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Risk desertification in Cabrobó / PE : climatic conditions and human activities

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ABSTRACT

The region of Desertification Core Cabrobó / PE has low annual rainfall and spatial distribution of heterogeneous precipitation. In the southern city of Cabrobó, where is the island of the Assumption, the combination of local climate characteristics, associated with atmospheric dynamics, and especially with the presence of human activities, allows the occurrence of a sharp process of land degradation. The objective of this study is to evaluate the risk of desertification in Cabrobó / PE, considering the climatic conditions and anthropogenic activities in the region. The climatic conditions were analyzed by the spatial distribution of precipitation, air temperature and aridity index, interpolating data from 58 stations located in the study area and its surroundings. In order to evaluate the anthropogenic activities in the region, a field visit was carried out in places that are in the process of degradation. The results indicated that the climatic conditions favor the process of desertification, but developed human activities such as irrigated agriculture by flooding, extensive cattle ranching and deforestation, contribute greatly to the advanced state of disrepair that some parts of the region meet.
Keywords: index of aridity, human activities, desertification, Cabrobó.

INTRODUCTION

The concept of the most accepted desertification phenomenon today is what is described in the United Nations Convention to Combat Desertification, in Article 1: "Desertification is the process of land degradation in arid, dry semi-arid and sub-humid, produced by several factors, including climatic variations and human activities. For land means bioproductive terrestrial system that comprises soil, water, vegetation, and other biotic components with ecological processes Quse developed within the system. For land degradation means reduction or loss of biological or economic productivity and complexity of agricultural land in dryland or irrigated by a process or combination of land use processes, including those resulting from human activities. After the French researcher Louis Lavauden mention for the first time in 1927, the term was popularized by Andre Aubreville in 40 years (Soares, Mota Filho and Nobrega, 2011). The multiplication of environmental studies of the last century to the present day also fall within the subject desertification. , Placing it in one of the most serious and discussed problems of dry land on the planet (Soares, Mota Filho and Nobrega, 2011 If by definition all arid, semi-arid and dry sub-humid areas are susceptible to desertification process (aridity index between 0.05 and 0.65, excluding arctic and subarctic regions), should take into account that the degree of vulnerability It varies according to local environmental characteristics (SOUZA, 2012). Thus, the threats that make up this table also have different origins, from the weather, with sharp interannual rainfall variability and the degree of aridity index the Brazilian semiarid region presents, to the socioeconomic organization process and the use of natural resources (CAVALCANTI et al, 2006). For climatic characteristics, the process of desertification is likely to occur in the semiarid The Northeastern environment, open, formed by the product of bilateral relations between society and the natural resources with which human beings come into contact, modifying them, according to the abiotic factors, biotic and socioeconomic space. Notwithstanding the explained, among these products, the weather, in fact, has a leading role in this process.

But not only the weather conditions the Brazilian semiarid region susceptibility, but pedologic too, and added to this, as Sa and Angelotti (2009) describe the practice of family farming dryland which was developed over the generations by increasing the use of soil and vegetation, without, therefore, introduced the use of technology, remains based on extensive methods of use and environmental management. During the process of occupation of the region, shifting cultivation was replaced by permanent agriculture and increased grazing pressure and extraction of firewood in remaining native vegetation are the most significant expressions of the increased use and dependence on natural resources (SAMPAIO et al, 2005).

At the end of 2011 was initiated to another great and lasting drought in northeastern Brazil. About two years after the release of the State Action Programs to Combat desertification and mitigate the effects of drought - PAE-PE, and a year of state law institution on the State Policy to Combat desertification and mitigate the effects of drought, 14091, 2010, subject desertification end triggering more concerns, particularly the long drought that extends to the present day.

The temerity area tends to increase due to strong pressure from land use and inadequate management, which brings the negative consequences the destruction of fertile soils of the region and the deforestation of the forest cover that is already in the degradation process (SOUZA et al , 2009). This feature, in turn, has been aggravated due to certain forms of use of these lands, which have been established for centuries, further intensifying the vulnerability of the population situation and developed economic activities (MELO et al, 2008).

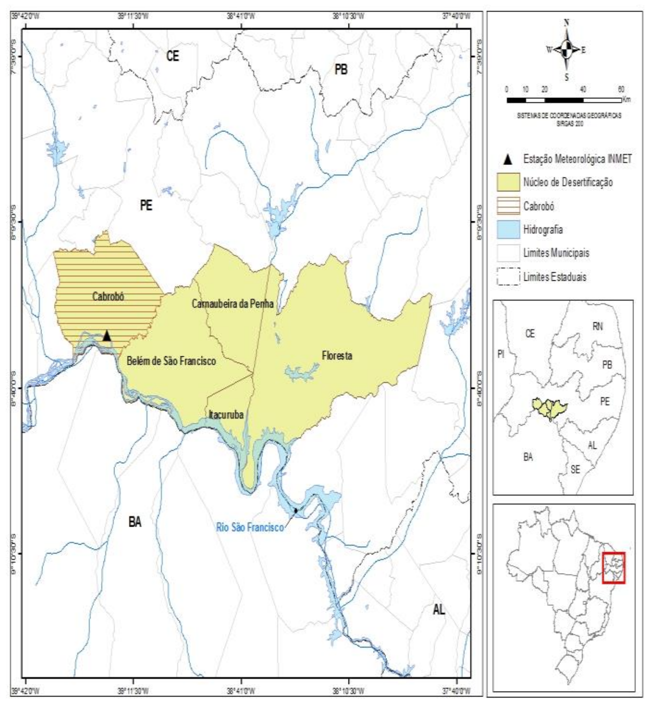
The Northeastern environment , open, formed by the product of bilateral relations between society and the natural resources with which human beings come into contact , modifying them , according to the abiotic factors, biotic and socioeconomic space . The climatic characteristics of the northeastern semi-arid with irregular seasonal rainfall concentrated in a few months and uneven spatial distribution , with the majority of the above year the intense sunlight and high water deficit , resulting in a high evapotranspiration rate if added environmental changes caused by human activity may intensify the process of desertification and bring various disorders to population and economic practices . In this perspective , this study aims to evaluate the process of desertification in Cabrobó / PE , considering the climatic conditions and anthropogenic activities in the region.

MATERIALS AND METHODS

1. The study area

The Desertification Core Cabrobó (Figure 01) is located in Pernambuco Hinterland in mesoregion San Francisco Pernambucano. It is formed by the municipalities of Belém de São Francisco, Cabrobó, Carnaubeira da Penha, Forest and Itacuruba (BRAZIL, 2007). The occupation of this region, as well as all the Brazilian semiarid region, occurred from the expansion of livestock and the development of subsistence farming, without any technical concerns associated with mismanagement of water resources. The socioeconomic formation was established with the inordinate use of natural resources without taking into account local environmental peculiarities (MELO et al. 2008). Noteworthy is the municipality of Cabrobó by population density greater than average mesoregion, with 18.62 inhabitants / km2 (IBGE, 2010). Historically the municipal population differs from other municipalities in the core. Cabrobó, Belém de São Francisco and Itacuruba present density greater than 10.00 inhabitants / km2 with population growth continue for some time and also economically, due mainly to the development of agriculture, made with irrigation techniques used since the 40s -50 when initially water wheels was used, and then diesel and electric oil. Forest has a greater land area, which contributes to a reduction in population density, however, the largest territorial portion is in caatinga hyperxerophilic area with shallow soils, and most of the population is concentrated near the river banks, in city Forest.

Figure 1 - Cabrobó desertification Center.

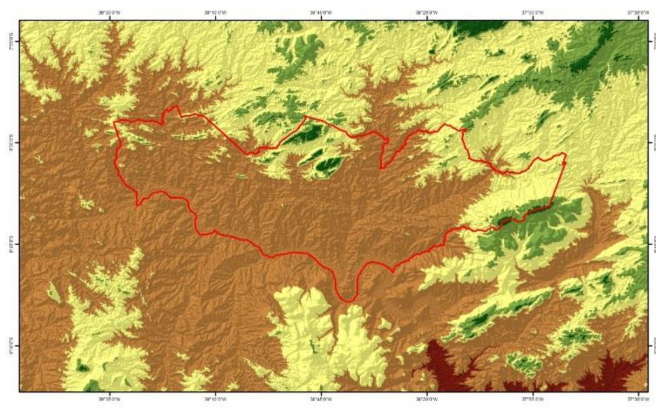


According to Smith (2012), agriculture practiced in Cabrobo has especially the onion crops (Allium cepa L.) and rice (Oryza sativa L.) bark, through the use of irrigation techniques that use a large volume água.Este produçãose method becomes a problem for this region since irrigation is not accompanied by a drainage structure. Livestock occurs predominantly extensively, particularly with the creation of cattle goats, sheep and cattle.

The predominant soils in the region are Planosols. imperfectly mineral soils or poorly drained, with maintaining a suspended water table during the rainy season, with the natural feature increased salt content (SOARES, 2012). The region has flat relief features of country depression occurring small slopes and a few areas with steep slopes that form sometimes well-defined ridges. The rivers are intermittent, except San Francisco, which bathes its southern portion. With predominance of savanna vegetation.

Figure 2 shows the relief core with altitudes ranging between 284 and 426m, with the exception of Carnaubeira municipalities of Penha and Forest presenting areas with elevations above 1000m.

Figure 2 – Relief of Cabrobó desertification Center.



2. Methodological Procedures

The work was divided into two parts, statistical analysis and field analysis. For statistical methodology they were were purchased precipitation data and air temperature (historical average) collected in the Department of Atmospheric, Federal University of Campina Grande Sciences for 58 mapped points and also data of precipitation and average air municipality of Cabrobó temperature, collected the National Institute of Meteorology (INMET). –

3. Statistical Analysis and Space

In order to validate the areas most susceptible to desertification process in the nucleus of Cabrobó, the aridity index was calculated. According to the National Action Program to Combat Desertification and Mitigate the Effects of Drought - PAN-Brazil, the areas susceptible to desertification are defined by the aridity index, which relates the volume of precipitation to evapotranspiration. The calculation of the dryness index was proposed by Thortnthwaite and Mather (1955) which calculates the difference between the inlet and the water loss in the system. From this ratio it is possible to establish climate classes according to the degree of dryness.

Table 1 - Climate classification according to the aridity index.

Classes Climáticas	Índice de Aridez
Hiperárido	<0,05
Árido	0,05 < 0,20
Semiárido	0,21 < 0,50
Subúmido Seco	0,51 < 0,65
Subúmido Úmido	>0,65

Source : Matallo JUNIOR, 2003

The aridity index can be calculated by the following formula : Ia = Pr / ETP where , Ia - is the aridity index, Pr - is the annual rainfall and ETP - potential evapotranspiration . To analyze the collected data and their distribution in space , maps were developed using the ArcGIS 10.2 software. The maid spatial statistical technique was Interpolation by Inverse Weighted Distance (Inverse Distance

Weighting - IDW), which estimates values for unknown points from the weighted sum of N known point values , having been selected by not estimate higher or lower data that the original data (LANDIM , 2000), IDW is defined by the following equation :

$$\frac{\sum_{i=1\ hij}^{n} \frac{zi}{\beta}}{\sum_{i=1\ hij}^{n} \frac{i}{\beta}}$$

Where Z is the interpolated value for the grid node , Zi is the value of the sample point to the next node , hij is the distance between the grid node , β is the exponent weighting and n the number of sampling points used . In Table 02 shows the locations of each collection station precipitation and temperature, with the data of latitude, longitude, altitude and county name.

Table 2 - Location of collection points in the Cabrobó / PE region.

Posto	Lat	Lon	Alt(m)	Município	Posto	Lat	Long	Alt(m)	Município
1	-8,433	-38,866	350	Floresta1	30	-8,0833	-38,4333	370	Serra Talhada4
2	-8,333	-38,416	395	Floresta2	31	-8,1666	-38,2166	465	Serra Talhada5
3	-8,383	-38,333	380	Floresta3	32	-8,2833	-38,4833	365	Serra Talhada6
4	-8,416	-37,933	470	Floresta4	33	-8,666	-38,2	390	Petrolandia1
5	-8,6	-38,583	317	Floresta5	34	-8,866	-38,466	290	Petrolandia2
6	-8,533	-38,2	361	Floresta6	35	-8,883	-38,126	375	Petrolandia3
7	-8,616	-38,383	325	Floresta7	36	-7,85	-37,9833	460	Flores1
8	-8,8	-38,4	400	Floresta8	37	-7,95	-37,7166	620	Flores2
9	-8,316	-39,616	550	Cabrobo1	38	-7,8	-37,8166	450	Carnaiba1
10	-8,316	-39,15	380	Cabrobo2	39	-7,7166	-38,8666	500	Carnaiba2
11	-8,4	-39,45	380	Cabrobo3	40	-7,8333	-38,1166	1010	Triunfo1
12	-8,5	-39,316	350	Cabrobo4	41	-7,933	-37,616	596	Custodia1
13	-8,516	-39,316	350	Cabrobo5	42	-8,1	-37,65	542	Custodia2
14	-8,533	-39,316	350	Cabrobo6	43	-8,35	-37,75	500	Custodia3
15	-8,666	-38,766	365	B. do S. Francisco1	44	-8,283	-38,033	431	Betania1
16	-8,766	-38,966	305	B. do S. Francisco2	45	-8,183	-37,916	480	Betania2
17	-8,816	-38,716	315	Itacuruba1	46	-8,216	-39,383	355	Terra Nova1
18	-8,016	-38,883	620	Mirandiba1	47	-8,083	-39,783	372	Parnamirim1
19	-8,116	-38,733	425	Mirandiba2	48	-8,083	-39,566	379	Parnamirim2
20	-8,233	-38,533	375	Mirandiba3	49	-8,166	-39,75	350	Parnamirim3
21	-8,066	-39,116	415	Salgueiro1	50	-8,283	-39,85	390	Parnamirim4
22	-8,066	-38,983	490	Salgueiro2	51	-7,716	-39,616	445	Granito1
23	-8,3	-38,933	480	Salgueiro3	52	-7,666	-39,166	588	Serrita1
24	-7,916	-38,983	455	Verdejante1	53	-7,816	-39,483	440	Serrita2
25	-7,866	-38,783	460	S. Jose do Belmonte1	54	-7,933	-39,316	425	Serrita3
26	-7,983	-38,633	450	S. Jose do Belmonte2	55	-8,33	-38,766	270	Rodelas1
27	-7,85	-38,5666	550	Serra Talhada1	56	-8,95	-38,533	280	Rodelas2
28	-7,9833	-38,3	435	Serra Talhada2	57	-8,983	-39,1	317	Chorrocho1
29	-8,0333	-38,1333	480	Serra Talhada3	58	-9,333	-39,15	380	Chorrocho2

Source : Academic Unit Data Atmospheric Sciences UFCG 2014 .

4. Statistical analysis Temporal

The temporal rainfall distribution Cabrobó / PE , corresponding to a time series from 1961 to 2014 the National Institute of Meteorology - INMET , was classified by the technique of quantile , based on the methodology proposed by Pinkayan (1966) and Xavier (2007) . For technical analysis of quantile was used five classes : Very Dry, Dry, Normal , rainy and very rainy in annual scale, aids in systematizing data and obtaining the normal or usual values for rain, represented by the quantile Q (0.15) , Q (0.35) Q (0.50) Q (0.65) and Q (0.85) .

5. Fieldwork

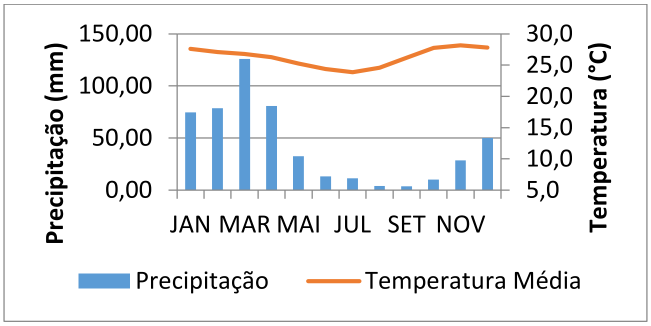
Fieldwork was conducted from 24 to 26 September 2014 were studied empirically the land management and environmental impacts of these on the island of Assumption , located in the São Francisco River, and two points in northeastern part of the municipality of Cabrobó .

RESULTS AND DISCUSSION

1. Statistical analysis Temporal and Spatial

The historical average rainfall values for Cabrobó, in the period 1961-2014 (Fig. 03) show the concentration of rainfall in the months of January to April, with the first rains starting in December , while the long period from May to November is characterized by drought . Temperatures keeps high all year , ranging between 24 and 28 ° C , which influences the high potential evapotranspiration and hence the aridity index.

Figure 3 - Climate in the municipality of Cabrobó / PE.



The average distribution of rainfall in Cabrobó Desertification Center is displayed in the interpolation of Figure 04. You can see that on average, the southern areas receive less rainfall over the years, this fact can be explained by the difference in altitude and orientation of the relief of the represented areas. The areas northeast of the image have higher altitude, depending on the plateaux relief, and orographic orientation to windward gives greater rainfall, as the recessed areas correspond to the São Francisco River Depression, with lower levels of rain, the center and south image. The analysis of Figure 05 shows that the study area has high average temperatures ranging between 24 ° C and 26 ° C approximately, due to its latitudinal location. Like the Precipitation values, temperatures are also influenced by the relief. It is established that the plateau areas northeast of the image have average temperatures milder when compared to core areas and Country and San Franciscan Depression.

Figure 4 - Spatial distribution of rainfall in the Cabrobó / PE.

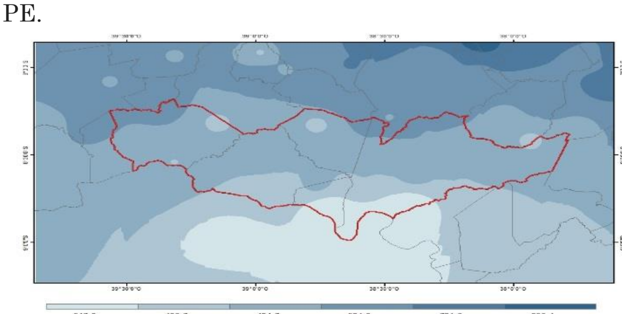
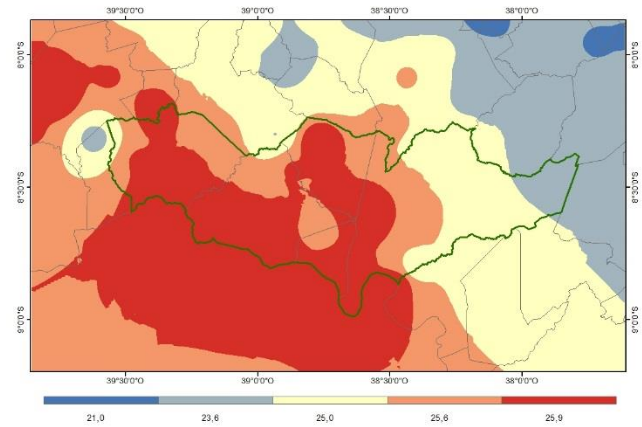
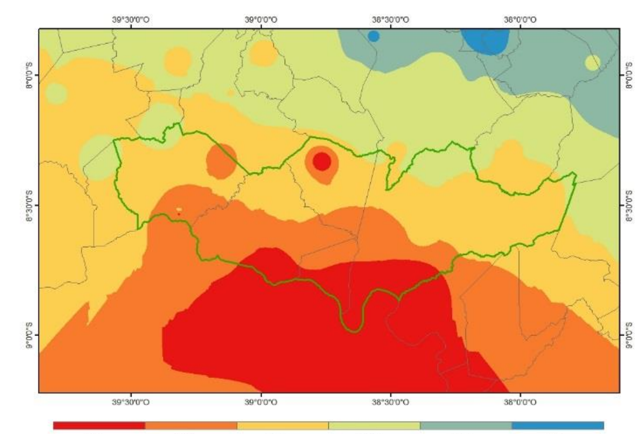


Figure 5 - Spatial distribution of average temperature in the Cabrobó / PE.



The spatial distribution of the aridity index, shown in Figure 6, identifies the areas most susceptible to desertification process , which fall under the municipalities defined as desertification core and the surrounding areas. It is observed that the central and southern area of the figure show higher degree of semiaridez , these areas include the southern state of Pernambuco and north of Bahia, where there is a severe semi-arid climate , characterized by low rainfall , high temperatures and high potential evapotranspiration , with rates of less than 0.40.

Figure 6 - Spatial distribution of the aridity index in Cabrobó / PE.



The temporal distribution of rainfall is characterized by high interannual variability , with very wet years and years very dry , in which the dry periods extend from one year to another, as can be seen in Table 3.

Table 3 - Classification of rainfall in quantile for the municipality of Cabrobó/PE.

	Quantil		Quantil
1961	Muito Seco	1988	Seco
1962	Normal	1989	Muito Chuvoso
1963	Normal	1990	Muito Seco
1964	Chuvoso	1991	Muito Seco
1965	Normal	1992	Normal
1966	Muito Chuvoso	1993	Muito Seco
1967	Muito Chuvoso	1994	Normal
1968	Normal	1995	Chuvoso
1969	Seco	1996	Normal
1970	Seco	1997	Chuvoso
1971	Chuvoso	1998	Seco
1972	Normal	1999	Seco
1973	Normal	2000	Chuvoso
1974	Muito chuvoso	2001	Normal
1975	Chuvoso	2002	Normal
1976	Chuvoso	2003	Seco
1977	Chuvoso	2004	Muito Chuvoso
1978	Chuvoso	2005	Chuvoso
1979	Seco	2006	Normal
1980	Normal	2007	Normal
1981	Seco	2008	Muito Chuvoso
1982	Muito Seco	2009	Muito Chuvoso
1983	Seco	2010	Normal
1984	Normal	2011	Chuvoso
1985	Muito Chuvoso	2012	Muito Seco
1986	Muito Seco	2013	Seco
1987	Seco	2014	Muito Seco

With the technique of quantile check the percentages 15 %, 20 % (15 % - 35 %), 30 % (35 % - 65 %), 20 % (65 % - 85 %) and 15 % , which are the odds or expected frequencies for the events " very dry " , "dry" , "normal" , " wet " and " very rainy " , respectively, during a sequence of years for which the maintenance of the same characteristics for rain possible in region considered , as shown in (Table 4).

Table 4 - Classification of Percentages of Quantile to Cabrobó / PE.

15%	35%	50%	65%	85%
<--------	<-------->	<----------->	<-------->	-------->
Muito Seco	Seco	Normal	Chuvoso	Muito Chuvoso
288,0mm	441,95	511,20	561,90	719,10
Q(0,15)	Q(0,35)	Q(0,50)	Q(0,65)	Q(0,85)

From the point of view of the dominant climate framework, this region has as main feature the irregular rainfall patterns, with poorly distributed rainfall in time and space, with seasonal variation, being mainly concentrated in the summer and early fall.

Also part of its climatology of the high temperatures, low humidity, high rates of evapotranspiration and high water deficit. Among the main climatic factors that determine the distribution of climatic elements in the Brazilian Northeast - NEB and seasonal variation are its geographical position, its relief, the nature of the surface and pressure systems operating in the region. The Brazilian Northeast is under the influence of Anticyclones Subtropical South Atlantic and North Atlantic and equatorial trough, whose seasonal variations of intensity and positioning determine the climate of the region, as (KAYANO And ANDREOLI, 2009).

The Intertropical Convergence Zone - ITCZ is considered the main weather system that plays an important role in facilitating the rains in the Northeast, with an extensive area of convergence of trade winds from the northeast, and southeast trade winds (MELO et al, 2009) . This system is characterized by upward movements of air, low pressure, one cloudiness band and rain in the east-west direction, moving from its position further north around 14 N, in August-September to the position further south around 5 S during March-April. In dry years in the Brazilian Northeast, the ITCZ is blocked by anticiclonal action, staying north of its usual position during the rainy season.

In the review of the causal mechanisms for the rain on the NEB held by mollion and Bernardo (2002), changes in atmospheric circulation settings of large-scale, ocean-atmosphere interaction in the Pacific Ocean and the Atlantic, producing an uneven distribution of rainfall, the temporal and spatial scales in the region.

Ferreira and Mello (2005) describe the weather systems of small, large and mesoscale that influence weather and climate in the Northeast of Brazil as the Intertropical Convergence Zone - ITCZ, Cold Front, Vortex Cyclonic of High Level, Jitter Lines , Mesoscale Convective Complexes, East Waves, Sea Breeze and Breeze Land. The authors also cited highlight the influence of the Pacific and Atlantic oceans in climate.

Nobrega and Santiago (2014) show the influence of the anomalies of the Sea Surface Temperature (SSTs) in the Pacific and Tropical North Atlantic Ocean and South in rainfall levels NEB. The Superficial temperature difference of the North and South Atlantic Tropical causes downward movements of air or ascendants that interfere with precipitation of the region. This anomaly also influences the latitudinal position of the ITCZ, important for the seasonal distribution of precipitation NEB.

2. Fieldwork

In the field visit held in the municipality of Cabrobó were studied three experimental sites. The first point studied was the Assunção Island, the São Francisco River, where it was possible to observe the practice of irrigated agriculture by flooding, standing out as main activity developed on the island. It was found that the water drainage conditions used for irrigation is very poor, which causes the salination process over large areas from the rapid evaporation and salt accumulation in the soil. some abandoned spots were observed, with a significant process of salinization and degradation, probably after intensive agricultural use, which presents great difficulties soil regeneration and native plant species. Therefore, the practice "irrigacionista" in agriculture without taking into account the limitations in terms of soil quality.

It was also found the occurrence of livestock , which appears as the second most important economic activity , and is practiced extensively associated with overgrazing and deforestation . Deforestation and fires observed in the study site , leave bare soil exposed to trampling of animals and prone to erosion. This fact constitutes an important cause of land degradation , making it dry , barren , leading to loss of its productive capacity .

So it is a very degraded area of environmental point of view , as a result of inadequate land management systems which cause a gradual loss of soil fertility , increasing susceptibility to desertification process .

Figure 7 - Banana crops and irrigated coconut on Assumption Island.

Figure 8 - Banana crops and irrigated coconut on Assumption Island.

Despite the great productive potential , natural resources are poorly and often underutilized as a means of seeking an appropriate agricultural management of the environmental and social characteristics of the semiarid region. Current practices observed in Asuncion Island have productive and ecological constraints , and must consider the level of resulting environmental degradation and productive inefficiency on the weather. Thus the activities controlled by man associated with natural conditions and prolonged droughts , the erosion by wind and by concentrated rainfall, and steep rates of evapotranspiration , lead the region to face risks desertification.

Figura 9 - Degraded areas from deforestation, fires and overgrazing.

Figura 10 - Degraded areas from deforestation, fires and overgrazing.

Figure 11 - Salinated area and small irrigation canal on Assumption Island.

Figure 12 - Salinated area and small irrigation canal on Assumption Island.

In the second experimental site studied in the northeastern part of the county, there are many areas still covered by vegetation of caatinga, presenting better degree of preservation in the other two sites studied. The caatinga of rich hyperxerophilic type shrubs with presence of sparse trees and is the harsh semi-arid climate in which it operates. However, at some points of caatinga were observed environmental changes related to extensive grazing and deforestation. In places with little or sparse vegetation of caatinga, some termite mounds took shelter in tree trunks probably because of the high soil temperatures. The third point is studied is a small farm, also located in the northeast of the city. In the area it was observed growing own fodder for dry climates like the spineless cactus, sort of cactaceous well adapted to semi-arid climate, and sorghum. Small farmers also used a cistern of the "boardwalk" to store rainwater, this kind of tool allowed the farmer a better production planning, on an important water catchment technology.

Figure 13 - mound of bush and deforested area in Cabrobó.

Figure 14 - mound of bush and deforested area in Cabrobó.

Given what was observed during the field work, it can be concluded that the vulnerability of farming communities in the semiarid region is associated with an inefficient management in harmony with ecological and unable able to meet human needs. There are a productive planning to adapt the agricultural managements to environmental conditions. In this sense, excessive deforestation, overgrazing, fires and salination from inadequate irrigation are some of the land management problems that contribute to the vulnerability of populations. The irregularity of rainfall becomes a problem when associated with cultural and economic character of issues related to land use.

For this reason, the process of desertification, understood as a consequence of environmental degradation generated by human activity in dry areas, is associated with the current socioeconomic and past tenses, represented by the prevailing spatial arrangements of land use in the semi-arid northeast. The high level of degradation in the environment increases the risk of conditions of communities in the face of irregular rainfall and cyclicality of drought, it makes even more precarious productive bases.

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