

SOCIAL AND ENVIRONMENTAL HYDROGRAPHICS IMPLICATIONS OF THE LAND USE IN THE PLAIN AND COASTAL BOARDS BETWEEN ILHÉUS AND OLIVENÇA – BA

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Abstract

Between the diverse units geomorphologicals of the Bahia, are presents also the coastal plains and the coastal trays. Following to present line of beach, healthy noticed by its sandy forms, with colorings homogeneous. Diverse works exist about the genesis litologics of those geomorphological rooms. It researches of big relevance published in national scope as the of Suguio (1975), Martin (1976) and Dominguez (1980) attribute of unanimous form the genesis of the present coastal plain and trays to the interactions between the erosive forces of the sea and depositional conditions on the part of the continental rivers. The objective of that work was map the Coastal Plain and the Coastal Tray in the stretch between Ilhéus and Olivença, and discuss about the activities of use of him soil that grant hidrographics impacts and partner-environmental about both. It was carried out the mapping in scale of detail (1:5.000) of the coastal plain utilizing image IKONUS high-resolution. The corresponding zone to the plain at present is utilized in diverse typologies of use of him soil, since cultivations to property lots. The friable texture of the substrate implies in a sensibility the antropological interventions in the same one. The deforestation in the trays, the urban growth, the extraction of sand and the absence of specific plannings for those rooms geomorphologicals are the present causes of hidrographics degradation and partner-environmental problems to same. The intention of that work is going to dispose facts for contribute with better planning in the area of study

Keywords: Sandy, Degradation, Ilhéus.

Introduction

The state of Bahia is an unit of Brazil that is in evidence since last centuries. The importance of the state is derived mainly from the historical events that later influenced and formed the whole Brazilian nation. Due to its

immense territory (564.692,67 km²), the state is also famous for the rich diversity of scenic beauties and landscapes that show due to a great variety of geomorphological units. The demarcations of the administrative areas (territories of identity), besides all the cultural essence indicate the traditional communities'

relationships with environmental elements, as mountains, great rivers, estuaries, etc., defined as "landscape marks" (MORALES, 2005, p.87).

Among all the relief units and the characteristics of the Bahia's geomorphology, it is also present the quaternary plain, or coastal plain. Following the current beach line, it is noticed the sandy form, plain and homogeneous. This type of plain is presented in many spaces of the coast, where it is usually associated with the marine or the outlet of great rivers during the Geological Era of the Quaternary (MARTIN, 1976). In municipal districts as Belmonte, Maraú, Canavieiras and Caravels, the plain is noticed mainly the extension in regional scale, produced by the accumulation of sea and fluvial sediments, with the presence of sea terraces, lagoons, coastal strings, mangroves and deltas.

Several works exist concerning the constituent genesis of the Bahia's plain coastal (classified as a landscape unit). Researches of great relevance such as the one of Martin (1974), Suguu (1976) and Dominguez (1982, 1986) attributed unanimous that the genesis of the coastal plain to the interactions between the erosive forces of the sea and depositions of the continental rivers.

In a regional level, different from the municipal districts mentioned previously by the presence of a coastal plain well developed, Ilhéus appear in the geological-geomorphological scenery as stage of a simple evolution/formation of that type of relief.

Works of coastal geological mapping accomplished by Dominguez (1980) revealed that in the surrounding city beach the plain was relatively a little enlarged and, in some places, interrupted by the direct contact of the rocky walls of the crystalline origin in contact with the sea, as it is noticed in the central area of the city and in districts as Serra Grande and Olivença.

The Ilhéus's scenery is important once the nature of the accumulation and transport of those sediments that built the plain are controlled, above all, for the interaction sea-continent, where the climate and the marine currents control the balance of sediments, as well as the biogeochemistry and connected hydrological. Anthropogenic actions of considerable magnitude can alter that dynamics or break the work of some of those agents, generating an unbalanced system (SENNÁ, 2012).

For being a land of sandy substratum little consolidated, highly permeable, of easy alteration, the Ilhéus's coastal plain is totally favorable to the urban growth and appearance of interventions of several types and dimensions. Between the city of Ilheus and the district of Olivença, beach zone, great works of urban stamp have been placing in risk the natural constitution of the coastal plain and mainly of bordering coastal of the plain. The local boards coastal places are basically rests of old cliffs, soil deposits originating from of the geomorphological activities that constituted the geological group of Barreiras.

This relationship of the coastal plain with the coastal boards in the study area is of fundamental analysis because the beach zone between Ilheus and Olivença is rich in watersheds of order zero, besides several springs that appears in the highest portions (boards) and immediately reach the ocean, crossing the coastal plain.

Reminding that the vegetation naturally is in general responsible for the hydric maintenance of the environment, and the suppression of the native forest in the study area elevates the chances of changes in the local ecosystems, mainly the hydrological composition of the area, where the carrying of sediments from the boards to the plains constitute processes of environmental degradation.

The social reality is the urban agglomerate (GEORGE, 1983), it is important to stress again that the study area is inserted relatively close to antropic zones (between Ilheus and Olivença) and submitted to the real estate beach speculations, considering that processes of environmental degradation is inevitable, because of the improper interventions in the coastal plain or the extraction of resources for several objectives, as, for instance, the retreat of sand and vegetation supply form the boards.

However, due to the presented environmental fragility of the study area, such local economical activities need administration tools and analyses concerning the types of soil use, previously approached in the projects that

contemplate facilities and operations in that area. Seeking that integration between society and nature, the objective of this work was to share information on the current composition of the environmental landscape that constitutes the plain and the coastal boards between Ilheus and Olivença through a detailed mapping. It was possible the analysis of the social and environmental implications in the domain areas of the geological substrata, of little consolidation. Specifically, the mapping implicated in the identification of: Soil use, hydrographic alterations and urban problems, being those the indicators for discussions on linked problems to interventions in the study area.

2. 2. Materials e Methods

2.1 Study Area

The municipal district of Ilheus is located among the latitude 39°00 ' and 39°30'W, and longitude 14°20 ' and 15°00'S, in the physiografic zone denominated South Coast Economical Region of the State of Bahia or Mesoregion Itabuna-Ilhéus. The actual population, according to IBGE (2010) is of 184.616 inhabitants distributed in nine districts plus the municipal headquarter. The district of Olivença, place in the limit of the coastal plain, is located in the south zone of the municipal district, about 15 km from the city of Ilheus (Illustration 1).



Illustration 1. Location of the municipal district of Ilheus and the district of Olivença.

Inserted in the Atlantic Forest biome, the area presents an index of annual precipitation annual of 1900 mm, being climatologically classified as Tropical Climate of Forest (Af), according to the classification of Köppen (1960). It is an area inserted in the plan of ecological corridors of IBAMA, presenting national and state Parks, areas of natural preservation and Refuge of wild life (Rebio).

In relation to the coastal plain and occurrences of coastal boards, the area of interest begins approximately 2 km from the center of the city, more precisely in the south zone of the city of Ilheus proceeding to the district of Olivença, in an extension of

approximately 15 km, as shown in the Illustrations 1 and 2.

The boards and the coastal plain represent the two great geological-geomorphological domains presents in this area. According to Dominguez (1990), this space is characterized by the emergence of Barreiras's formation and coastal sandy deposits what explains the beds of sand. The coastal boards are constituted by sandy-loamy sediments of the tertiary age from the Barreiras's group, while the coastal plain of Ilheus is formed by quaternary sediments of sea origin and estuary, including sea terraces there, lake terraces, humid lands (swamps, salted swamp and swamps) and beaches.

In the outlet of the river Cururupe (km10 south), one of the few places in the municipal district of Ilheus that present a reasonable development (in comparison to the plains of the municipal districts of Caravelas and Canavieiras, with about 20 km of width in relation to the sea) of the coastal plain (DEINA, 2011).

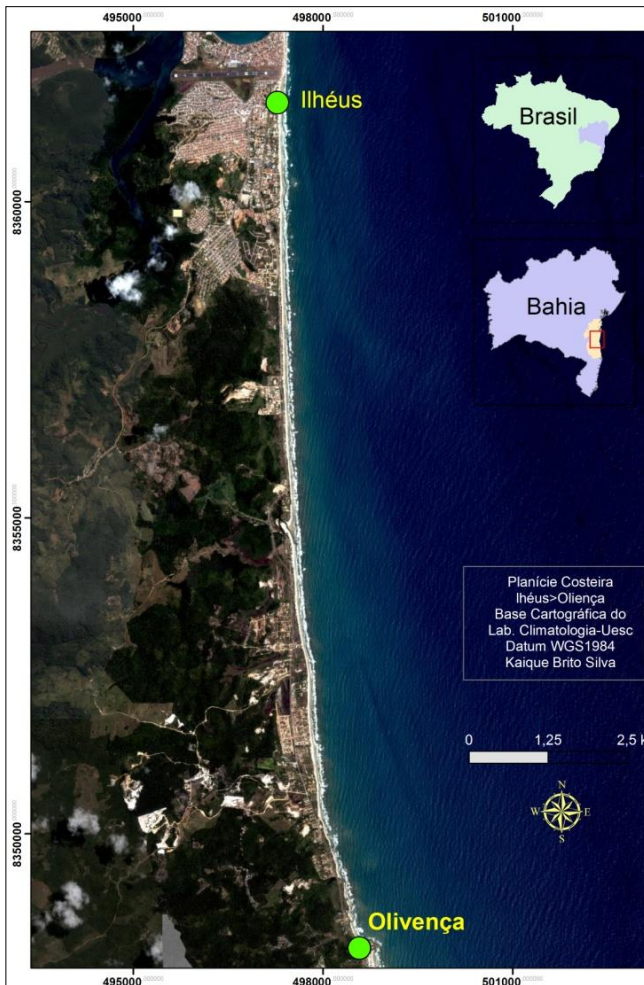


Illustration 2. Area of occurrence of the Plain and Coastal Boards between Ilheus and Olivença

2.2 Mapping

Seeking the current identification of the homogeneous areas with relationship to the texture of the vegetation and antropic activities, it was developed of present land use

along the coastal plain and the contact zone with the boards. The used method was the digitalization of polygons based on the satellite image IKONOS 2013, resolution 1:1 (1 píxel = 1 meter). Such operation was accomplished by using the Geographical Information System - SIG ArcGis 10.1. The identified classes correspond to the model adopted by the project " Geoprocessamento Aplicado ao Planejamento da Paisagem do Mini-corredor Ecológico PESC – Boa Esperança", of the Instituto Floresta Viva in 2010, based on the derived environmental zonings of the resolutions CONAMA (law 6.938/81, article 9th, interruption II). Such a model assumes important mark for taking in consideration regional social and environmental characteristics, presented in Table 1.

Classe	Descrição
Acquatic Surface	Mapped areas representative of the of local drainage system
Antropic Area	Zonas with urban elements
Degraded Area	Degraded areas of exposed soil, caused by the suppression of the vegetable covering induced by different types of antropic activities.
Pasture	Area of low vegetation destined to the cattle production with cattle breeding or others animals
Humid Areas	Swamps, salted swamps and swamps

Cabruca	System of cocoa cultivation under the forest
Forest	Atlantic forest vegetation typically forest and seasonal forest
Cultivations	Several cultivations, except Cabruças

Quadro 1 - Classes de uso do solo adotadas.

The available cartographic bases in general bring space representations in scale 1:100.000. The data on the Plains and Coastal Boards of Bahia in such a scale are resulted of geological surveys accomplished since 1974.

It was developed a restructuring of the coastal units through cartographic data of the informational digital on-line data bank TOPODATA (VALERIANO, 2005), specifically the level curves and the Digital Models of Elevation - MDE's. The GIS was used for such an objective it was ArcGis 10.1, specifically the module ArcMap. Para a identificação de mudanças do corpo hidrográfico da área de estudo foram sobrepostas cartas da SUDENE de 1971, Bahia_SEI-2000 e dados obtidos pela identificação de zonas de erosão através da

imagem de satélite IKONOS do ano de 2013, de resolução já citada.

For the identification of changes in the rivers network it was the maps of SUDENE, 1971 and Bahia_SEI, 2000 together with the erosion data obtained through the satellite image of IKONOS from 2013.

It is important to point out that for the presented analyses it was of highest importance field researches, being for the certification of the mapped areas and corrections of the geographical coordinates, using a GPS's model GARMIN OREGON 550, available in the Laboratory of Climatology of Santa Cruz's State University.

3. Results and Discussions

3.1 Mapping of the Plain and Boards

The result of the mapping of the Plain and the Coastal Boards presented a substratum well delimited and in agreement with the registrations of some other works as the one of Domiguez (1980) and Martin (1974, 1980). The difference was the method of crossing the matrix (image) and the vector (lines, level curves data) that generated the possibility of space representations in scale of 1:5.000, as they show the Illustrations 3 and 4.

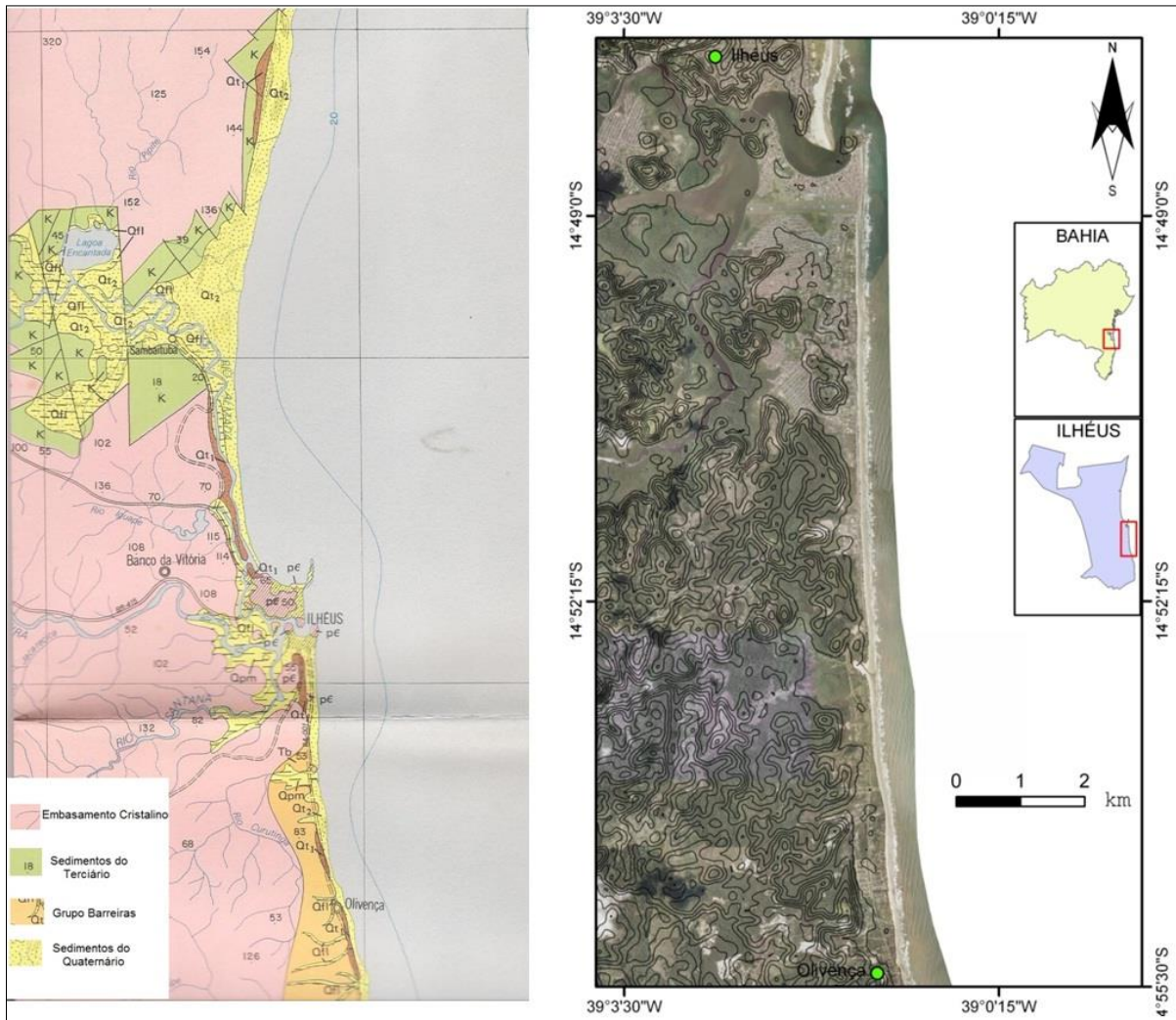


Illustration 3. Image (left): coastal mapping in scale 1:100.000 of Dominguez and Martin et al. (1980); image (right): Image IKONOS 2013 (1:1m) over layered by the TOPODATA in scale 1:5:000.

Considering that the topographical behavior of the residual sea deposits (sea plain) and of the shows in a homogeneous way in the landscape, the most appropriate GIS method for the obtaining that relief class was through fototopographic data obtained in scale 1:30.000 derived from the digital database TOPODATA. The analysis of the Land Digital Model (LDM), as presented in the Illustration 3, allowed evaluating the distribution of the different hypsometric classes in the study area.

The coastal plain presented natural limits in the quotas greater than 8 m.

The boards were identified in summits starting from 50 m of altitude, and the transition zone among the two classes it is characterized by the presence of alluvial spots. Finally, it was obtained in field the real accuracy information of points considered as anomalies, which were simply vertexes of the landscape classes that were at incorrect places. The final map corresponds the Illustration 4.

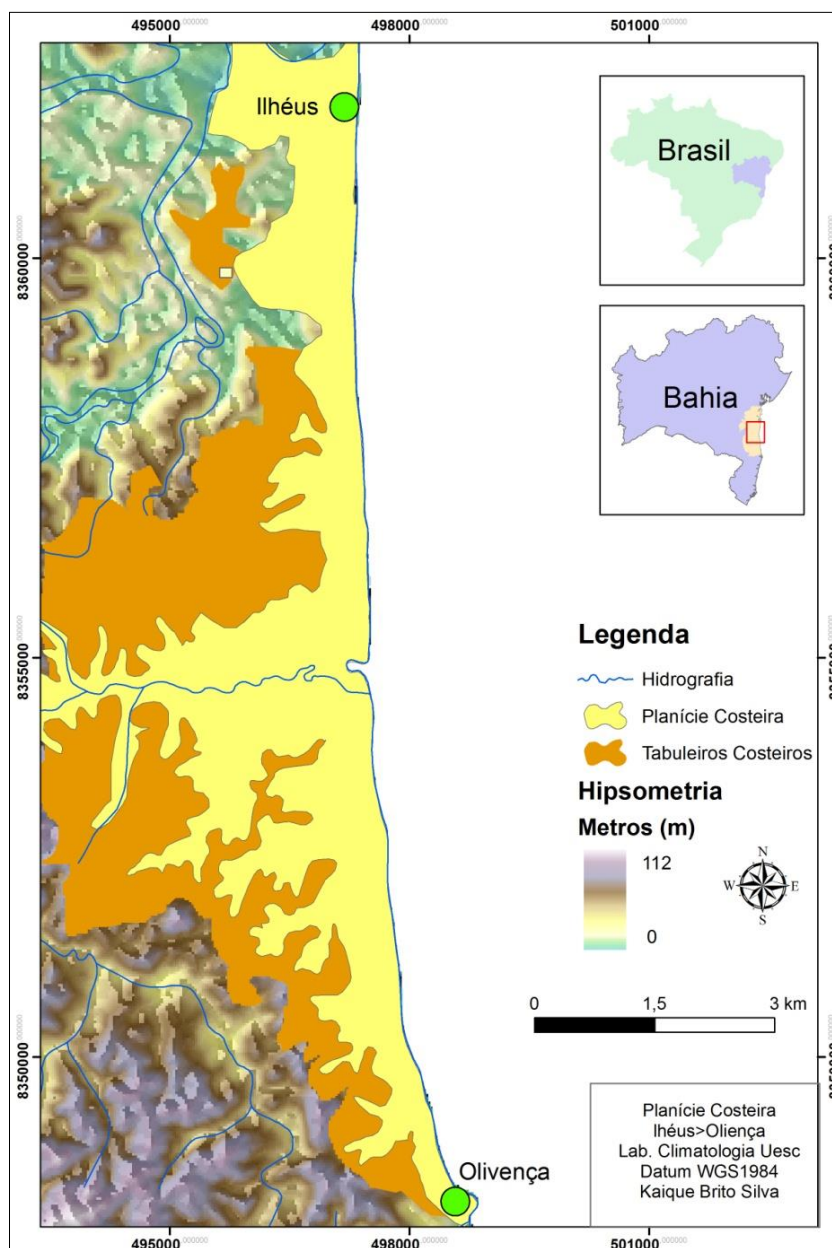


Illustration 4. Map of the coastal plain generated in scale 1:5.000

3.2 Soil Use

Considering that the soil use is a combination of a type of use (activity) and an establishment type (construction) (BOTELHO, 1999), it is admitted a great variety related the society activities in the study area. In first observation level, scale of regional level, the used image presents some differentiations of

easy perception in the landscape. It is a panorama that reveals the antropic areas, rural systems and mainly the Atlantic forest and Cabruca. In second moment, it is possible to identify elements as plantations, pastures, humid areas and water bodies.

Regarding the antropic areas, the great identified occurrence along the study area is

related to the growth of the human occupation in the south zone of Ilheus, fomented mainly by the real estate valorization of lands by the sea. It is a continuous process since the second half of the XX century. The area suffered an economical stagnation after a degradation biogenetic of the cocoa's farming in the decade of 1970. Due to that, the development was ruled by alternative activities and recently the tourist activity, the construction of real estate lots and coastal condominiums appear as growth vectors, that consequently settle on the coastal plain.

In relation to the Cabruca system, the identified areas are part of the residual cultivations formerly dominant in the study area, for being in the past century the main regional economical activity. However, it is the predominant class of the landscape in the study area. The presence of forest fragments of considerable sizes in areas considered inappropriate for cultivations of cocoa and/or extraction of natural resources as sand and whitewash. This fragments occupy relief lands relatively accident, hillsides and sandy tops of

the group Barreiras (boards). Such a characteristic contributed that in the central area of the study (illustration 5) actually is a conservation unit of the type Area of Environmental Protection (APA), the Cururupe's APA.

The areas of pastures and several cultivations are basically properties of regional cooperatives and small farmers that invested in alternative agricultural activities, as cattle breeding and fruitful plantations; It is also presented in the study area small businesses producing of pulp of fruits.

The humid areas are swamps and flooding intermittent or permanently flooded, usually associated to salted swamps (areas flooded in tides), growth of mangroves or topographical portions that favor the accumulation of water. The degraded areas are areas without vegetation and of sand and whitewash removal.

Illustration 5 shows the final map of soil use and Table 2 the dimensions of the units.

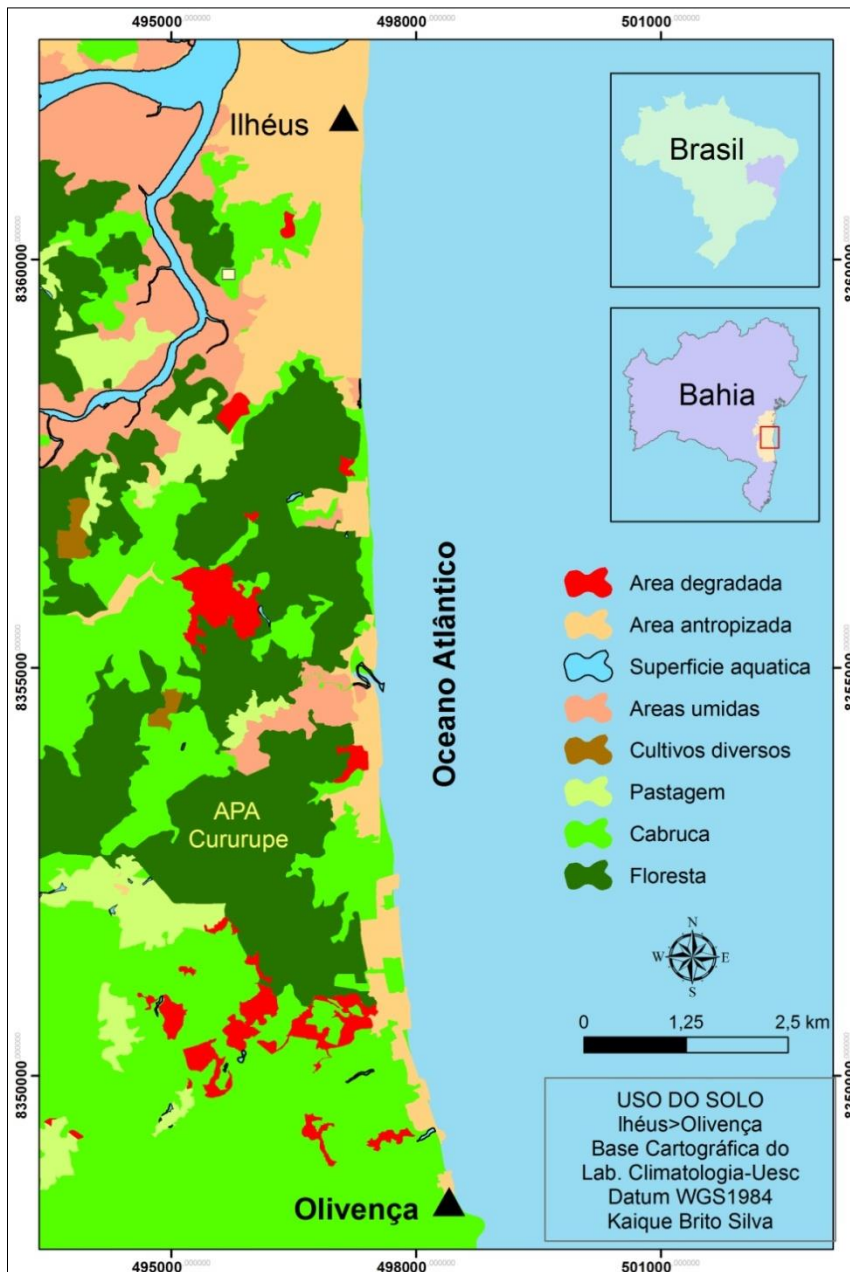


Illustration 5. Soil use map

Class	Area
Aquatic surfaces	0,6 km ²
Antropic areas	13 km ²
Degraded areas	4,6 km ²
Pasture	7,8 km ²
Humid areas	2,3 km ²
Cabruca	32 km ²
Florest	18 km ²
Other cultivation	1,4 km ²

Table 2 – Soil use mapping areas

3.3 Hydrographic alterations and environmental problems.

It was possible to identify through the satellite image, cartographic data and field work, that the hydrograph in the area is constituted mainly by streams of 1st or 2nd order, except for the hydrographic basin of the river Cururupe, in the center of the study area. They are perennial streams with fluvial regimes, fit in open sandy valleys and proceed from the higher portions of the boards to the ocean, crossing the plains. The class aquatic surface corresponds basically to those occurrences.

The identified degraded areas is approached here by the representation of places where the deforestation and the retreats of sand and whitewash for building sites have been accentuating the degree of transformation of the landscape in the study area, influencing directly the pattern of local drainage and leading several social and environmental problems.

Not only in Ilheus but also in all zones of the coastal plain, the construction or amplification of urban agglomerates close to a field of sandy deposition always leads to a natural degradation, generating patrimonial losses, costs and accidents. Another type of great impacts is the big constructions (in the case of this study area, the highway, BA001) in the sandy substratum that without geological studies technologically appropriate can generate several structural problems (ALONSO, 2007).

The fast removal of the vegetation from the coastal boards the erosion process sculpt the land totally formed by the sandy substratum. The transport and the deposit of sediments in that area are accentuated by the antropoc occupation. This process is similar to the natural formation of the alluvial spots, where the absence of vegetation and change of the water courses alters the local geomorphology (Illustration 6).



Illustration 6. A) areas face degraded by removal of vegetation; B) withdrawal process of vegetation and formation of gullies.

Erosion zones are results from improper handling, and at the same time have become potential for increasing the degraded areas. According Alonso (2007), degradation of areas with gullies in the coastal plains are difficult to reverse for engineering. Thus, the erosion areas are the main river agents of change in the study area, dramatically altering the course of fluvial channels, if not, the

extinguishing of their natural occurrences. In Figure 7, the comparison between the cartographic databases of Hydrography Martin et al. (1980) and the digitization of satellite images over field surveys of this research reveal where deforestation has caused the formation of strictly sandy gullies and changed the waterways.

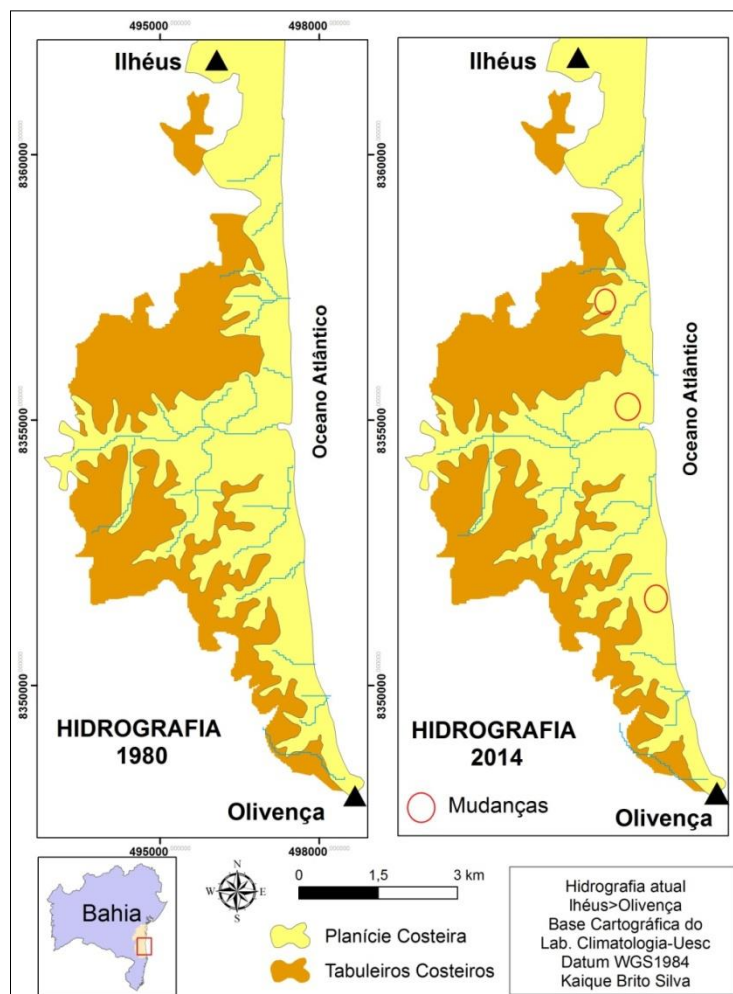


Illustration 7. Hydrographic comparison between 1980 and 2014 and identified changes

The eroded spots and the change in the course of the fluvial channels are the characteristics that affects more the structure of the constructions in the south zone of Ilhéus, generating punctual problems in the houses and roads, as well as it is also

responsible for the increased cost of housing maintenance. On that moment, it is important to stress that the occurrence antropic areas is in the coastal plain, receiving the whole erosive dynamics. In that way, problems as cracks in the walls of the properties, inclination of posts,

beams and fences, frequent appearance of holes in the roads and also inside the houses, break of tubes of channeled water and sewages are frequent for the population that reside on top of the coastal plain and in the contact zone with the coastal boards.

4. Conclusions

The mapping method of the Coastal Plain and of the Coastal Board presented demonstrated that the crossing of cartographic information and field work data using a GISIG, it was possible to detailed delimitation of the substrata, revealing more information at local level of the area in agreement with previously accomplishments.

The landscape units delimitation allowed the identification that several antropoc activities on the Coastal Boards can happen without larger damages since the processes don't consider the deforestation, because the suppression of the vegetation leads to problems that alter the formation and direction of the water courses, eroded places and the growth of degraded areas and disturbances in the constructions that compose the antropoc areas.

Even presenting a little developed plain along the south coast, the municipal district of Iheus is composed by neighborhoods, districts and places that are on the Coastal Plain, demanding frequent inspections and urban guidelines in order to avoid or mitigate damages caused by inadequate interventions in the sandy substrata.

The results obtaining by the development of this work can subsidize infrastructure work in regional level regarding the sustainable development of the studied area.

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6. References

- Alonso, J.A, et.al. Estudo Dos Edifícios Inclinados Na Orla De Santos. Revista Ceciliana, Nº28, 2007, pág. 13-28.
- Botelho, R.G.M. 1999. Planejamento Ambiental Em Microbacia Hidrográfica. In: A.J.T.Guerra Et Al. (Org.). Erosão E Conservação Dos Solos. Conceitos, Temas E Aplicações. Bertrand Brasil, Rio De Janeiro. P. 269-300.
- Deina, M.A. 2011. Variação Morfológica Do Cordão Litorâneo Associado À Foz Do Rio Jucu (Es) Revista Geografares, Nº9, P 203-230, Jul./Dez.
- Dominguez J.M.L. 1990. Deltas dominados Por Ondas: Crítica as Idéias Atuais Com Referência Particular Ao Modelo De Coleman E Wright. Revista Brasileira De Geociências, 20:352–361.
- Dominguez. J.M.L., Bittencourt. A.C.S.P., Martin. L., Li-Ma, R.C.C. E Costa. I.V.G. 1986. Roteiro De Excursão Geológica A Planície Costeiro Do Rio Jequitinhonha (B.4) e Turfeiras Associadas. XsXii Congresso. Bras. Geologia. Salvador, Boletim N:13. 201-235.
- Dominguez, J.M.L. 1980. Evolução Quaternária Da Planície Costeira Associada à Foz Do Rio Jequitinhonha

- (Ba): Influência Das Variações do Nivel do Mar e da Deriva Litorânea de Sedimentos. Dissertação De Mestrado, 73 P.
- Dominguez, J.M.L.. Bittencourt, A.C.S.P. E Martin, L. 1982. Esquema Evolutivo Da Sedimentação Quaternária Nas Feições Deltaicas Dos Rios São Francisco (Se Al), Jequitinhonha (Ba), Doce (Es) E Paraíba Do Sul (Rj). Rev. Bras. Geociências. 11 (4): pag. 227-237.
- George, P. Geografia Urbana. Paris, 1983. Instituto Brasileiro De Geografia E Estatística (Ibge). Censo 2010. 2010. Disponível Em:<[Http://Www.Sidra.Ibge.Gov.Br](http://www.sidra.ibge.gov.br)>. Acesso Em: 06 Mar. 2014.
- Köppen, W. 1960. Climatologia. Mexico, Ed. Fondo De La Cultura Economica.
- Martin, L. "Formação Das Planícies Costeiras". In Ii Simpósio De Ecossistemas Da Costa Sul-Sudeste Brasileira, Estrutura, Função E Manejo. Anais. Águas De Lindóia. 1974.
- Martin, L. et al. 1980. O Quaternário Marinho Costeiro Brasileiro (Litoral Baiano, Fluminense e Paulista) C.A.H. O.R.S.T.O.M, série Geológica. Vol. XI.
- Morales, W. F. 2005. 12.000 Anos De Ocupação:Um Estudo De Arqueologia Regional Na Bacia Do Córrego Água Fria, Médio Curso Do Rio Tocantins. São Paulo: Mae/Usp, Tese De Doutorado.
- PESC. 2012. Geoprocessamento Aplicado Ao Planejamento Da Paisagem Do Mini-Corredor Ecológico Pesc-Boa Esperança. Ilhéus. Relatório De Pesquisa.
- Senna, N. 2012. Restingas De Ilhéus: Caracterização, Uso, Ocupação E Problemas Ambientais. Anais Do Encontro Nacional De Geógrafos. Belo Horizonte.
- Suguio, K. Martin, L. 1976. Mecanismos De Gênese Das Planícies Sedimentares Quaternárias Do Litoral Do Estado De São Paulo. In: Xxix Congresso Brasileiro De Geologia, Ouro Preto (Mg), Sbg. Anais, Vol.1, Parte 2, P. 295-305.
- Valeriano, M. M. 2005. Modelo Digital De Variáveis Morfométricas Com Dados Srtm Para O Território Nacional: O Projeto TOPODATA. In: Xii Simpósio Brasileiro De Sensoriamento Remoto, 2005, Goiânia, Go. Anais Do Xii Simpósio Brasileiro De Sensoriamento Remoto,. P. 1-8.