá	NGO	Environmental Education /Restoration	Regional: Guapimirim PP (Rio de Janeiro)
10	Associação Caraguatás Ambiental	NGO	Environmental Education	Local: Caraguatatuba (São Paulo)
11	Projeto Manguezal Terra do Guaiamum	NGO	Biodiversity conservation	Local: Ubatuba (São Paulo)
12	Associação Caiçara do Rio Juqueriquerê	NGO	Community articulation	Local: Caraguatatuba (São Paulo)
13	ECOMUSEU Natural do Mangue	NGO	Environmental education	Local: Fortaleza (Ceará)
14	Instituto Peabiru	NOG	Research / Environmental Education / Restoration	Regional: Coast of Pará State
15	Manguezal Vivo	NGO	Community-Based Tourism	Local: Cubatão (São Paulo)
16	Laboratório PROMANG	University of Pernambuco	Research / Environmental Education	Regional: Coast of Pernambuco and Alagoas states
17	Fundação Vovó do Mangue	NGO	Environmental Education / Restoration	Local: Maragogipe (Bahia)
18	NEMA – Núcleo de Estudos em Manguezais	State University of Rio de Janeiro	Research / Environmental Education	National
19	Nosso Mangue	NGO	Environmental Education / Restoration / Community-Based Tourism	Regional Metropolitan Region of Maceio (Alagoas)
20	Mangue Vivo	Federal University of Ceará	Environmental Education	Regional: Coast of Ceará State
21	SOS Manguezal Cajueiro da Praia	NGO	Environmental Education	Local: Cajueiro da praia (Piauí)
22	Manguериders	NGO	Community-Based Tourism	Local: Morro de São Paulo (Bahia)
23	Laboratório de pesquisas em estuários e manguezais	Federal University of Alagoas	Research / Environmental Education	Regional: Coast of Alagoas State
24	Projeto Verde Vida Mangue	NGO	Environmental Education / Restoration	Regional: Delta do Parnaíba (Piauí)
25	Fundação Mamíferos Aquáticos	NGO	Biodiversity Conservation / Environmental Education	Regional: Coast of Sergipe and Paraíba state
26	Instituto Yandê	NGO	Community Articulation / Environmental Education	Local: São Miguel dos Milagres and Porto de Pedras (Alagoas)
27	Instituto Biota	NGO	Biodiversity Conservation / Environmental Education	Regional: Coast of Alagoas State
28	Centro Educacional Araçá	NGO	Environmental education	Local: São Mateus (Espírito Santo)
29	Laboratório de Educação Ambiental - LabEA	University Center of Norte do Espírito Santo - CEUNES	Environmental education	Regional: Coastal Plain of Rio Doce and Northern Espírito Santo.
30	Laboratório de Ecologia de Manguezais	University Center of Norte do Espírito Santo - CEUNES	Research / Restoration	Regional: Central and Northern Espírito Santo State
31	Mater Natura (PR)	NGO	Research / Restoration	Regional: Coast of Paraná State
32	SPVS (Sociedade de Pesquisa em Vida Selvagem e Educação Ambiental) (PR)	NGO	Research / Environmental Education / Restoration	Regional: Guaraqueçaba (Paraná)
33	Instituto Çarakura (SC)	NGO	Environmental Education / Restoration	Regional: Grande Florianópolis (Santa Catarina)
34	Instituto caranguejo de Educação Ambiental	NGO	Environmental Education	National
35	Comissão Ilha Ativa (CIA)	NGO	Environmental Education / Restoration / Community Articulation	Regional: Delta do Parnaíba PPA (Piauí)
36	Laboratório de Geoecologia da Paisagem	Federal University of Ceará	Research / Environmental Education	Regional: Coast of Ceará State
37	Instituto Linha D'água	NGO	Community Articulation	Regional: Southern coast of Rio de Janeiro State to the Northern coast of Paraná State
38	Museu do Caranguejo Vivo	NGO	Environmental Education	Local: Timbó River, Northern Coast of Pernambuco State


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7 REFERENCE

7. REFERENCE

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