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SPATIAL ANALYSIS OF CAATINGA VEGETATION IN THE MUNICIPALITY OF IBIMIRIM-PE

Luciana Mayla de Aquino França[1], Tiago Henrique de Oliveira[2], João Antonio dos Santos Pereira[1], Taynã Maria Pinto Lins[1] and Josiclêda Domiciano Galvíncio[3]

[1]Undergraduate in Geography, Universidade Federal de Pernambuco – UFPE, email: lucianamayla@hotmail.com; antoniopereira.278@gmail.com; tay-lins@hotmail.com. [2]Mestre em Geografia pela Universidade Federal de Pernambuco, email: tholiveira50@gmail.com. [3]Professor of Departamento de Ciências Geográficas, DCG-UFPE, email: josicleda@hotmail.com.. Universidade Federal de Pernambuco, Departamento de Ciências Geográficas. Av. Prof. Moraes Rego, 1235 – Cidade Universitária, CEP: 50670-901 Recife/PE-Brasil.

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Abstract

The use of satellite images has been widely used as help get better answers on vegetation dynamics. The semi-arid Northeast is characterized for presenting distinct characteristics of other Brazilian biomes so that there will be major changes in vegetation in a short time. This study aims to evaluate the behavior of the caatinga vegetation in the municipality of Ibimirim, located in the pernambucan hinterland, through Landsat TM images taking into account climatological data. We used Satellite Landsat-5 images with passing on 9/3/1989, 9/30/1993, 9/20/1995, 9/28/1998, 9/18/2006 and 9/29/2010 all for the dry period and calculated the EVI and NDWI ERDAS Imagine 9.1 software. By analyzing the indexes, we achieved a greater value of EVI and NDWI for 1989 and lowest EVI for the year 2010 and less NDWI value for the year 1998, in addition to a gradual increase of temperature between that periods. It is also noticeable water deficiency present in the studied period and the dependency of the municipality of irrigated agriculture to obtain greener areas. The highest percentage of EVI is in class with values of between 0.150 -0.200 while the NDWI presents highest percentage in class with values less than 0, the semiarid situation of the municipality.

Keywords: remote sensing; EVI; NDWI.

Introduction

Understand the changes that occur in vegetation cover is of paramount importance to assess the spatial distribution and monitoring environment. These assessments are most relevant to areas that have physical

Corresponding author:
josicleda@hotmail.com

characteristics heterogeneous and depend on several factors, such as climatic characteristics and human action. The municipality of Ibimirim is present in the semiarid Pernambuco which presents peculiar characteristics compared to other biomes present in the state. Its vegetation undergoes changes according to climatic influences or high terrain.

Queiroz, (2011) within the various elements characteristic of the semiarid region, the vegetation is a component of great potential for the development of the region since the other elements integrated development promoters.

The middle region of the interior of Pernambuco is practically half the state of Pernambuco, containing an area of 32,450 km ², being characterized by low annual rainfall, ranging between 500 and 800 mm. The rains most of the backcountry focus in the months from January to April where, this time, precipitate 60-70% of total annual,(Eberibe, 2012). Undoubtedly, in the Northeast, the element that marks the landscape more sensitively and more worries man is the climate through rainfall patterns and externalized by natural vegetation.

The use of Remote Sensing and GIS has proven quite effective a resource for environmental monitoring, especially to assess the dynamic vegetation. It is a technique that allows the monitoring of natural resources, and enable the identification of the use and land cover, and its variation over time with the changes occurring in the landscape. Moreover, their tools enable the study of the canopy, observing the spectral parameters, and vegetation biophysical parameters of the landscape enables observations of changes in the landscape through changes in reflectance and vegetation indices (CHAGAS et al., 2008).

Among the plethora of indices that can be obtained through remote sensing, there is the EVI (Enhanced Vegetation Index) by (Huete et al., 1997). It was development for promote the reduction of atmospheric influence and background soil in vegetable canopy monitoring (Justice et al., 1998). Considering your particularities, EVI, as well as NDVI (Normalized Difference Vegetation Index) is considerable a simple index for monitoring of vegetation and show great correlation with health of vegetation and your productivity (Chandrasekar et al., 2006), in NDVI (Ribeiro et al., 2009).

More recent, the NDWI (Normalized Difference Water Index) have detached in monitoring of hydric stress in semiarid environment. The estimate of water in vegetation is strongly correlated with near and medium infrared band. Thus NDWI permit to estimate the water in plant (Oliveira et al., 2010).

The northeast of Brazil is showing an intense development of irrigate agriculture, even with presence of droughts frequent and lack of rain for most of the year. It has been employed the use of new technologies through the irrigated areas, as in the present municipality of Ibimirim and Lower Acaraú in the Ceará state. (Santos, 2000) say that the northeast of Brazil have irregular water research in time and space, in results of meteorology and geomorphology factors. When there isn't disponible water in soil, occurs hidric stress. The high water demand, therefore, is intrinsic plant, which, if not satisfied, affects the growth and yield (Pires et al., 2008).

This study have as objective to determine the evolution space-temporal of EVI and NDWI in Ibimirim-PE considering of climate data.

The municipality is located in Ibimirim Mesorregião Sertão Pernambucano and microregion of the Sertao of Moxotó. Distance of about 300km from the capital, it is bounded by the municipalities of Floresta, Betânia, Custódia, Sertânia, Tupanatinga, Manari and Inajá (Figure 1). It lies between 8 ° 32'26 " south latitude and 37 ° 41'25 " west longitude according to the geographic coordinate system. According to the Köppen climate classification, the climate of the city is BShW (Semiarid) with the highest concentration of rain between the months of January to April and average rainfall of less than 800mm.

Material and methods

Study area

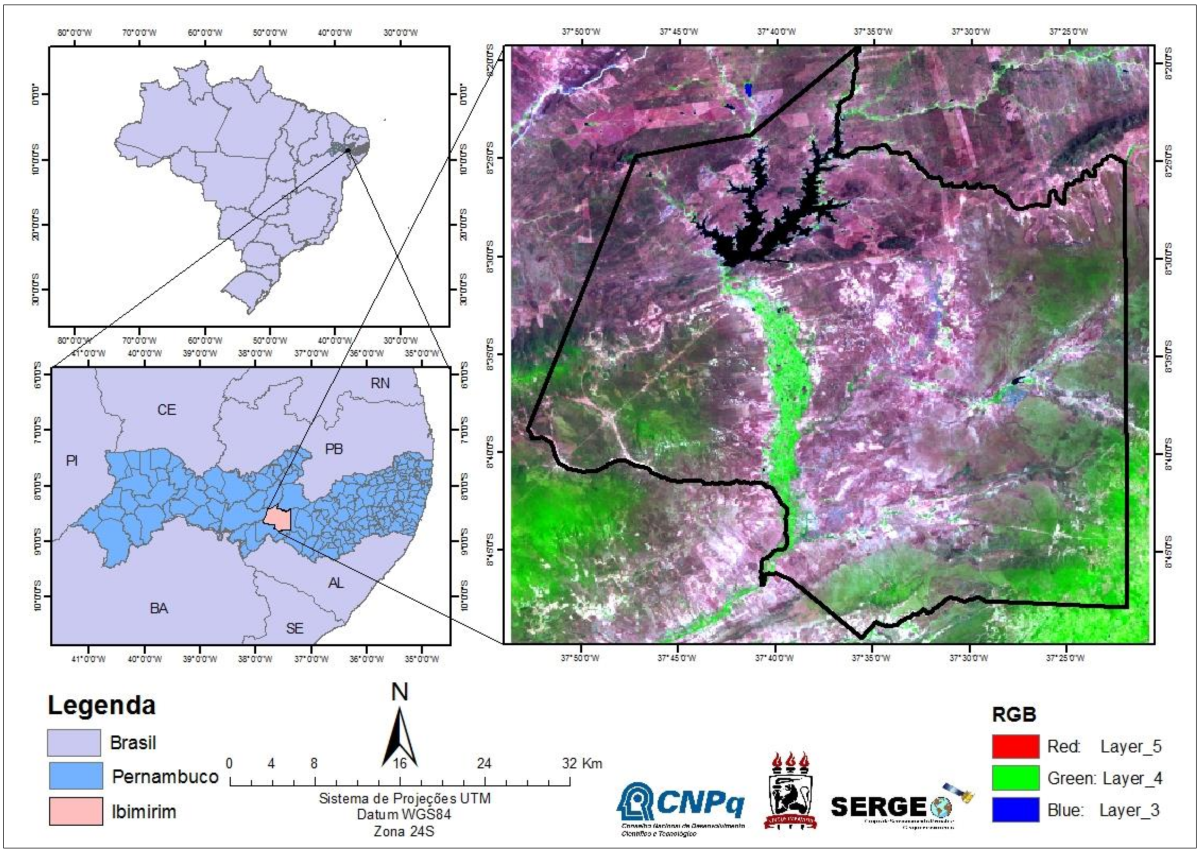

Figure 1: Localization of Ibimirim municipality.

Data and image processing

We used satellite images from orbit and point 215/66, passing the days September 3, 1989, September 30, 1993, September 20, 1995, September 28, 1998, September 18, 2006 and September 29 2010 thematic mapper (TM) satellite Landsat5 acquired free through the catalog of images from INPE (National Institute for Space Research). The images were selected to contain little or no cloud cover. All images were registered and orthorectified based on the image acquired through the site Landsat.org. Data were acquired in temperature and precipitation for the month study of all the years of research in the portal of Agritempo (Sistema de Monitoramento Agrometeorológico) in Ibimirim – Ibimirim-PCD (LAMEPE/ITEP) station.

The radiometric calibration, reflectance and NDWI can see in (Oliveira et al., 2010). The estimate of EVI can be obtained by:

$$EVI = G\left(\frac{Pivp - Pv}{Pivp + C_1 * Pv - C_2 * P_A + L}\right) \qquad (1)$$

Where $(Pivp)$ is reflectance in near infrared band, (Pv) is reflectance in red band, (P_A) is reflectance in blue band, (C_1) is coefficient of correlation of atmospheric effects in red (6,0), (C_2) is the coeficient of the atmospheric correction in blue band (7,5), (L) is factor of correction for interference of soil (1,0) and (G) is factor of gain (2,5).

For the classification of areas was used the methodology of (Lourenço and Landim, 2004).

Results and discussion

The average precipitation and temperature for the month of September every year on study (1989, 1993, 1995, 1998 and 2010) are shown in Figure 2. Note that the year 1989 has a rainfall in September than normal average this month in the city and the average temperature in September lower than 15 ° C. In 1993, the September average temperature increases to between 15 and 20 ° C, while the precipitation decreases not exceeding 5 mm. Between 1995 and 2006 there are peaks of rainfall, while 1998 was dry, with temperatures above 20 ° C.

The temperature must be reviewed in detail, it is apparent to high temperature variations in the study area. Between 1998 and 2006 there is a difference of more than 10 degrees.

Best detailing the events of the years where rainfall was lower, there is the occurrence of the El Niño event responsible for the warming waters of the Pacific Ocean causing droughts in northeast Brazil. In the six years of the period under study the phenomenon occurred in three, 1993, 1998 and 2010. In the years 1993 and 1998 the phenomenon was more intense, causing the worst droughts in recorded history in the region, while in 2010 the event was registered with intensity moderate.

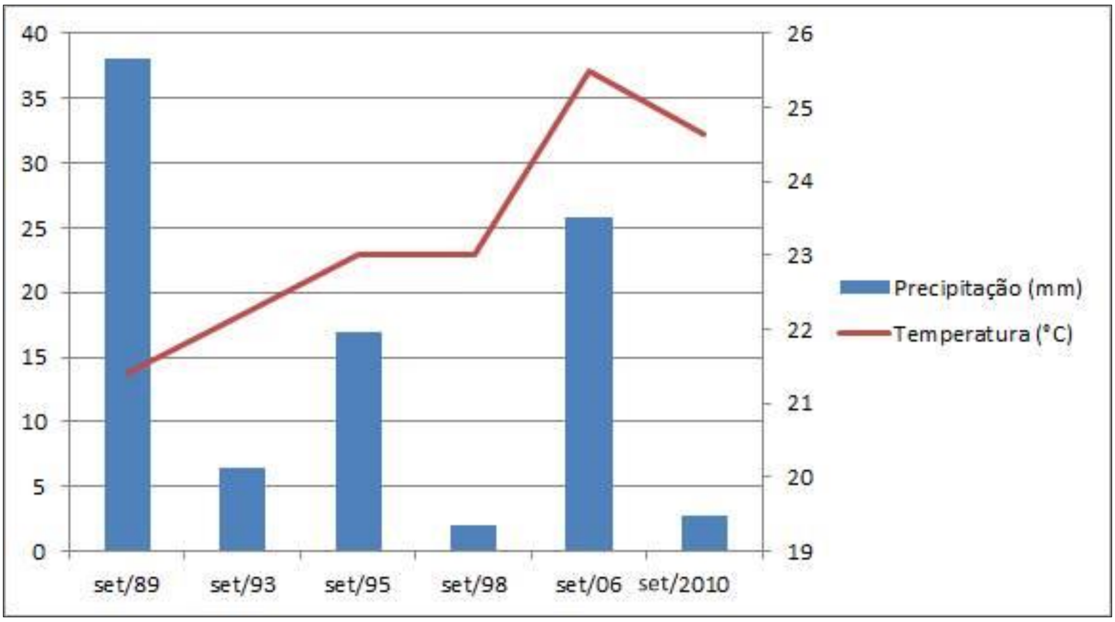

Figure 2: Rainfall and temperature for Ibimirin-Pernambuco.

EVI

Through EVI (Figure 3) is notable areas where there is presence of green vegetation and vegetation drier. Water bodies and areas with soil too waterlogged (the dam in this county and irrigated areas) correspond to values of EVI below 0. Classes with values ranging from 0.100 to 0.250 were predominant in the images as they are low values for the vegetation index, characteristic of the dry period in the region. The more intense this period will be more prevalent classes with low values, demonstrating that feature an intense increase in the years 1993, 1995 and especially in 1998. Comparing Figure 2 with Figure 3, we see that in September 1998, the total rainfall was the lowest in the period under study, not coming to 5mm, and a high temperature. Is remarkable the great impact of climate in vegetation cover in 1998, EVI does not exceed 0,400. Comparing the years 2006 and 2010, it is noted that in general presents EVI 2006 greater than 2010.

EVI values between 0.250 and 0.400, corresponding to areas of vegetation is sparse, the upright plant habit, typical of savanna vegetation, present in much of the study area. Classes that have values above 0.400 correspond to areas of dense vegetation, woody character more, being present in all the years under study, mainly in the southeast and west of the city and along the areas of irrigated agriculture. The EVI is more sensitive to variation in canopy structure, including leaf area index (LAI), the physiognomy of the plant and canopy architecture (Gao et al., 2000), (Huete et al., 2002).

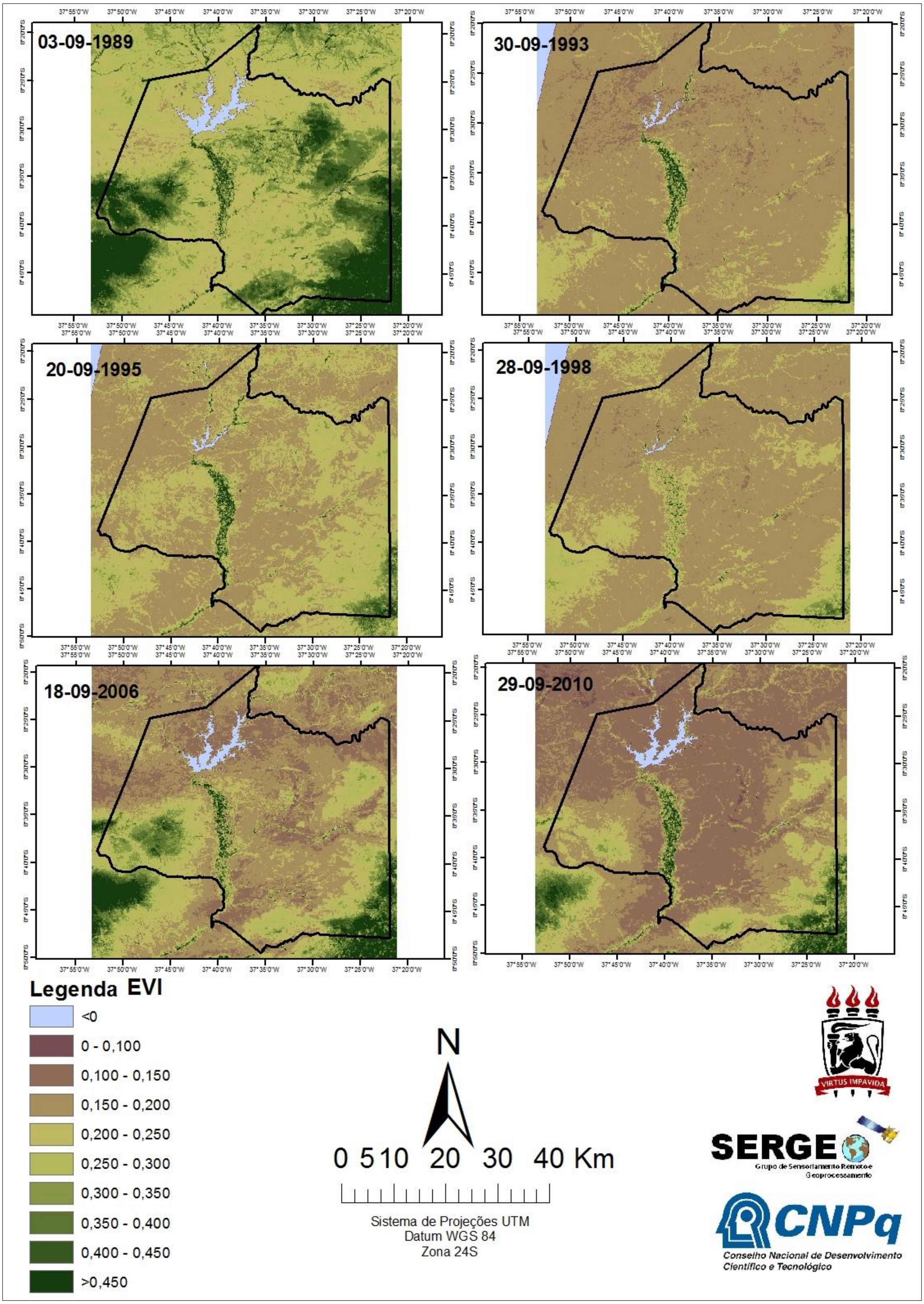

Figure 3: EVI of Ibimirim-Pernambuco municipality.

You can check the percentage of pixels in the images for each class of EVI in Figure 4. It can be seen that the first class (<0) does not represent 10% of the pixels for all the years under study. The second class (0 to 0.100) is the least present in this period, getting just a little in evidence in 2010. From the third class (0.100 to 0.150) until the fifth grade (0.200 to 0.250) are the values that represent over the period analyzed.

The third class is more present in the image in 2010 and 2006, peaking at no more than 5% in other years. The fourth class (0.150 to 0.200) is the most representative of the study area, except for 1989, considered atypical. These values for the EVI are considered low, showing a vegetation drier and less arboreal.

EVI minimizes the effects of the spectral response of soil and atmospheric influence, as well as high sensitivity variations phenological, showing that their use satisfies the studies on vegetation and canopy structure (Oliveira et al., 2010).

In 1993 and 1998 the driest years of the period the percentage of fourth grade can go beyond 70% for the former and 60% for the second, and held more than 20% in other years. From the sixth grade, the measured values of the classes are increasing, there begins to be the percentage decrease, proving that the area has a small amount of dense green vegetation. The year 1989 is the one that stands out in the study of these classes (values above 0.250), with about 10% for each area.

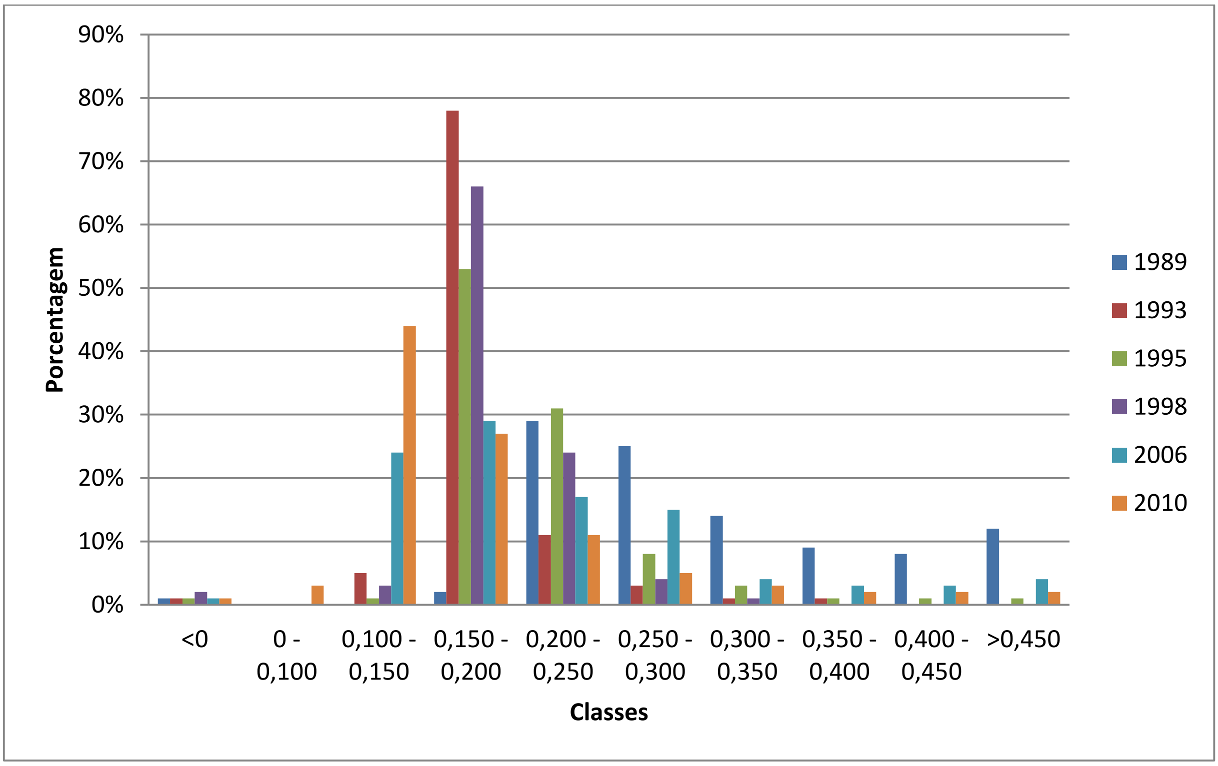

Figure 4: Percentage of interval of the EVI.

NDWI

Considering NDWI (Figure 5), note that large area show value of EVI between 0.100 and 0,250. In general, show low value, minor that 0 for water index, hydric stress area.

The areas that showed EVI between 0.300 and 0.400 (shrub), present values for humidity index (NDWI) between 0.150 and 0.250, being areas considered dry or with very little moisture. For the EVI values above 0.400 obtained for the NDWI values above 0.350, and areas with high humidity. The images of the years 1989, 1995 and 2006, are the most characteristic example of this since NDWI showed values greater than 0,350, mainly west / southeast of the city. Within this example, it is possible to note that the monthly rainfall totals were the highest in the period under study, as seen in Figure 2, which occurred over 15 mm rain these years, reaching a maximum in 1989 .

The characteristics are due to the drought year of 1998, and the EVI, the NDWI for this year also showed lower values, less than 0 or not exceeding 0,100, except in the waters of the dam. These low values are explained as due to the smaller amount of green leaves, the water dissipates faster, because the vegetation retain water and consequently better moisture.

Irrigated areas of present values of the moisture content greater than 0.200 in all images used, resulting similar to that obtained by (Oliveira et al., 2010) for river basin Moxotó. This value is obtained not only in the year 1998 was extremely dry, where even the irrigated areas suffered decline. It is notable that the areas with the presence of savanna vegetation and remote areas of agriculture are the most feature water stress.

The areas classified EVI values greater than 0.400 (woody vegetation) present values for NDWI over 0,300, and you can view them on all images, since they are located close to water bodies and greater prevalence of vegetation.

Correlating the EVI and NDWI image for 1989, we see that for both indices the year is atypical. The NDWI has a good distribution with high values above 0.350. As rainfall occurred in earlier days, so the joining NDWI great sensitivity of the vegetation water storage, can distinguish many classes in the image.

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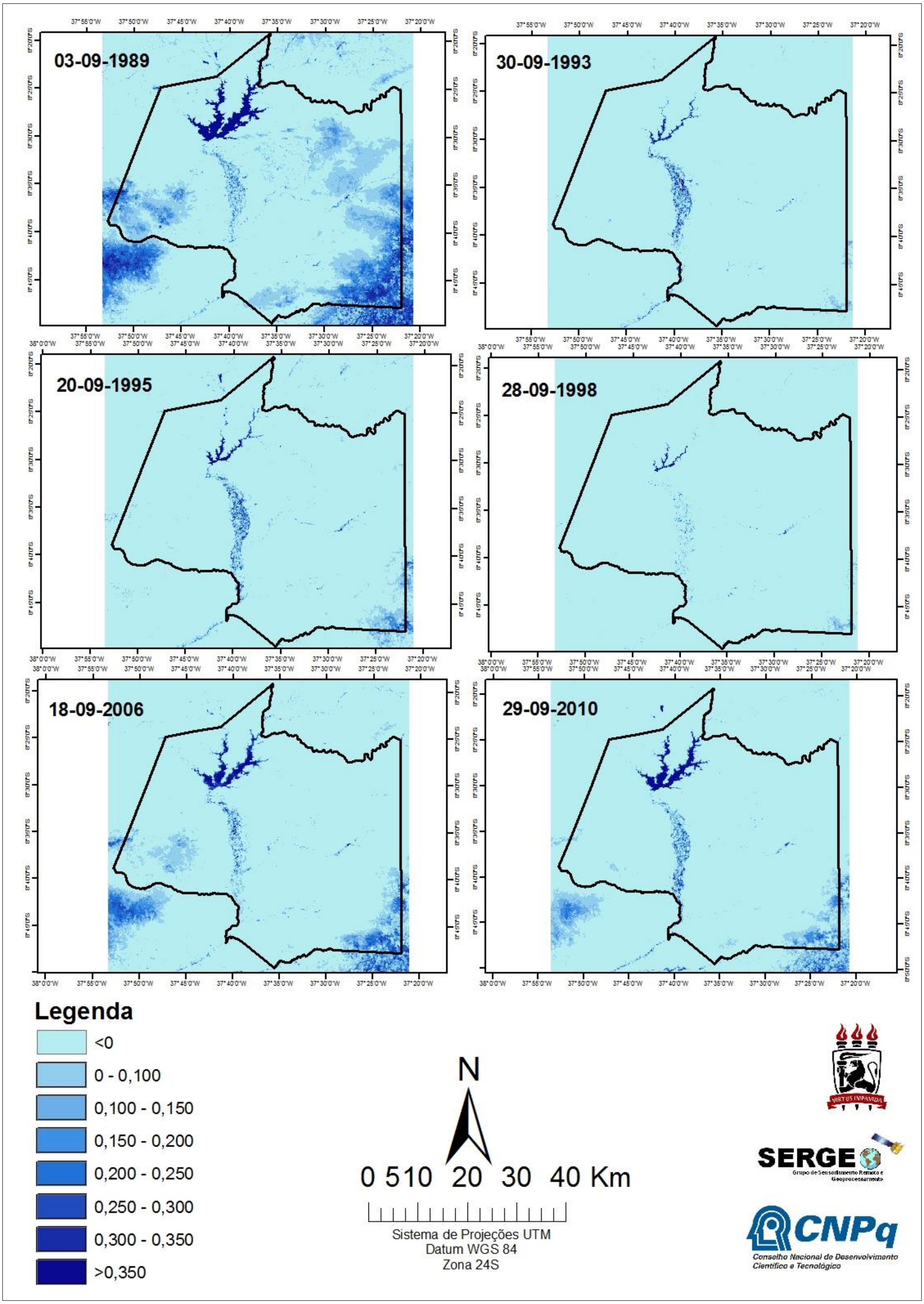

Figure 5: NDWI of Ibimirim-Pernambuco municipality.

You may notice the amount of pixels in the images for each class NDWI, (Figure 6) It can be seen that the first class (<0) is the most representative of the study area for all years except 1989 where the greatest number of pixels is in the second class. The first class refers to negative NDWI, with characteristic dry areas where the vegetation suffers intense water stress. The more presents this year class is the 1998, being considered dry as previously mentioned. In other classes, the years 1989 and 2006 stand out, which have pixels that should represent a little more than 1% of the study area. The first and second class, responsible for most of the pixels of all the images allude to semiarid climate.

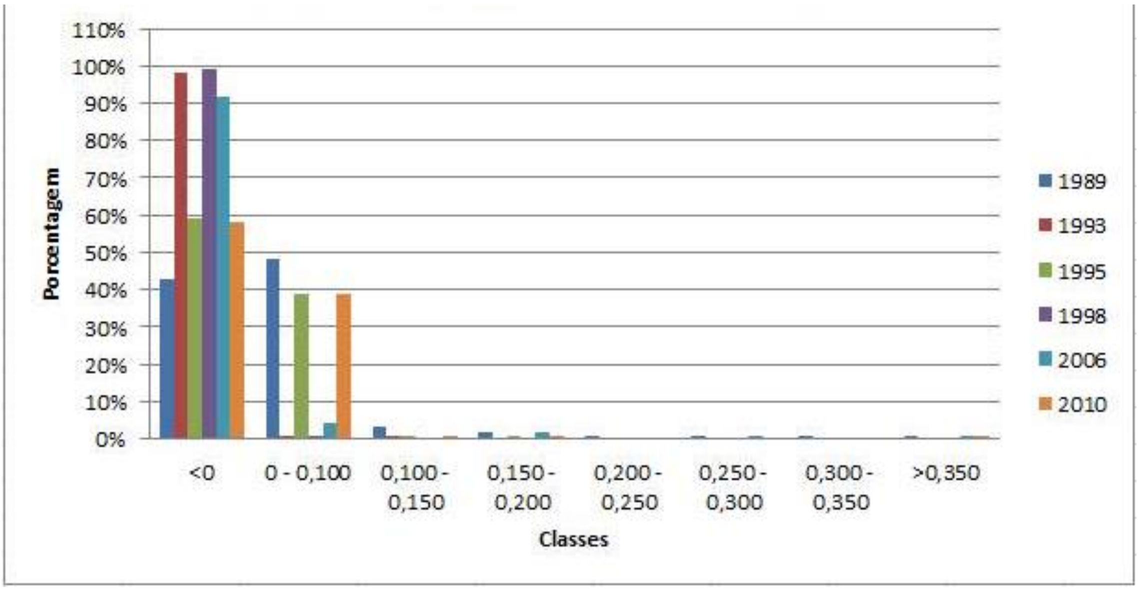

Figura 6: Gráfico de porcentagem para as classes de NDWI.

With the analysis of all the data presented we find that the lowest values of EVI and NDWI are associated with areas with a predominance of soil, whereas the highest values were associated with areas with high prevalence of water, a result similar to (Gao et al., 2000) obtained for the Pantanal region. (Gao, 1996) and (Gao et al., 2000) noted that soils with higher reflectance values indicate that the higher these values, the greater the NDWI. It is also notable that the EVI is highly sensitive to changes in vegetation during the dry season.

Conclusion

The use of EVI with the NDWI is efficient because they allow better analyze how it behaves vegetation dynamics due to climatic variations in semiarid environment. It was also found that in El Niño year's rainfall decreases dramatically, causing great stress on vegetation. It was also noted that the percentages by class for the two indexes get more value in the lower classes, represented by values between 0.150 and 0.200 of EVI and negative values for NDWI.

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