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Formation of processes erosion associated with the use and occupation of soil in the Ribeira river basin, city of Santa Rita / PB

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ABSTRACT

The way the man has appropriated natural resources, has been revealed as the source of many problems in the environment, which has been reflected directly in the depletion of natural resources and quality of life. The erosion and loss of soil are part of these degenerative processes of the natural landscape. The watershed of the river Ribeira, located in Santa Rita, Paraíba State, is a current example of such processes that are directly associated with forms of land use. Actions arising mainly from the extensive cultivation of cane sugar has been revealed through the development of geomorphological processes that mark the landscape through erosional features, such as small fillets, grooves, and gully, plus a large amount of alluvial fans that protrude over the lowlands often silted water bodies.

Keywords: erosion, land use, river basin area of Riverside, Santa Rita-PB.

INTRODUCTION

The terrestrial relief is the result of the relationship between tectonic processes and climate action, where the first acts, especially in the structure and the second is responsible for modeled. It is through this complex association of processes that are sculptured various natural landscapes

The geomorphological science seeks to understand the landforms at different spatial and temporal scales, explaining not only their genesis, but also how they evolve in time and space. This evolution occurs naturally from the interaction of weathering agents associated with lithological characteristics of each place. However, one cannot disregard the social actions, since appropriating land to develop its activities, man becomes an important relief processing agent (ARAUJO et al., 2007).

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The various human activities are carried out directly or indirectly on the earth's surface, or on the natural landscape. However, it is known that, in most cases, these activities do not consider the carrying capacity and the natural processes that develop in terrestrial systems, and there is therefore a harmonic relationship between man and the natural environment. Thus, it can be said that the use and occupation of land improperly by human actions throughout history, have left deep scars on the environment and dramatically altered the dynamics of nature. The various human activities are carried out directly or indirectly on the earth's surface, or on the natural landscape. However, it is known that, in most cases, these activities do not consider the carrying capacity and the natural processes that develop in terrestrial systems, and there is therefore a harmonic relationship between man and the natural environment. Thus, it can be said that the use and occupation of land improperly by human actions throughout history, have left deep scars on the environment and dramatically altered the dynamics of nature.

Agricultural activities are an important human action that has directly influenced the changes in environmental systems, mainly on relief. It is common the association of erosive processes to agricultural activities, with greater emphasis activities related to monoculture.

Guerra and Marçal (2012) state that the intensive use of land without the adoption of conservation practices has caused serious erosion problems. According to these authors, the erosive processes can be initiated through the sheet eroded by cleaning the top soil, resulting in loss of fertility, and silting and pollute the various bodies of water, due to the heavy use of pesticides.

Lepsch (2010) defines erosion as the process of removal of soil particles from the higher parts of the relief by the action of rain water and the wind action, silted these particles into the lower parts of the relief (lakes, rivers and oceans). The same author presents the classification of erosion in three phases: 1) a laminar erosion caused by the gradual removal of a thin surface layer of relatively uniform thickness, covering practically all the relief; 2) erosion grooves, as the wear on narrow tracks directed along the major terrain slopes; and 3) the erosion gullies result of the displacement of masses of soil, forming large landslides or cavities in the ground.

The removal of vegetation exposes the soil, accelerating erosion by increasing the speed of runoff of rainwater. The process begins by diffuse runoff (sheet eroded) through the concentrating streams (erosion gullies), which can then progress to a more concentrated flow, coming to form gullies, which are deeper incisions on the ground, coming , most of the time, to reach the water table (Guerra and Marçal, 2012). For these authors, the practice of agriculture can be directly responsible for changes in the relief of an area, causing changes in sediment transport, which generates changes in the quality and quantity of water in the rivers and the various bodies of water present therein, which commits increasingly the quality of life of the population depends on these resources.

According Goudie (1990), soil erosion is the main and most serious impact of human action on the environment. This arises due to a reckless attitude of society towards the urban and rural areas.

The formation of erosion depends on both the natural conditions as the models of use and occupation (ARAUJO et al., 2007). Guerra, et al. (2010) affirm that these processes result from the

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action of rain, covering almost the entire land surface, especially where rainfall is high, such as in areas with humid tropical climate, with deforestation one of the factors contributor to accelerate this process.

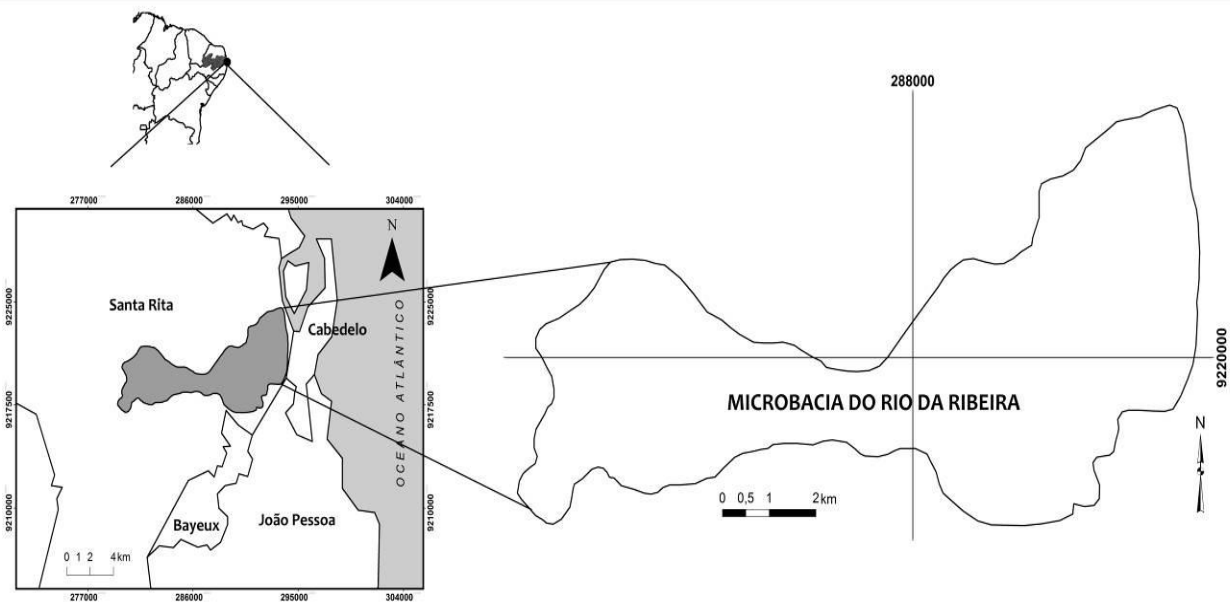
Lepsch (2010) presents four factors, which he said, influence the greater or lesser degree of susceptibility of land, opposite the water erosion. They are: climate, type of soil, land slope, soil management.

In this sense, this work aims to recognize the formation of associated erosion or resulting from so that is the use and occupation of land in the watershed of the river Ribeira, municipality of Santa Rita-PB.

The study area comprises a small portion of the rural municipality of Santa Rita - PB. More precisely, it corresponds to area of a watershed on the left bank of the estuary of the Paraiba River, called River Ribeira. In the past, before that designation, was named Gargaú river, city in which also was located one of the first sugar mills in Paraíba, ie the Gargaú ingenuity. The study area comprises a small portion of the rural municipality of Santa Rita - PB. More precisely, it corresponds to area of a watershed on the left bank of the estuary of the Paraiba River, called River Ribeira. In the past, before that designation, was named Gargaú river, city in which also was located one of the first sugar mills in Paraíba, ie the Gargaú ingenuity.

Among other basins that make up the lower course of the river Paraíba (Paroeira, Tibiri, Guide, Mandacarú, Sanhauá and Tambiá) the watershed of the river Ribeira is located west of Stuart and Tibiriri Islands. It offers total area of 52 km2, and fits in a rectangular polygon according to geographic coordinates 7 ° 0'03 "S 7 ° 5'5" S latitude and 34 ° 59'49 "W to 34 ° 51'40 "W longitude (Figure 1).

Figure 1: Location of the study area



Said basin is located within the basin of the Paraiba River, which in turn sits on the Alhandra sub-basin, which together with the Miriri sub-basins and Olinda, so Sedimentary Basin Paraíba.

The Alhandra sub-basin is made up of three layers lithostratigraphic: Training Beberibe /

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Itamaracá, the Gramame Education and Training Maria Farinha, all covered by sediments of the Barreiras Formation, which is not part of the geological formation of the said sub-basin.

Training Beberibe / Itamaracá is the basal layer of the Paraíba Group, consists predominantly of sandstones of medium grained and can sometimes be conglomeratic (Araujo, 2012). Training Gramame, and consists predominantly of calcareous, occurs throughout the basin, outcropping on the surface in an environment plans and lowered, making the valleys and river plains that make up the hydrographic network of the area. Training Maria Farinha is stratigraphic layer of the most superficial Paraíba Group, being restricted to its occurrence to Alhandra sub-basins and Olinda, however, there is no record of their occurrence within the study area.

The Barreiras Formation is the main lithostratigraphic unit present in the study area and represents about 80% of the sedimentary Phanerozoic that compose it. This formation consists of sandy clay sediments poorly consolidated continental origin, providing in sandy-silty layers, sandy, conglomeratic and ferruginous, covering other lithostratigraphic formations that make up the Paraíba Group.

From the point of agricultural and economic view, this area is the predominance of sugarcane monoculture activity, occupying the floodplains, sheds and trays tops. According to Moreira and Targino (1997) until the 1970s this crop was restricted areas the most favorable natural conditions, such as wider floodplains of Paraiba coast. The coastal plains were a natural limit to the expansion of this economic activity due, mainly, the low fertility of their soils. Between 1970 and 1980, the harvested area of sugarcane in the state grew by 10.5%, representing an increase of 58,000 hectares of planted area. Harvested area increased from 120,000 hectares to 178,000 hectares in this period actually allowed by technological advances adopted in agricultural production, with the use of chemicals such as correctives to the ground, fungicides, pesticides and various other types of pesticides (MOREIRA and TARGINO, 1997).

Based on observations made in the vicinity of the Paraiba River estuary, especially in the vicinity of the river, the Ribeira area of study of this work, we observed the formation of various erosional features, showing significant dynamism of surface processes, through ravines and gullies, the tops and slopes of the trays and deposition in the areas of downloaded. These erosional features, occur more evidence sobtretudo in the area of sugarcane plantation and its surroundings.

MATERIALS AND METHODS

This paper adopts the methodological basis analog deductive method, geossistêmicos principles and geomorphological mapping methodology available in Ross (1992).

Initially a literature search was made, comprising theoretical and methodological framework that guided this research. In a second step, it carried out the cartographic survey of the study area, based on topographic maps and satellite images.

The delimitation of the study area was carried from the extraction of altimetric terrain information in topographic maps of 1: 25,000 scale corresponding to the leaves João Pessoa and Mata Aldeia, through a Geographic Information System. From the vectorization of contour lines

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made possible the production of a digital elevation model (DEM).

With the EAW were obtained accumulated data flow and flow direction, which were extracted all drainages with threshold> 100, which allowed the drainage of distinction with greater accuracy of detail. The drainage density level obtained from this process enabled the demarcation of several catchments distributed along the River Paraiba North estuary region, among them the watershed of the river Ribeira.

The catchments obtained automatically were compared with the existing contours on topographic maps of 1: 25,000 to process reliability validation, where close proximity was found between the information, so that topographic map helped substantially in the identification of topographic splitters and consequently the closing the delimitation of the watershed in question.

To make the land cover and use map, were used images from *Rapideye* satellite with a spatial resolution of 5 meters, allowing mappings in detail scales, has three bands in the visible and two near infrared, in addition to having high efficiency temporal resolution.

The level of this resolution in the images of the satellite allowed the distinction of different classes of coverage and land use. two levels of classification were defined, and the level I the distinction of agricultural anthropic areas and non-agricultural, natural vegetation area and water. The level II features natural environments and human activities themselves, relating to classification levels (level I). These classes were defined based in Brazil (2006) (Figure 2).

Figure 2 – classes of soli use. Source: Brazil (2006).

Nivel I	Nivel II	
1. Áreas Antrópicas Não Agrícolas	1.1	Área Urbanizada
	1.2	Área de Mineração
2. Área Antrópicas Agrícolas	2.1	Cultura Temporária
	2.2	Cultura Permanente
	2.3	Pastagem
	2.4	Silvicultura
3. Áreas de Vegetação Natural	3.1	Florestal
	3.2	Campestre
4. Água	4.1	Corpos d'água continentais
	4.2	Corpos d'água costeiros

A Mapped classes were validated through the information obtained in the field. Basically, were collected location coordinates of different points distributed throughout the watershed, and defined together information on land use and geomorphological processes occurring in that area. Later, the data were entered into the Geographic Information System and worked.

The map of geomorphological units was established based on the digital elevation model and satellite image, based on the methodological proposal of Ross (1992).

The field work had as its central purpose the recognition of geomorphological processes where erosion features and deposition within the watershed were identified to characterize not only the morphodynamics, but also the use and occupation of land and its influence on the processes.

The first field stage was intended to the general recognition of the area in order to characterize the environmental impacts present in the locality and its relevance in geomorphological terms.

The second stage aimed to cover the largest possible part of strategic points regarding the occurrence of morphodynamic processes and

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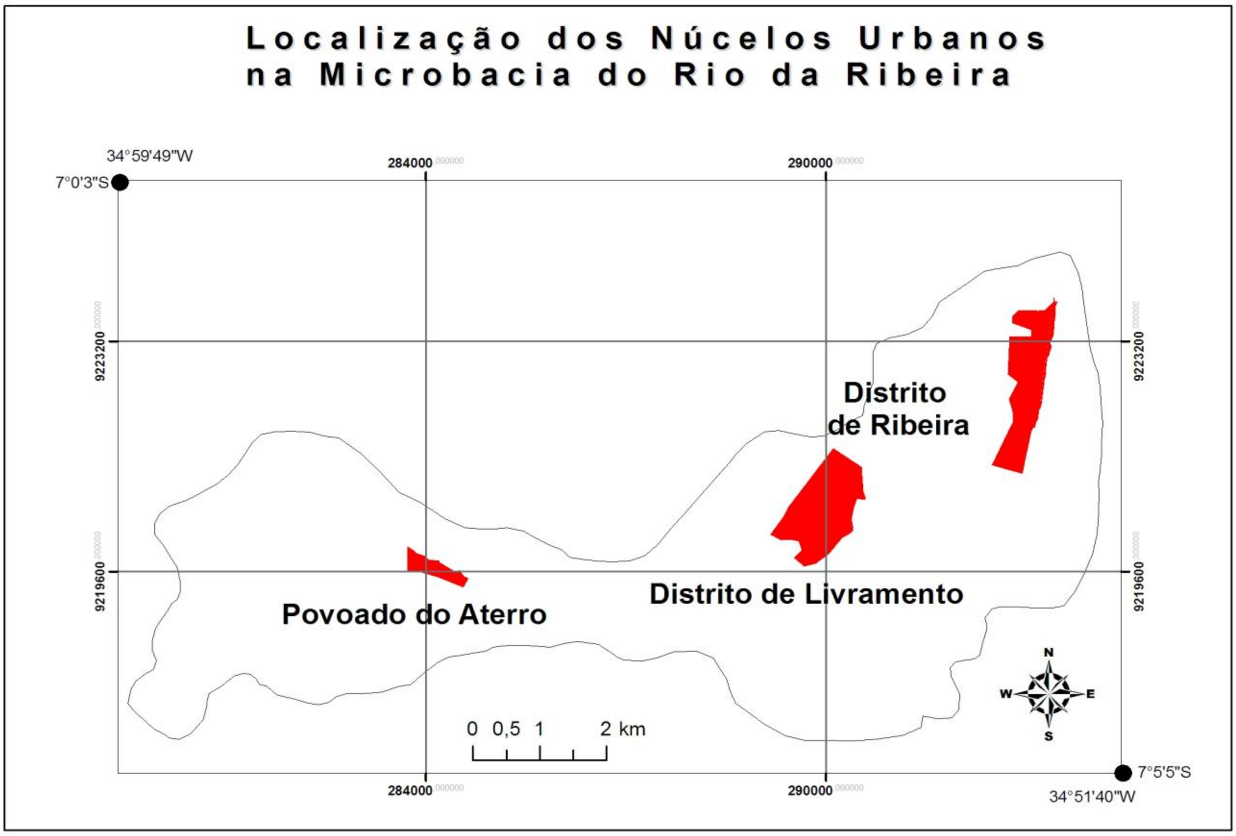
identify the type of land use in these regions, to establish relations between both the variables.

RESULTS AND DISCUSSION

1. Use and land cover

As previously referenced the land use classes follow the classification of Brazil (2006). Mapped classes were quantified from a Geographic Information System where the percentage of use and watershed soil cover for each class were obtained (Figure 3).

Figure 3 - urban cores of the watershed of the river Ribeira.



Thus, non-agricultural anthropic areas, are represented in the area of the watershed by small population centers: Aterro, Livramento and Ribeira, as well as the areas where outcrop limestone formation Gramame, as they represent ancient sites of exploitation of this rock. This occupancy level is only 2% of the total area of the watershed.

Agricultural anthropic areas represent most of the economic activities in the watershed. This level of employment corresponds to the main form of land use and represents about 46% of that area being occupied almost entirely by sugarcane. Subsistence crops also were observed, however, due to occupy small areas, were disregarded. Another important aspect to highlight is that areas with exposed soil, which corresponds to about 14% of the surface of the basin, were you consider as sugarcane growing areas, therefore, are located in similar areas and evaded by this culture.

Natural areas are represented by vegetation of mangroves, which corresponds to about 24% of the catchment area and areas with preserved

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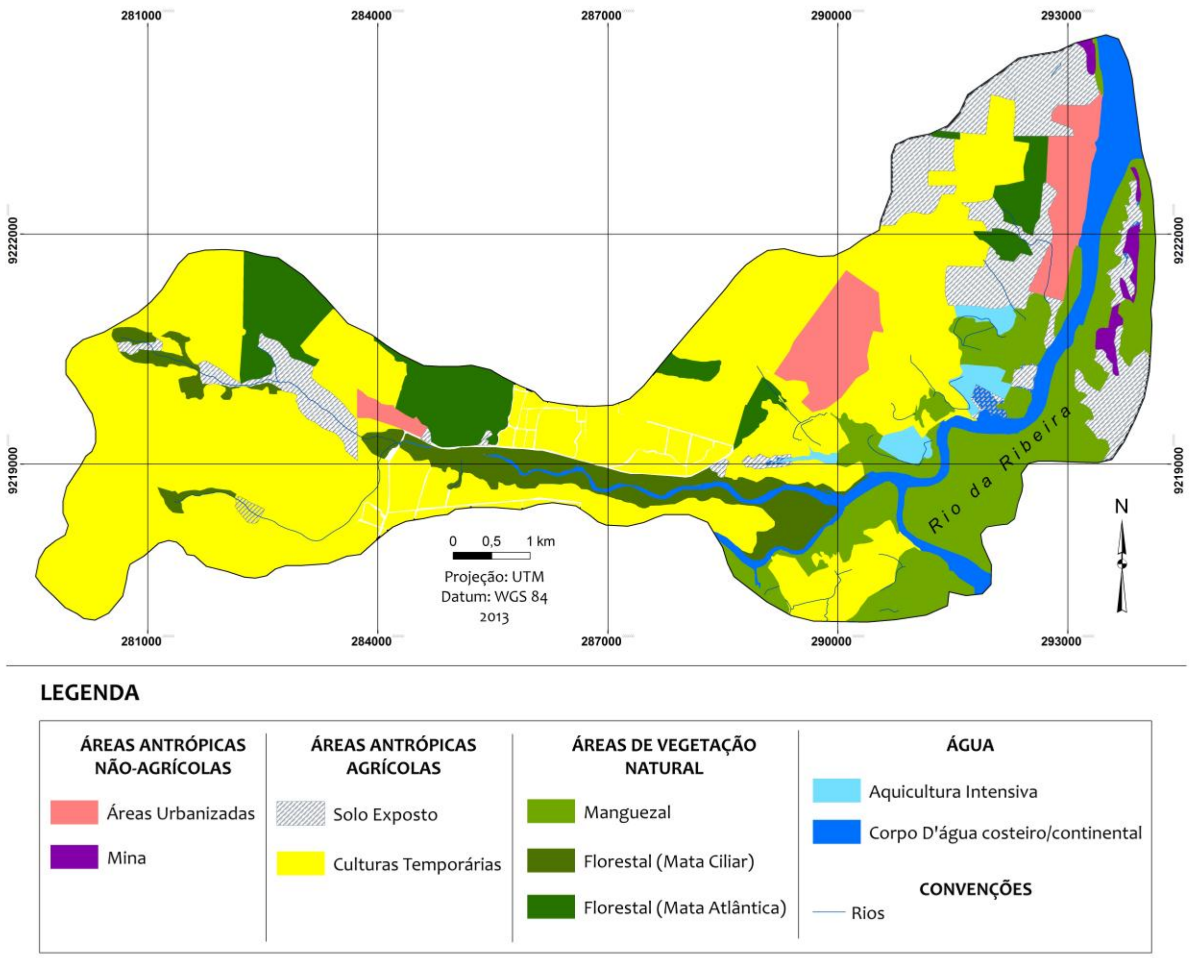
vegetation, where about 6% of the surface correspond to the Atlantic Forest reserves and 17% of the area is occupied by Mata riparian.

In some places, we see a strong spatial proximity between areas with natural vegetation and cane sugar plantations. The cane field burning is a cultural practice of soil management to facilitate harvesting. This procedure enhances the risk of destruction of the areas where there is a predominance of natural vegetation (Figure 4).

Figure 4: Land Use in the river basin of Ribeira.



The presence of Riparian Forest along the banks of the Ribeira river is 17% of the total area of the watershed, and is present only in a small section near the village Aterro on its left bank, downstream. Its right bank is fully occupied by sugarcane plantations, being noticeable in some places the presence of mangrove vegetation.

The land use class or water classification level (BRAZIL, 2006) is the existence of aqueous bodies within the area of the watershed, identified as the tanks for intensive aquaculture bodies of coastal and inland water. Shrimp farming activity represents only 2% of land use in the area (Figure 5).

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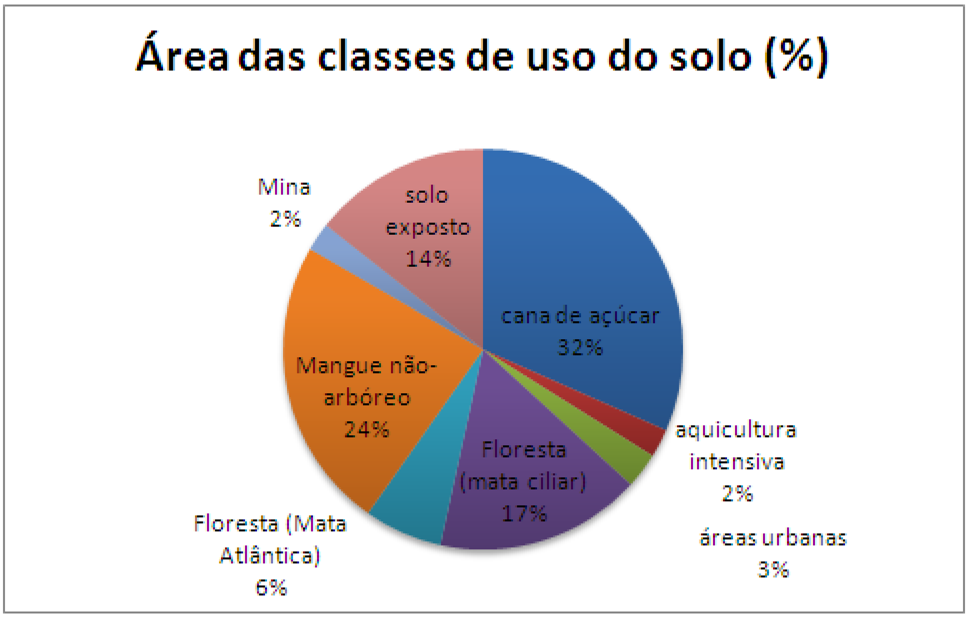
Figure 5: Percentage of use and occupation for each activity developed in the study area.



Geomorphology

Among the units of relief identified from the compartmentalization of relief map, they are: 1) forms with convex tops, 2) forms of river terrace, 3) forms of colluvial and fluvial terrace and 4) forms of interdial plain (mangrove) (Figure 6).

The geomorphological dynamics that influence the deflagration of erosive processes within this basin, was discussed taking into consideration three main plots of relief: 1) trays (top relief), 2) strands, and 3) fluviomarinha plain.

The trays are presented in tabular form, corresponding to higher areas, with a maximum altitude in its top 90 meters, and gentle slopes to the east of the continental resulting erosion basically consist of poorly consolidated sediments arenoargilosos of Barreiras. In general, this geomorphological unit is characterized by having gently dissected relief plan top.

Its top features low erosive gradient and predominance of the processes of pedogenesis, due to its gentle slope, thereby facilitating the infiltration of rain water into the soil. The sandy material that makes up this relief unit functions as a porous sponge, allowing rainwater to infiltrate, silted fine sediment and nutrients to the soil. These fine sediments (silt and clay) are deposited in the soil horizon B, and will form a ferruginous layer, which when hardened are called "duripan" and when they are humidified are called "fragipan".

The cultivation of sugarcane in this unity of relief is a factor that is directly associated with erosive processes that occur there. This is because without vegetation, the soil becomes more vulnerable to the action of rainwater, which acts directly on it, silted certain amount sediments to the most recessed areas of the relief. However, the predominance of linear erosion is not noticeable in this unity of relief, being more evident the formation of laminar erosion (Figure 6).

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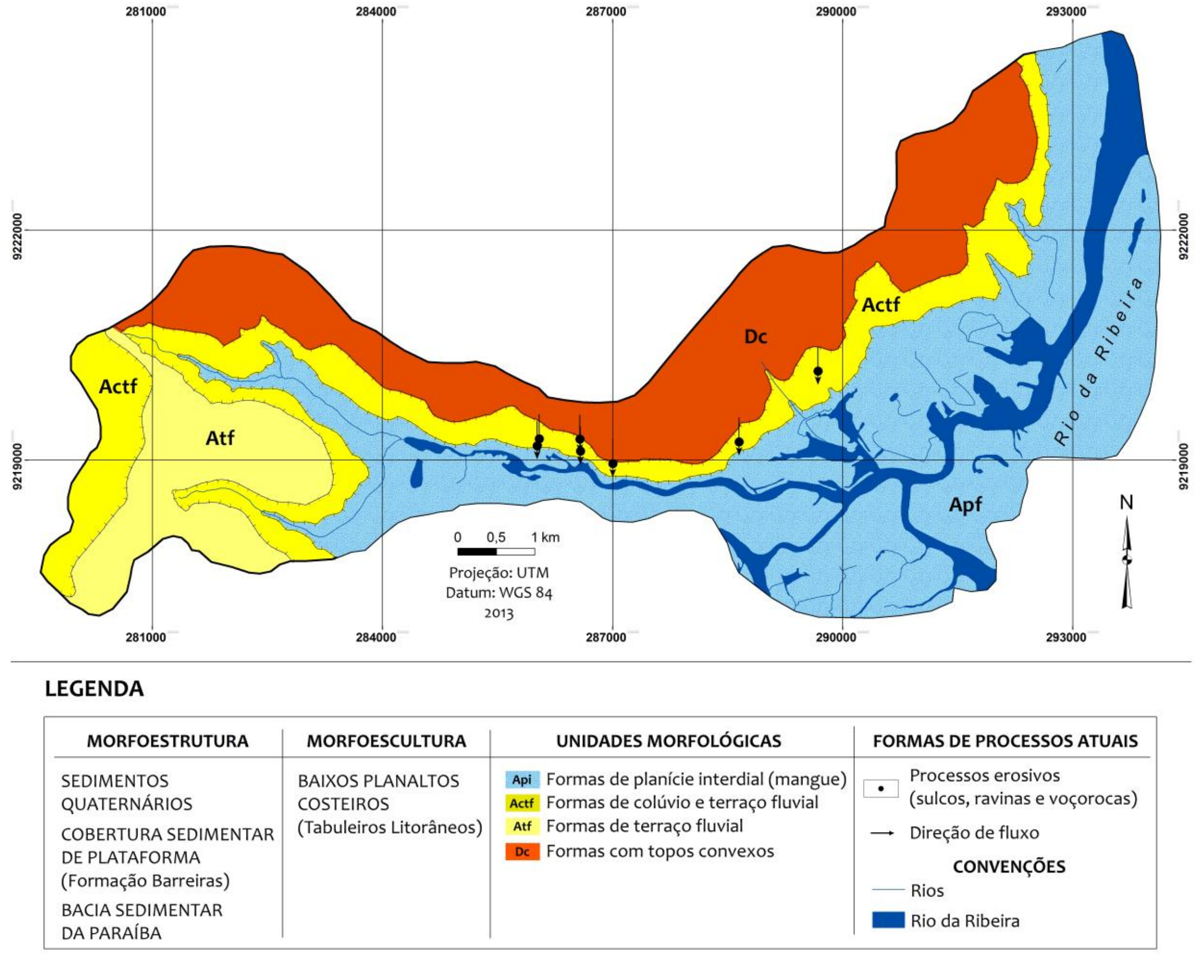
Figure 6: Relief units in the river basin of Ribeira



In the field of human action occurs in this geomorphological unit to change the natural dynamics of geomorphological processes, because this situation increases the leaching process from the top of the trays, carrying to the most recessed areas of the relief, contributing to the river silting process of Ribeira.

The strands are formed by arenoargiloso material, poorly consolidated coming from the top of the trays. Generally have smooth gradients between 8 and 13%, reaching 45% in some places toward the riverbed of Ribeira. This geomorphological unit is more susceptible to erosion, a result of the sedimentary material association that makes up with its slope, which gives it greater fragility front of erosive processes.

Also this unity of relief, found the planting of sugarcane as directly linked factor to severe occurrence of erosive processes, therefore, the development of this activity does not consider hipsometric features or characteristics of the soil. This case is perceived with more evidence in the cultivated area between the village and the Landfill Livramento District, since they are placed exactly on the slopes. In this location, the strands behave generally as a gentle slope ramps stabilized by colluvium itself which is deposited on its base through the natural deposition process. However, the massive deforestation caused in agriculture has been constituted as a factor that enhances the erosive processes, making them more intense and therefore affecting the environment.

It is noticeable in all its extension the erosive action on the slopes and the transport of large amounts of sandy sediments, and exposure of the

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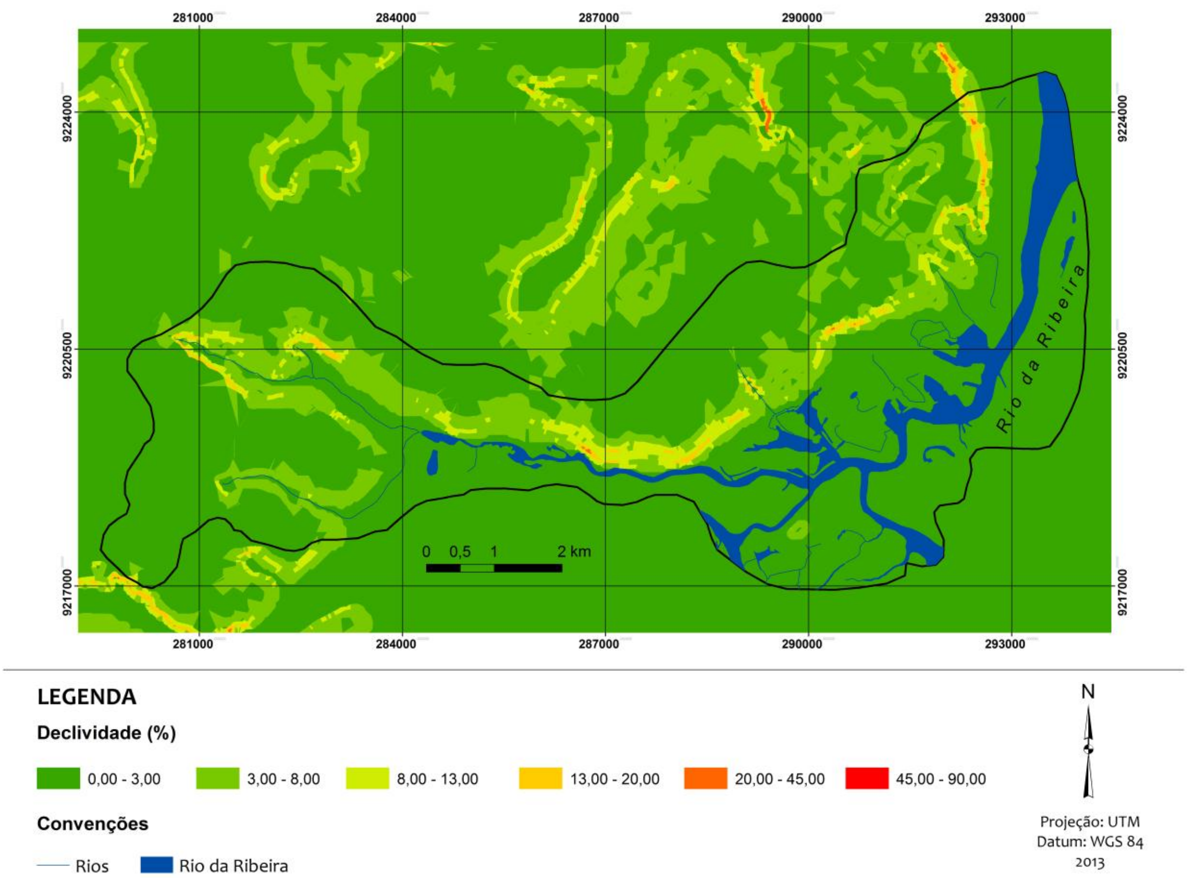
soil due to erosion suffered. In somital portion of the shed, it was identified the formation of small drainage headboards and channeling flows, reaching in some cases to form tributaries.

This situation is aggravated by the lack of original vegetation composed this geomorphological unit. Once the exposed soil or in preparation for planting by plowing process, the power of rainwater erosion increases to the point of causing incisions in the soil, such as fillets, grooves, ravines and gullies. Noteworthy is thus the emergence of numerous erosive processes such both in the areas of land use for farming, as in urban areas.

Figure 7: slope occupied by sugarcane plantations.

Figure 8: ravine observed in somital portion of the slope, forming a small network drainage.

Figure 9: Slope map in the study area



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In urban areas, more precisely, in Livramento District, the concentration of sewage in a culvert, resulted in the formation of a gully, forming the sharpest erosion within the study area. This erosive feature has approximate dimensions of around 10 meters wide and 30 meters deep, extending for more than 200 meters long. The presence of vegetation is noticeable developing in the deepest part of the feature, and the presence of fallen tree trunks from the upper areas have eroded (Figure 10).

Based on information obtained from the map that shows the basic data on the geomorphology of the study area, it is clear that it is about the strands that occur the most pronounced erosion, as it is also an area of intense land use, mainly by agricultural activities.

Figure 10: Gullies formed in the urban area of Livramento District.

The fluviomarinha Plain, is a relief area gently plane, formed by the deposition of continental sediments under the influence of tidal action. Changes made in other relief units mentioned above will be reflected directly in this environment, because the large load of sediments deposited in this environment will result in silting of the river Ribeira, changing all the natural dynamics of environmental processes that take place in this environment.

Quaternary sediments that originate at the top of the trays and the slopes are projected on the surface of this geomorphological feature forming several alluvial fans, that jut inland rail bridging them. Aside from this, you can quote the soil and river water, the indiscriminate use of pesticides in sugarcane plantations.

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The location of shrimp farming ponds in this geomorphological unit presents itself as another important factor contributing to the impacts that occur in that environment. This activity is used the favorable conditions found there, such as the salinity of the estuary water to settle their tanks creation.

There is, therefore, the silting of the river channel and the contamination of its waters for shrimp farming also as one of the main environmental impacts present in fluviomarinha Plain study area (Figure 11).

Figure 11 - Shrimp farming tanks located in fluviomarinha plain.

Understanding how human activities are related to the different elements that make up the Earth system is an important tool to obtain in fact what is now called sustainable development. This is achieved from the respect to the natural characteristics and limits pre-established by its dynamics.

The results of this study show the importance of establishing a harmonious relationship between human activities and natural features that make up the physical environment. Without taking this into account, the result is extremely damaging to both parties.

The data obtained in the survey show that association of sugarcane activity as it develops in the study area, with the geomorphological processes that characterizes it, is a serious problem to the environment, and erosion on the slopes the main representative of this process, because the planting of sugarcane is done without considering the soil characteristics, geomorphological processes or relief shapes that characterize the area.

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The crossing of the land use map information with the map of the geomorphology of the watershed of the Ribeira River allows state that it is in the areas where there are the most pronounced erosion in the study area, generating a significant amount of sediment transported in this geomorphological feature.

As a result of intense erosion occurs consequent siltation of the river Ribeira, responding to the significant increase in the amount of sediment released in his bed, as well as soil and water bodies by pesticides used in plantations, thus causing a serious imbalance to natural systems that occur there.

Apart from this, the power of action in urban areas are also responsible for the formation of erosive processes, with a view to occurrence of a gully in Livramento District, arising from the disposal of storm sewer and connections from the sewer system.

Therefore, it is understood that the formation of erosion in the watershed of the river Ribeira, is linked to the way is the use and occupation of land. The form of agricultural management and land use adopted in the study area are classified as unsustainable, given the characteristics and natural processes that mark the geomorphological units that make up the watershed of the river Ribeira.

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