

Use, Land Occupation and Environmental Impacts on São Marcos Beach, São Luís, Brazil

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ABSTRACT

Local beaches in coastal areas are areas that stand out as one of the most frequented natural environments due to their attractions: source of food, leisure, mineral resources and tourism, not to mention great biodiversity. São Marcos beach, in São Luís, Maranhão, has been greatly impacted by tourist activities and the urban expansion materialized in the suppression of vegetation, waterproofing of the soil, discharge of fresh effluents. The main objectives of this research are to identify the use and occupation of São Marcos beach and the environmental impacts, through technical field visits and satellite images worked in Map Viewer 7.0 geoprocessing programs and Google Earth associated with ENVI. The results of serious anthropic impacts on the beach under study such as occupation in dunes and discharge of sewage directly on the beach.

Keywords: impact assessment, urban occupation, urban beaches.

INTRODUCTION

In Brazil, of the 17 coastal states, 13 capitals and their Metropolitan Regions are located on the coast and have several urban beaches. Within the mosaic of coastal ecosystems, each of them has its talents and most appropriate uses, as well as the most appropriate forms of human occupations. suitable for its use (COSTA et al 2008).

Costa et al (2008) state that after the first decades of occupation of oceanic coasts, it became clear that vacationers migrate from beach to beach, giving way to consolidated residential clusters. They also realized that living on the beach is much more impactful than vacationing. The evolution of urbanization expressed by the high level of occupation along the coastal fringe under study represents the transformation of a natural beach into an urbanized one, which highlights the need to propose measures that will provide, regardless of its urbanization, good quality conditions for social and ecology of São Marcos beach.

n the beach areas north of the city of São Luís, MA, São Marcos beach, with a greater

frequency of bathers, environmental degradation is materialized by the release of effluents, solid waste, removal of coastal dunes and urban constructions in and around around beaches, associated with real estate speculation, tourism, and port activities with a constant threat of spills of oil and other chemical products, as well as the introduction of exotic species through ballast water (Rêgo et al 2018).

This work aimed to investigate the current state of environmental degradation of São Marcos beach, in São Luís, capital of the State of Maranhão, on the coast of the northeast region of Brazil, related to occupation and urbanization. This beach was selected for study because it has a series of historical data measuring physical, chemical and biological parameters that have been carried out by the State Department of the Environment. Other important factors for choosing this area were: I - better accessibility; II - increase in vertical integration and real estate speculation; III - location of the hotel chain concentrated in this area; IV - tidal dynamics of the estuaries of the Anil and Bacanga rivers, which release a range of contaminants and pollutants.

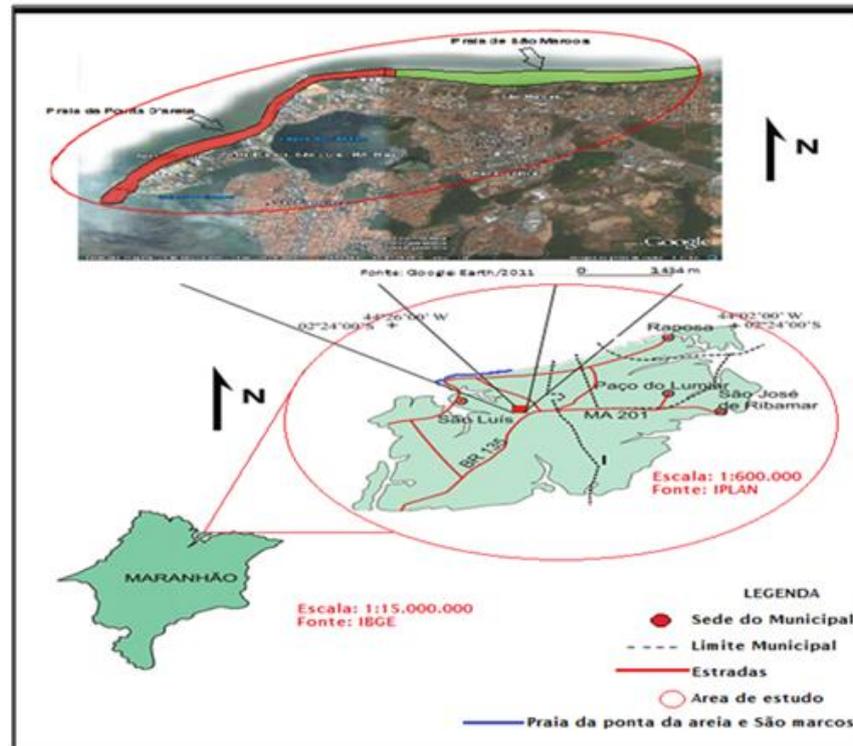
GEO ENVIRONMENTAL CHARACTERIZATION OF THE STUDY AREA

Location

The island of Maranhão is located in the coastal region of the State, limited to the north by the Atlantic Ocean; to the south, with Arraial Bay and Estreito dos Mosquitos; to the east with São José Bay and to the west with São Marcos Bay. The area under study is located north of Maranhão Island. São Marcos beach is located

between the São Marcos lighthouse and the Calhau river, 4.0 km long (Map 01).

The beach's coast is classified as oceanic and dissipative sandy, made up of fine and quartz sands, presenting an extensive stretch area resulting from the large amplitude of tides characteristic of the region, which during spring tides reach 7.0 m (EL ROBRINI et al, 2012).



Map1. Location of the study area. Sources : (Google Earth/20011,IPLAN,IBGE)

Geological and Geomorphological Characteristics

The São Luís coastal sedimentary basin is of the tectonic fossa type, intensely faulted, it is separated from the Parnaíba intracratonic basin by the Ferrer – Urbano Santos Arch (regional structural high), having, below the rift cycle sediments, the occurrence of sediments deposited in conditions of relative tectonic calm, formed in a pre-rift cycle, appropriate for their correlation to a sequence on the continent, due to the fluo-lacustrine deposition environments. (DIAS & NOGUEIRA JUNIOR, 2005).

The Itapecuru Formation (Cretaceous) is made up of reddish pink sandstones spotted with kaolin, with intercalations of siltstones and mudstones; Barreiras Formation (Tertiary), consisting of conglomerates, sandstones, siltstones and mudstones, with poorly sorted and poorly consolidated sediments; Açu Formation

(Quaternary), consisting of deposits in river-marine plains, alluvium, beaches, dunes, mangroves and restingas (MARANHÃO, 1998).

The Golfão Maranhense, located in the coastal sedimentary basin of São Luís, in the northern part, is considered the second largest gulf on the Brazilian coast. It extends from Ponta dos Atins to Santana Island, covering the municipalities of Alcântara, São Luís, Paço do Lumiar, São José de Ribamar, Humberto de Campos and Raposa. (MARANHÃO, 1998).

On the island of Maranhão, the morphological features of the north and east areas comprise wide beaches of marine quartz sand with fine to very fine grains, backed by the emerged coast characterized by the occurrence of barriers (cliffs) with active marine, pluvial and wind erosion, interspersed by sandy ridges, mobile dunes and paleodunes in places where the barriers are retreated and covered by these sandy

surface formations (MARANHÃO, 1998). Among the morphological formations in the area under study, the presence of tablelands, dunes, peledunes, beaches and tidal flats can be seen.

Quartz sands include marine quartz sands and dunes. They represent 27,750 km², that is, 8% of the state's surface. Quartz sands (AQ) are sandy soils, well drained, strongly acidic and with very low natural fertility. They are present in areas of flat to gently undulating relief, originating from Tertiary sediments and sandstones from the Devonian and Cretaceous, concentrating mainly in the north of the State of Maranhão, south and east of the Lençóis Maranhenses National Park (FEITOSA 1996, p.47).

Climatic Characteristics

According to Koeppen's classification apud Maranhão (1998), the climate of São Luís is type Aw, Tropical Rainy, with a predominance of rain in the months of January to April. The average rainfall is 1954 mm. The average annual temperature fluctuates around 28°. The maximum values occur between September and November (average around 30°) while the minimum values occur between May and July (average of 25°).

According to Santos (1996), these climatic agents, in the study area, have a significant participation in coastal morphogenesis through physical-chemical weathering, through the significant wind action on the stretch (during low tide) and the current dunes, especially in the dry period, increase in erosion processes (in gullies, cliffs, slopes and other features) due to the high rainfall, characteristic of the rainy season, resulting in a considerable sedimentation rate in lowered areas.

Vegetation

The State of Maranhão has a great phytogeographic diversity, highlighting arboreal formations such as the Amazon Equatorial Forest, cerrado, mangroves, floodable fields, dune and beach vegetation and cocai forest (REIS, 2005; FEITOSA & TROVÃO, 2006). On the island of Maranhão, the main plant types are Mangroves, Restingas, Babaçuais, Secondary Forest and Riparian Forest.

The restinga makes up beach ecosystems, showing strong degradation due to urbanization. According to Cunha et al (2010) the restinga

was described from two points of view: geological and phytogeographic. For Geology, the term restinga defines coastal sand ridges and sand deposits of different origins. In Phytogeography, it defines formations that cover the Holocene sands from the ocean, or just the woody, shrub or arboreal vegetation, further inland.

According to studies by Santos (1996), the most common plant species in the study area are *Rhizophora mangle* L. (red mangrove), *Avicennia nitida* J. (Siriba or Siriúba mangrove), *Pirix tresine portulacoides* (beach rosemary); *Hybanthus ipeacacuamba* (beach grass); *Panicum racemosum* (paraturá grass); *Spartina altermifolia* (beach bean); *Canavalia obtusifolia*; *Ipomoea pes-caprae* (beach parsley); *Ipomea stolonifera* (beach grass); *Sporobolus virginicus*; *Cassia* sp; *Anacardium occidentale* L. (cashew tree), *Byrsonima crassifolia* (L) Kuntn, (murici); *Psidium guajava* (wild guava); *Chrysobalanus icacol* (guajiru).

Oceanographic Characteristics

The coastline of Maranhão Island is subject to rigid hydrodynamics due to the dominance of semi-diurnal tides (two high tides and two low tides per lunar day), with an average amplitude of 4.6 m that can reach 7.2 m when spring tides, but 75% of the time tidal amplitudes are less than 5.50m, neap tides (PORTOBRÁS, 1998).

In São Marcos Bay, tidal current speeds reach up to 2.5 m/s in the Boqueirão Channel. In the channel east of Banco dos Cavalos, tidal currents reach speeds of 2.3 m and 1.2 to 1.5 m/s in the inner part and in the respective bay the waves present characteristics exclusively caused by the action of the wind (MORAIS, 1977).

The brown color of the beach waters of Maranhão Island is due to the high concentration of sediments from large river discharges. The union of oceanographic factors in the study area such as tides, waves, winds, and currents are the main factors responsible for modeling the beaches under study.

Occupation

The basins of the Bacanga and Anil rivers, the main bodies of water influencing the study area, suffer from occupation processes throughout their basin which, according to Maranhão, 2008, in general, civil infrastructure and support works combined with the installation of urban

equipment necessary for these settlements, cause direct and indirect impacts, with total compromise of the natural components of the occupied areas.

These basins have been intensely modified by increasing urbanization, enhanced by the gradual removal of vegetation cover, with consequent exposure of soils to intense weathering processes, and water pollution caused by the release of liquid effluents from both domestic and industrial environments.

The increase in urbanization and population expansion in recent decades on Maranhão Island is mainly due to large industrial projects culminating in a considerable increase in disorderly occupations and consequently the emergence of environmental, aesthetic and socioeconomic problems.

According to Ferreira (1999), from the 1950s onwards, significant changes occurred in São Luís. Between 1951 and 1970, the city underwent disorganized horizontal growth, given the absence of physical-territorial planning combined with the pressure of the population increase of 137.66%.

Real estate speculation in the area under study is characterized as a worrying situation, as several projects in the real estate market have been built over the years without, however, taking into account the type of impact they could cause to the environment and the visitors themselves. location (CORREIA ET AL, 2006).

METHODOLOGY

The methodology of this research included three main actions: (i) a bibliographical research, (ii) carrying out a technical visit to the study site and (iii) construction of images with the data obtained.

The bibliographic research included searching the collections of the libraries of public and private universities in the State, scientific journals in the main databases available on the world wide web, such as Scielo and Periódicos Capes, among others.

The field visit included photographic recording of the study area, marking between points (S 02° 30.656' W 44° 19.676') and (S 02° 29.076' W 44° 15.815'), using the Waky Ponts tool of GPS, and the application of a form and field (protocol), whose main objective was to characterize the areas visited and identify the main environmental impacts.

The third stage included the generation of several maps using Landsat 5 images of the 2011 study area. This image was worked on in the Map Viewer 7.0 cartographic programs and Google Earth associated with ENVI, which helped in generating a map of use and occupation of the area. soil (fig. 01 and fig. 04). From such activities, the study area was demarcated as the coastal coast, ranging from the post beach to approximately 1 km inland.

RESULTS AND DISCUSSIONS

The beaches on the north coast of Maranhão Island, in relation to a classification of their typology taking into account levels of occupation or urbanization, are quite diverse. In relation to Moraes' classification (2004), São Marcos beach will be listed respectively as:

I. Dense residential or tourist urban: Seaside land occupied by vertical constructions, high density of buildings and populations, landscape completely formed with anthropism, high contamination.

II. Residential or tourist urban: Occupied seaside land, medium population density, landscape completely formed with anthropism, possible contamination.

According to Moraes (2007), urbanization models are incompatible with the environment because they require extensive modeling of the terrain, which implies eradication of native vegetation and significant transformation of natural drainage. In the area under study, urbanization is totally incompatible with the environment in which it was inserted and caused the almost total deterioration of the vegetation, dune ranges, mangroves, paleodunes, rivers and streams.

The beach, object of study, is marked by the presence of dunes, paleodunes, trays and water courses, which are of significant importance for the area under study, where they have been constantly removed, giving way to avenues, bars, standardized or non-standardized beach huts, parking lots and residential buildings. The current dunes and paleodunes, which in recent years have been significantly reduced and altered, due to the multiple human activities existing in this part of the coastal fringe, most commonly observed in the area, include clandestine sand extraction and earthworks aimed at installing roadways. access and/or tourist developments and residences in violation

of current environmental legislation (SANTOS, 1996).

In the urbanization of São Marcos beach, the paleodunes and, consequently, part of its vegetation were preserved, despite Avenida Litorânea running parallel to the beach. There was some concern in maintaining some beach aspects, which was not observed on other beaches on the island of Maranhão. The characteristics described are shown in Figure 01.

On the beach under study, the arrangement of these buildings is further away from the coastal strip, that is, with significantly lower urban pressure, but these urban models still favor the destruction of the coastal environment,

fragmentation of the forest and loss of morphological and ecological characteristics. It can be seen that an urbanization model more compatible with the coastal environment was not thought of, with the aim of preserving the characteristics of the beach environment.

The values, goods and services that dunes can offer include the protection of anthropogenic structures, niches for plants, habitable substrates, refuge areas for fauna and nesting sites, as well as having specific local value as a source of underground water (NORDSTROM, 2010).



Figure1. Configuration diagram of São Marcos Beach. (SOURCE Joherbeth Rêgo)

The presence of solid waste from ships that are docked close to the beach was observed in the area under study, which are being thrown directly into the sea and reaching the beach. Buildings being built on dune sites, decks and construction debris being deposited directly on the beach without any supervision. In the area under study, it was noted that there was a marked presence in some sections of walls built within the stretch to protect anthropogenic works. And local roads built between the dunes and the beach to provide access for motor vehicles to hotels, restaurants, bars and parking lots, further degrading and polluting the entire ecosystem under study.

In relation to the Calhau River, according to Santos (1996), this river resource has been constantly attacked due to deforestation, the

release of raw waste and solid waste in certain stretches of its banks. Such practices end up contributing to pollution and siltation and reducing flow.

The constant release of solid waste and liquid effluents into the environment affects, among other factors, the metabolism and behavior of several species, being responsible for the reduction in diversity and richness. This contamination is a major problem for the beach's fauna, causing the reduction, contamination and mortality of a series of species typical of this environment, causing a serious disturbance in coastal ecology, (Rêgo, et al 2018)

On the beach under study, there is a large number of sewer “mouths” of varying diameters

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that have the function of capturing only rainwater, but are currently used clandestinely to receive liquid waste from most futuristic projects. Some of these drains are inactive in relation to the release of liquid effluents, but the majority are active and causing major biological disturbances to beach biodiversity.

At the mouth of the Calhau river, one can see how much engineering works have harmed this river course, where previously what should have been riparian forests, strings of dunes and restingas gave way to concrete walls, windings and iron beams exposed in the sand. beach (Figure 02).



Figure2. Deterioration of human-made construction at the mouth of the Calhau river. (Photo Joherbeth Rêgo)

The progressive erosion of beaches, associated with human attempts to retain seaside buildings and infrastructure in fixed positions, can result in a reduction or complete loss of beach environments, dunes and active coastal slopes (NORDSTROM, 2010).

Erosion on São Marcos beach is another problem caused, mainly, by the “sewers” which, in addition to dumping large quantities of raw

sewage onto the beach sand, also causes erosion not only in the stretch, but also in the dune ranges. existing areas leaving a trail of erosion and pollution on the beach under study (Figure 03). During the rainy season, due to the force of rainwater, erosion on the beach occurs in a more intense way, eroding the beach sand and the dune ranges.



Figure3. Erosion caused by sewage pipes (Photo Joherbeth Rêgo)

The verticalization on the beachfront, as well as the strong urbanization in the basins of the Bacanga and Anil rivers that flow close to the study area, combined with the lack and poor functioning of liquid effluent treatment plants, contribute to the contamination and pollution of

our beach waters. Over the years, various bathing reports from the main monitoring bodies such as the State Secretariat for the Environment and Water Resources have identified that the main beaches in the municipality of São Luís

are unsuitable for bathing, including the beach in study.

On the beach under study, real skyscrapers are appearing, taking over the space of the dunes and paleodunes, where the projection of the shadow of these buildings on the beach harms not only the bather who goes to the beach due to the sun, but the entire biodiversity of this environment. Furthermore, it is possible to observe the damage to air circulation, which has concrete walls as barriers, bringing serious changes in the microclimate of this coastal environment and the intense traffic causing not only noise pollution but also air pollution, transforming an environment of peace and contemplation of nature at certain times of the day in a totally hostile area.

Fires in the dunes and paleodunes on São Marcos beach are often caused in a criminal manner, causing degradation of the soil, flora, and fauna present in these beach environments, where many of these arson fires go unpunished, contributing to the practice of this crime and resulting in the reduction of all the biological diversity of the area.

Another worrying factor is the threat posed by the large port activity close to our beaches, where numerous ships loaded, most of the time with products that cause deleterious effects on biodiversity, are anchored very close to the beach under study.

According to the magazine UFMA Portal da Ciência (2010), the ballast water from these ships, often dumped without any supervision, introduces exotic species that compromise local biodiversity. Where 22 exotic species have already been found in our waters, including crustaceans, molluscs, porifers, bryozoans, annelids, hydrozoans and ascidians in collections from October 2008 to November 2009. Many of these exotic species do not have natural predators in our environment, starting to exercise process of dominance over native biodiversity, altering the natural characteristics and functioning of ecological processes and the flow of matter and energy, leading many of those species to extinction.

In a report by the newspaper Pequeno (14/09/2009) there is a complaint about the port dynamics in São Luís and its effects on the environment. In the last 25 years alone, around 40 thousand ships and various vessels from all over the world have entered this port complex, discharging their ballast water, bilge water

contaminated by hydrocarbons and dissolving, through friction in the seawater, the poisoned paints. of their hulls, which are made up of heavy metals such as lead, copper and mercury. Other contaminants come from the loading and unloading of ships that fall overboard due to strong winds and the quality of port operations. They are: copper, aluminum powder, manganese, limestone, iron, various fertilizers, pig iron dust, fuels, bauxite, alumina, caustic soda, coke dust, mineral coal dust and ammonia. All this material over time is decanted and added to the bottom substrate.

As for the tents, they are much more numerous on São Marcos beach, where many of them are already at odds with their original standardization structure, increasing the area into the beach, anthropizing and particularizing a democratic space where everyone has the right to access. free. It was observed that some tents have grassy gardens, light sources, stages and playgrounds built irregularly within the beach.

According to Law no. 7,661, of May 16, 1988, establishing the National Coastal Management Plan, beaches being considered public assets for the use of the people, are areas periodically covered and discovered by the sea. Art.10 of this Law conditions the use and prohibits urbanization or any form of use that prevents or hinders access to the beaches. It also determines that beaches are public assets for the common use of the people, with free and open access to them and to the sea being guaranteed at all times, in any direction and direction, with the exception of stretches considered to be of national security interest or included in areas protected by specific legislation.

The federal public prosecutor's office is taking action against the city hall of São Luís (case no. 94245-6) and some owners of shacks located on São Marcos beach. According to the MPF, the Municipality of São Luís promotes the construction of beverage sales stalls in fixed, non-removable buildings in the beach area of this Municipality. Considering that these are private buildings in the Union's domain, for the common use of the people, which goes against the pertinent legal provisions, as it represents in practice a "privatization", in favor of a few, of what is general and indiscriminate use by the population and the immediate degradation of the environment, caused by the installation of food and drink outlets completely devoid of the most basic hygiene and sanitation conditions.

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The occupation type map identified the presence of tents along the coastal strip under analysis. The spatial distribution of these tents is located on the coastal strip and also on the avenues and sidewalks along the coast (Figure 04). These tents were built inside the beach, preventing the natural process of sand movement. They do not have a selective collection of their solid waste nor do they use liquid waste treatment where they often clandestinely use rainwater networks to release their effluents, polluting and/or directly contaminating the beach sand and consequently damaging the entire biodiversity of the area. beach biota and putting several

bathers and visitors to these establishments at risk of contamination.

The Union's heritage superintendence has been taking action against all the stalls on Avenida Litorânea since 2009 where all the bar owners removed the additions built by default and if they did not remove them, the SPU would demolish all the irregular structures, but the association of micro-entrepreneurs on the avenue Litorânea obtained an injunction suspending the demolitions (BRASIL, 2010). This action continues through the courts to this day without any definition and work continues in some bars to expand their establishments further and further into the beach.



Figure 4. Spatialization of tents in the study area. (Source Google Earth adapted by the author)

From figure 04, the existence of commercial stalls can be identified mainly in the beach environment itself, in the northern portion of the image, which comprises São Marcos beach. These commercial stalls are bars and restaurants standardized by the city hall to carry out their commercial activities.

In the western portion, other commercial stalls are identified, but already on Ponta D'areia beach. An important observation must be made: on this beach the tents are not on the coastal strip, but on the avenue and sidewalks of the place, unlike São Marcos beach. This configuration is due to two supposed factors: the level of urbanization of the area, which is much older compared to São Marcos beach, and the

size available for use of the site, which is smaller compared to São Marcos beach. It is observed that the tents are also located on the sidewalks near Laguna da Jansen, but this location is already outside the study area.

The natural barriers on the beach under study that protect the coast naturally, such as strings of dunes and paleodunes, are being replaced by anthropogenic enterprises aimed at tourism and real estate speculation, exposing the entire population residing in the vicinity to suffer increasingly devastating effects from natural phenomena such as tsunamis, storm surges, hurricanes and cyclones.

The urbanization of coastal environments affects biodiversity mainly in terms of habitat loss and

modification, putting at risk a series of species that depend directly or indirectly on this environment. On São Marcos beach, many coastal and marine species that used this ecosystem as a place to reproduce, feed and live had their space occupied by human constructions.

FINAL CONSIDERATIONS

São Marcos beach is mainly occupied by tourist activities, causing an accelerated urbanization process, with hotels, restaurants, bars and stalls occupying the coastal fringe. These activities generate solid waste and sewage that are discarded directly into the sea, leading to seawater contamination. The most significant problems detected were deforestation in permanent protection areas, the removal of dunes and paleodunes, and the construction of engineering works in inappropriate locations.

For the recovery of the area, urgent actions are recommended by federal, state and municipal public authorities and civil society itself, aiming to protect the aforementioned environment as an alternative proposal in order to minimize negative impacts, namely: Containment of constructions close to the high water line, dunes, paleodunes, plateaus and cliffs; protect areas of dunes, paleodunes and mangroves against deforestation, ensuring the maintenance of the biodiversity still present; installation of a sewage collection and treatment system; creation of a coastal protection committee for the island of Maranhão, given the importance of coastal environments; carry out environmental education activities aimed at popular participation in the protection of this important space.

REFERENCES

- [1] BRASIL. MINISTÉRIO DO PLANEJAMENTO, ORÇAMENTO E GESTÃO. Secretaria de Patrimônio da União – SPU, Superintendência do Patrimônio da União no Estado do Maranhão. Brasília, Relatório de Gestão, 2010.
- [2] BRASIL. Plano Nacional de Gerenciamento Costeiro. Disponível em: <http://www.planalto.gov.br/ccivil_03/leis/L7661.htm>. Acesso em 02 mar. 2012.
- [3] COSTA, M. F et al. Verticalização da Praia da Boa Viagem (Recife, Pernambuco) e suas Conseqüências Sócio-Ambientais. Revista da Gestão Costeira Integrada, v. 8, n. 2, p.233-245, 2008.
- [4] CUNHA, Suênia Evelline et al. A problemática da restinga da praia de Piedade, Recife – PE.

- Anais. X Jornada de Ensino Pesquisa e Extensão – JEPEX Recife: UFRPE, 2010.
- [5] DIAS, Luiz Jorge Bezera da Silva; NOGUEIRA JUNIOR, João de Matos. Contribuições às análises da problemática ambientais da Ilha do Maranhão. Ciências Humanas em Revista, v. 3, n.2, p.127-145, 2005.
- [6] EL ROBRINI, et al. Erosão e Progradação do Litoral Brasileiro – Maranhão. Disponível em http://www.mma.gov.br/estruturas/sqa_sigercosm/_arquivos/ma_erosao.pdf. Acessado:10/01/2012
- [7] FEITOSA, Antonio Cordeiro. Dinâmica dos processos geomorfológicos da área costeira a nordeste da Ilha do Maranhão. Rio Claro; Universidade Estadual Paulista Júlio de Mesquita Filho, 1996. Tese de Doutorado
- [8] FERREIRA, A.J.A. O Estado e as políticas do urbano em São Luís. Dissertação (Mestrado em Geografia Humana) – Universidade de São Paulo, São Paulo, 1999.
- [9] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. Instituto de Planejamento de Gestão Governamental, 2005. Disponível em: www.ibge.gov.br. Acessado em: 04/05/2012.
- [10] JornalPequeno.Disponível:<http://jornalpequeno.com.br/edicao/2009/09/14/dragagem-do-porto-do-itaqui-pode-estar-ocasionando-morte-de-peixes-nas-praias/>. Acessado em: 05/11/2011.
- [11] MARANHÃO. Secretaria de Estado do Meio Ambiente e Recursos Hídricos. Programa Estadual de Gerenciamento Costeiro. Macrozoneamento do Golfão Maranhense: diagnostico ambiental da microrregião de aglomeração urbana de São Luís e dos municípios de Alcântara, Bacabeira e Rosário. Estudo de Geologia. São Luís,1998
- [12] Secretaria Estadual de Meio Ambiente. Estudo de impacto ambiental espigão costeiro da Ponta D' areia e dragagem do canal de acesso ao antigo porto de São Luís. 2008
- [13] Secretaria de Estado de Meio Ambiente e Recursos Hídricos. Código de proteção de Meio Abiente do Estado do Maranhão: Lei Estadual nº 5.405 de 08.04.92, Decreto Estadual nº 13.494 de 12/11/93_São Luís.
- [14] MINISTÉRIO PÚBLICO FEDERAL. Ação nº 94245-9. Disponível em: http://noticias.pgr.mpf.gov.br/noticias/noticias-do-site/copy_of_meio-ambiente-e-patrimonio-cultural/mpf-ma-irregularidades-em-barracas-de-praia-na-avenida-litoranea-continuam-sendo-apuradas. Acesso em 04/06/2012.
- [15] MORAES, A, C, R. Contribuições para a Gestão da Zona Costeira do Brasil: Elementos para uma geografia do litoral brasileiro. 1ª Ed. Annablume. 2007. 232 p.

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- [16] MORAIS, J.O. O Processo de Sedimentação na Baía de São Marcos. Estado do MARANHÃO, BRASIL. Arquivo de Ciências do Mar, Fortaleza, v. 17, n. 2, p. 153-164, 1977.
- [17] NORDSTROM, K, F. Recuperação de praias e dunas. São Paulo: Oficina de textos, 2010. 263p.
- [18] PORTOBRÁS. Parecer Técnico quanto aos aspectos hidráulicos/sedimentológicos referentes as alternativas de solução para implantação do Píer petróleo do Porto Comercial do Itaqui. v. 1,1998. 51p
- [19] Rêgo, Joherbeth Carlos Lima ; Soares-Gomes, Abílio; da Silva, Fabrício Sousa; Loss of vegetation cover in a tropical island of the Amazon coastal zone (Maranhão Island, Brazil) .Land use policy 2018 v.71 pp. 593-601. Revista Portal da Ciência disponível em: <https://issuu.com/ufmapublicacoes>
- [20] REIS, Rosalva de Jesus. Costa sudeste do município de São Luís-MA análise e proposta para gestão ambiental. Recife: UFPE. Dissertação de Mestrado, 2005
- [21] REVISTA PORTAL DA CIÊNCIA. ISSN: 2178-9290. São Luis: EDUFMA, Outubro/2010.
- [22] SANTOS, J. H. S. dos. Análise por Geoprocessamento da Ocupação na Franja Costeira ao Norte da Cidade de São Luís - MA. Dissertação de mestrado, 1996, Pág. 149, Universidade Federal do Rio de Janeiro. Rio de Janeiro – RJ
- [23] VIANA, J. R. Estudo da Morfodinâmica da Praia de São Marcos São Luís – MA. Trabalho de Conclusão de Curso. Curso de Geografia. UFMA. 2000. 91p.

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