

Analysis comparison behavior of vegetation in the Paraíba State using remote sensing AVHRR/NOAA and precipitation pluvial

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Abstract

This study aims to make a monthly monitoring of the spatial variability of vegetation in the Paraíba State, from daily images of AVHRR / NOAA sensor systems during the years 2013 and 2014, with a spatial resolution of 4 km. We used the software ENVI (Environment for Visualizing Images) to do the calibration processing and processing of images. We calculated the value higher NDVI (Difference Vegetation Index Normalized) monthly at each grid point and made up the monthly maps of vegetation indices for the Paraíba State. The results showed that the vegetation index is an indicator of the response of rainfall in a given region, ie, a dry / wet season causes a decrease / increase in NDVI, thus underlining the importance of rain in the dynamics of the regional vegetation. It is worth noting that although the years have presented below the climatological average, the year 2014 was also drier than in 2013.

Keywords: Spatial Variability, rainfall, NDVI.

1. Introduction

Nature functions as a perfect machine in which each of the elements that compose it play its role. Every action of planning, managing or monitoring the space should include the analysis of the various environmental components. For this type of analysis is great the contribution of remote sensing (RS) technology (Araújo et al., 2009).

Colwell (1983) define (RS) as the measurement or acquisition of information of some property of the object or phenomenon by a

recording device that is not in physical or intimate contact with the object or phenomenon under study. The way the solar radiation interacts with the vegetation is needed to interpret the processes (RS) applied to agriculture. This approach seeks to make more operational monitoring system of vegetation using meteorological and environmental satellites, such as Landsat / TM and AVHRR / NOAA, Aster, MODIS, among others, because it is a low operating cost and the ease of obtaining the imaging tool. We used the NOAA satellite series because the same display great temporal

resolution, as their data are daily covering the entire globe, in order to monitor the regional vegetation in the Paraíba State. Multi-temporal data obtained by (RS) for different weather and environmental satellites have been used for different purposes by researchers around the world. In 2009, Araújo et al. used NDVI data from the Landsat-5-TM to assess the environmental impact on the Araripe-CE. The results showed that some areas have undergone the process of environmental degradation and other showed signs of recovery. In 2012, Sousa et al. perform monitoring of vegetation for the Paraíba State through images obtained from AVHRR / NOAA and concluded that the NDVI faithfully portrayed the rainfall in the region especially in areas dominated by Caatinga vegetation, the vegetation responds quickly soil moisture changes. In 2013, Dantas et al. used time series of precipitation, and images of AVHRR / NOAA to monitor vegetation in the Paraíba State, the authors realized that the variability of NDVI can be a good indicator of rainfall in the region. In 2014, Dantas et al. using data from the AVHRR / NOAA to evaluate the vegetation dynamics in the last decade in the States of Paraíba and Pernambuco. The result show that even in years of below-average rainfall did not occur significant fluctuations in the Forest and Coastal Zone.

Based on various applicability of (RS), the study aims to use data from the AVHRR / NOAA to analyze the temporal spatial behavior of vegetation in the years 2013 and 2014, as well as identify which regions of the State vegetation was most affected with low rainfall during the study period.

2. Material and methods

2.1 Study area

The study area is the Paraíba State, located in the Brazilian Northeast (highlighted in Figure 1) with area corresponding to 56,469.744 km² (IBGE, 2015) the climate is tropical in the coastal region and semiarid inside the vegetation is composed of mangroves in the coastal region; next tropical forest and savanna in the coastal hinterland.

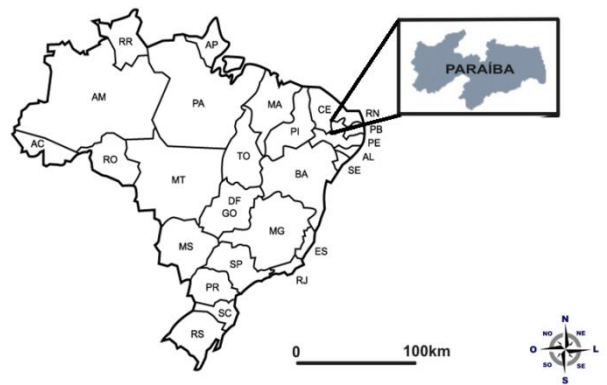


Figure 1 - Geographic location of the Paraíba State.

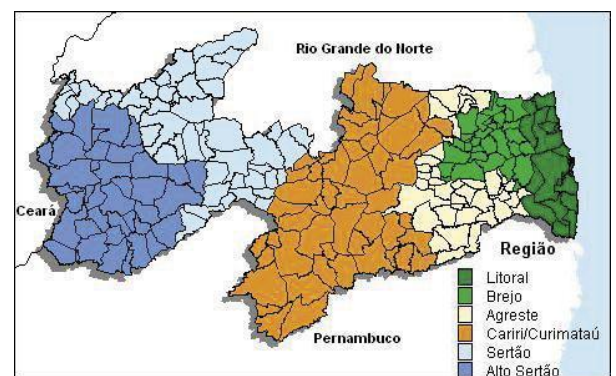


Figure 2 - Geographic location of homogeneous regions precipitation of the Paraíba State. Source: Brito and Braga (2005).

We used total monthly rainfall data and Normalized Difference Vegetation Index (NDVI) of Paraíba State for the period of 2013 and 2014.. Rainfall data comes from weather stations and rain gauges distributed in the homogeneous regions of the Paraíba State (Figure 2), which are available on the website Agência Executiva de Gestão das Águas do Estado da Paraíba - AESA. Remote sensing data is Meteorological Satellite NOAA series from January 2013 to December 2014, from channels 1 and 2 (visible and near infrared) of AVHRR. They are converted into processed and calibrated reflectance units with ENVI software (Environment for Visualizing Images). Homogenates were to spatial resolution of 4 km x 4 km. The combination of reflectance of infrared spectral bands near IR and VIS visible measures the force of vegetation. The literature shows that the use of NDVI has been widely used to give a strong signal of vegetation and

offer a good contrast to other targets surface (Parkinson, 1997). The NDVI is determined by the ratio of two spectral reflectances (equation 1).

$$IVDN = \frac{(IV-VIS)}{(IV+VIS)} \quad (1)$$

Wherein: IV is the measurement of reflectance in the spectral band of the near infrared (0,725 to 1, 10 μm) and VIS is the measure of visible (0,58 to 0,68 μm) of AVHRR / NOAA. The NDVI values vary from -1 to +1.

Data were arranged in a matrix. We used a computer program to select the highest value in each of the NDVI monthly grid point and location. This procedure aims to minimize the atmospheric effects such as contamination by clouds, water vapor, aerosols reduce the contrast between the reflectance between the visible and near infrared (Dantas et al., 2013, 2014). Made up maps of the spatial distribution of precipitation to better understand the behavior of vegetation in relation to rainfall in the state of Paraíba.

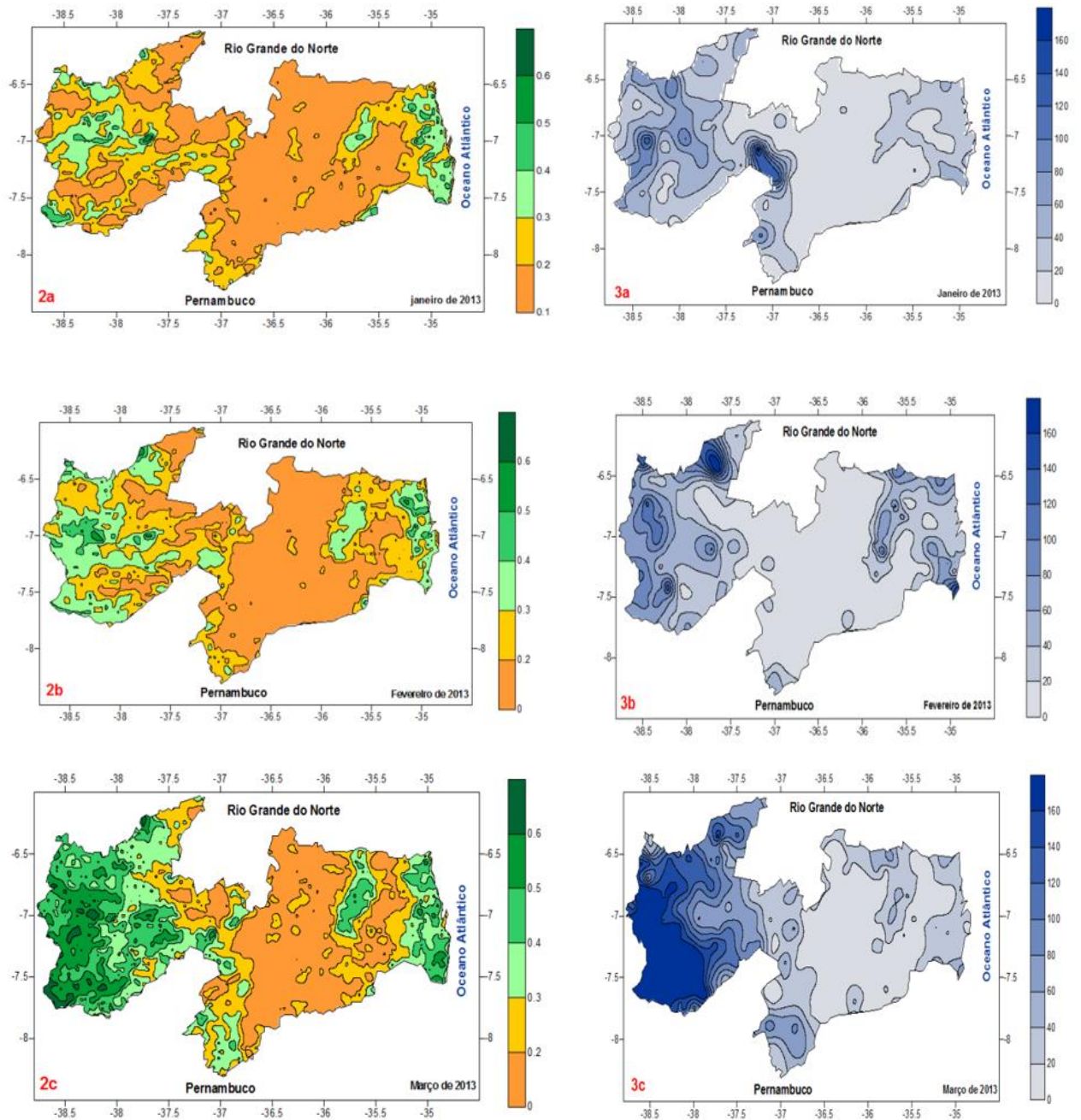
3. Results and discussion

The following are the thematic maps of monthly precipitation and NDVI images from AVHRR / NOAA sensor. The analysis of maps is based on the specialization of NDVI and rainfall in the State to evaluate the different regions of the State development or decline in vegetation.

3.1 Monthly spatial analysis of NDVI and rainfall for the year 2013

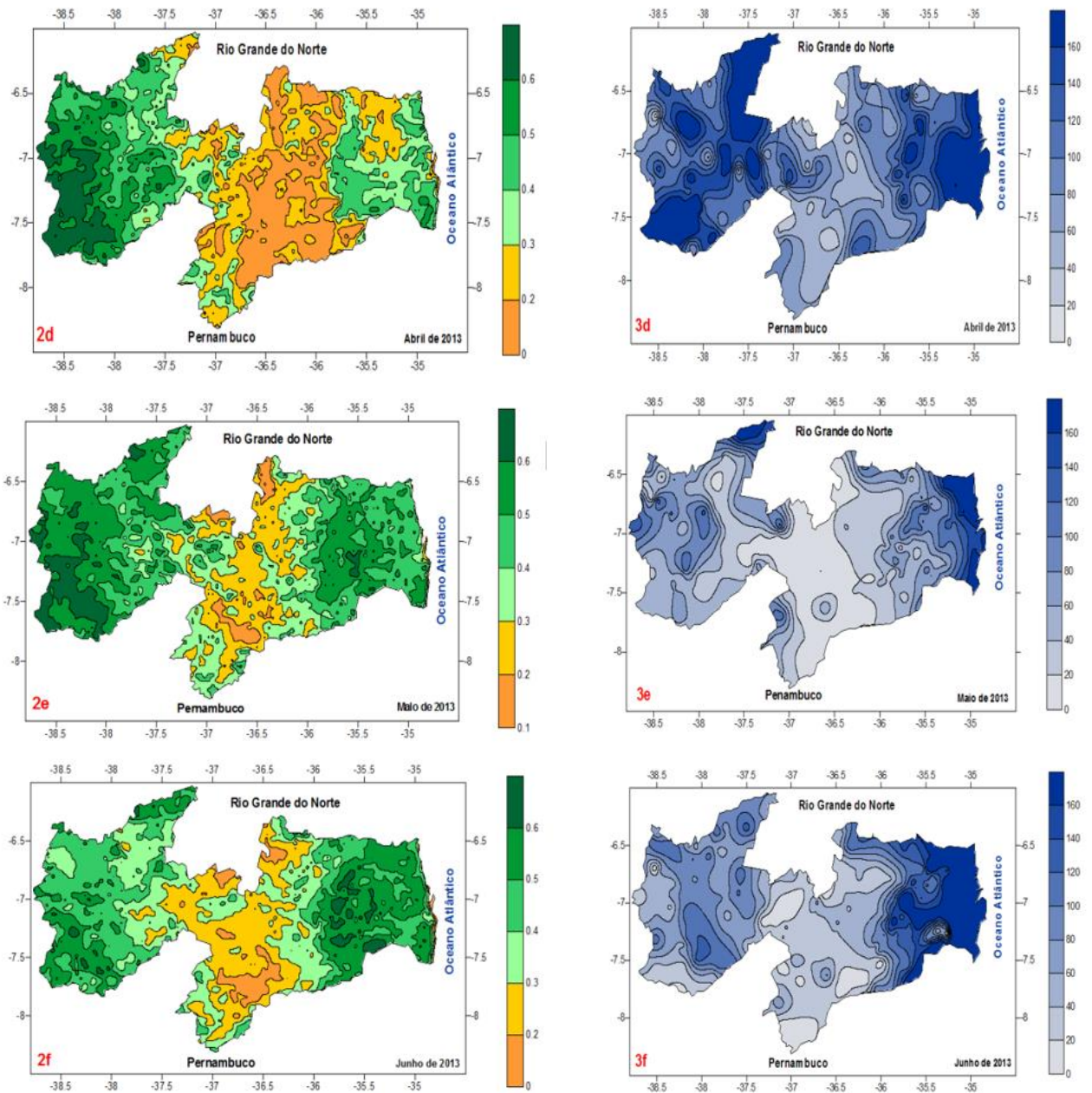
In January 2013 (Figures 2a and 3a), it can be observed in the central sertão, brejo and coast that vegetation appears green, Factor probably caused by rainfall in the region in December 2012 (AESA, 2015). In the months of February and March (Figures 2b and 3b, 2c and

3c), an increase of NDVI in the Sertão and Coast, favored by the rains in January and February (Figure b and c), which exceeded 60 mm. In other regions, the vegetation has similar behavior to January (Figure 2a). In April and May (Figures 2d, 3d, 2e, 3e), the vegetation is recovering slowly in almost every State. In the Sertão the highest rates are higher than 0.4. In May (Figure 2e and 3e), in the east of the State sector, there is a considerable increase in vegetation caused by the rains of this month and earlier. The rainfall in the month were greater than 80 mm. In June and July with the decrease in rainfall within the NDVI decreases as shown in (Figure 2f and 3f; 2g and 3g), reaching the lowest in the central region (NDVI <0.3). On the east coast, the index remains high in view of the rainy season in the region, where rainfall exceeded 90mm in months. In August (Figure 2h and 3h), it is observed that the most developed vegetation lies the Agreste the coast of Paraíba, with index greater than 0.4. Also are less significant indexes in the State's Sertão above 0.3. In the central part of Paraíba are smaller NDVI values. In the State of East monthly precipitation (Figure 3h) was more than 60 mm. In other regions the rainfall was below 40 mm. In September and October (Figure 2i, 3j), the index decreases considerably the rough to the State's Sertão, with index less than 0.2, due to the dry period. In October (Figure 2j and 3j). In the Forest Zone the IVDN oscillated between 0.3 and 0.5. In November (Figure 2k and 3k), found themselves isolated rainfall in some regions, interfering with the development of vegetation. You can view the order NDVI 0.4 on top Sertão (northwest). In December (Figure 2l and 3l), the rains increase the Sertão to the west of Cariri region and small areas of the Agreste region (Figure 3l). The vegetation in turn recovers slowly from Borborema region to the west of State. The information can be seen in the Figure 3.



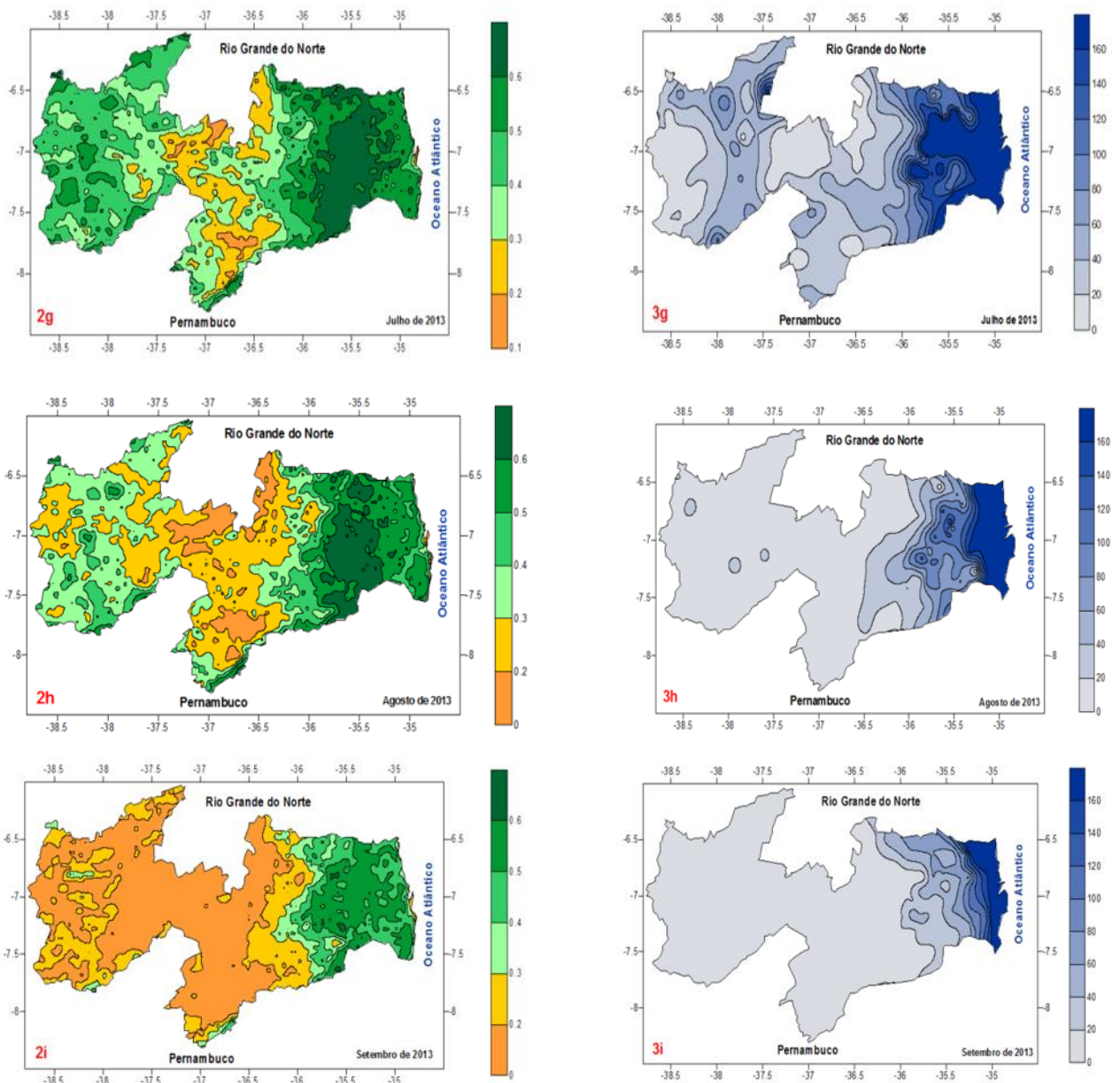
Figures 3- Spatial distribution of NDVI for the Paraíba State of January 2013 to December 2013 (2a, 2b, 2c, 2d, 2e, 2f, 2g, 2h, 2i, 2j, 2k, 2l) end monthly rainfall for the Paraíba State in the months of January 2013 to December 2013 (3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 3i, 3j, 3k, 3l).

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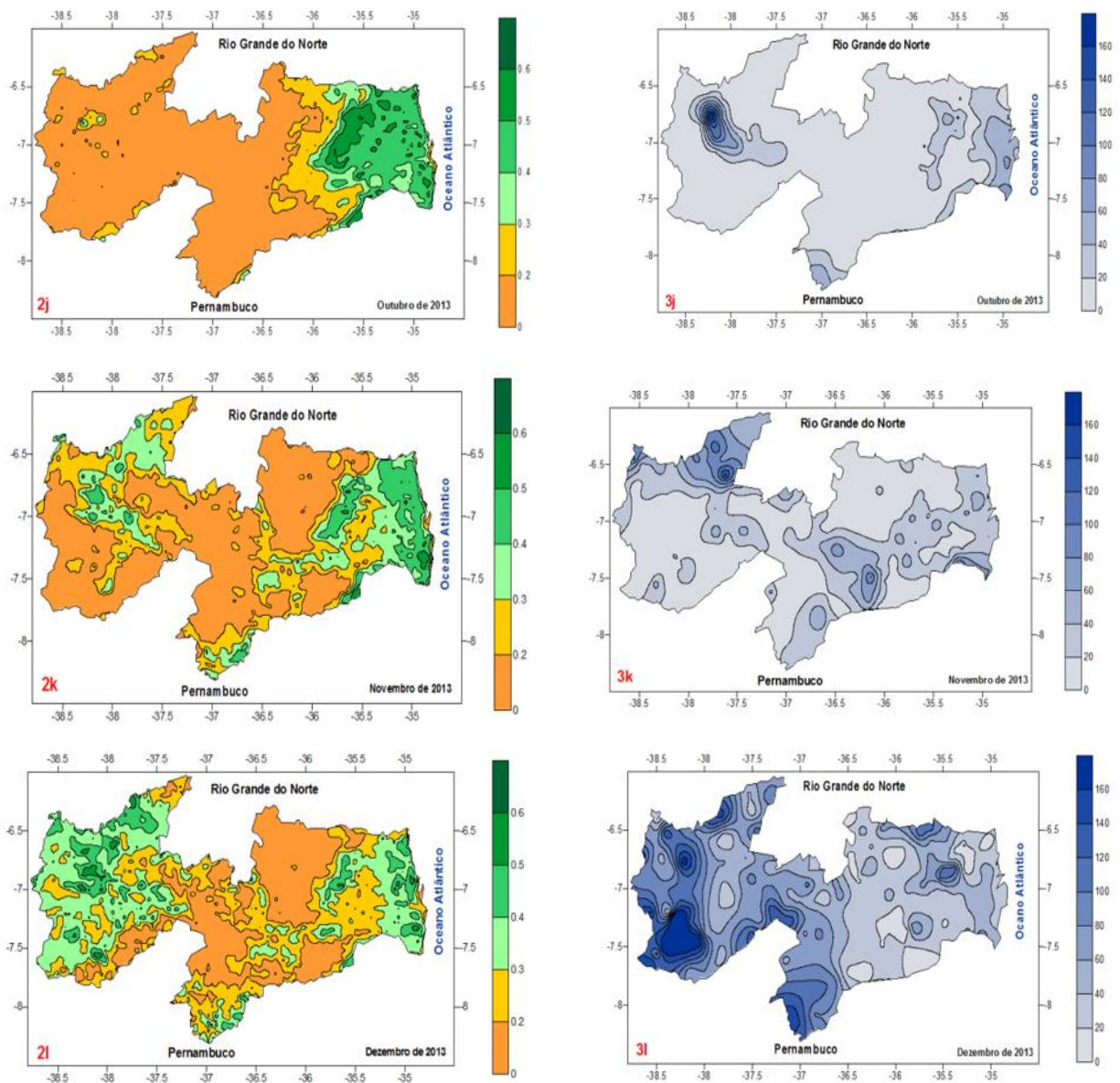
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Figures 3- Spatial distribution of NDVI for the Paraíba State of January 2013 to December 2013 (2a, 2b, 2c, 2d, 2e, 2f, 2g, 2h, 2i, 2j, 2k, 2l) and monthly rainfall for the Paraíba State in the months of January 2013 to December 2013 (3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 3i, 3j, 3k, 3l).

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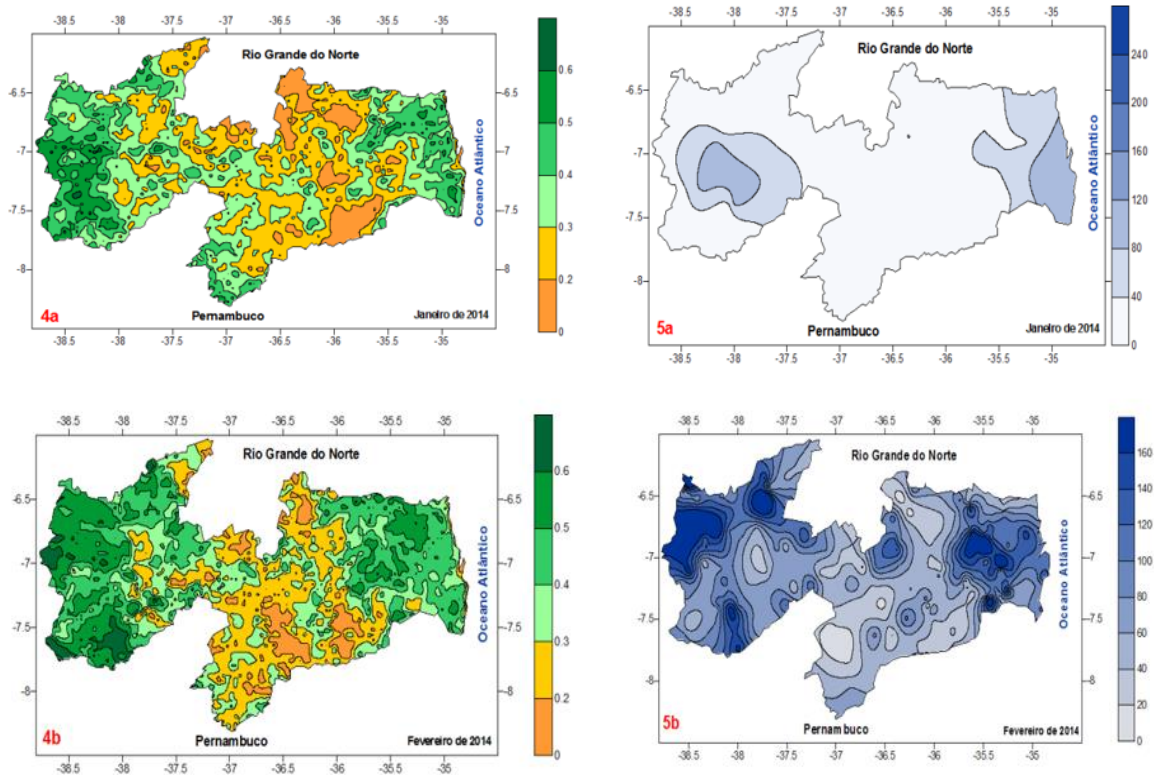
3.2 Monthly spatial analysis of NDVI and rainfall and for the year 2014

For January 2014 (Figure 4a and 5a), the NDVI has evolved considerably throughout the State, because of the rains that occurred in December 2013 (Figure 3l), with the highest rates of up to 0.6 found in the sertão. In the Forest Zone of Paraíba NDVI showed a

significant change from the previous month. In the months of February and March (Figures 4b and 5b, 4c and 5c) NDVI had an increase in the Sertão and Coast, favored by the rains of February (Figure 5b), which exceeded 80mm. In other regions, the vegetation has similar behavior to January (Figure 4a). In April (Figures 4d and 5d) the vegetation recovers slowly across the

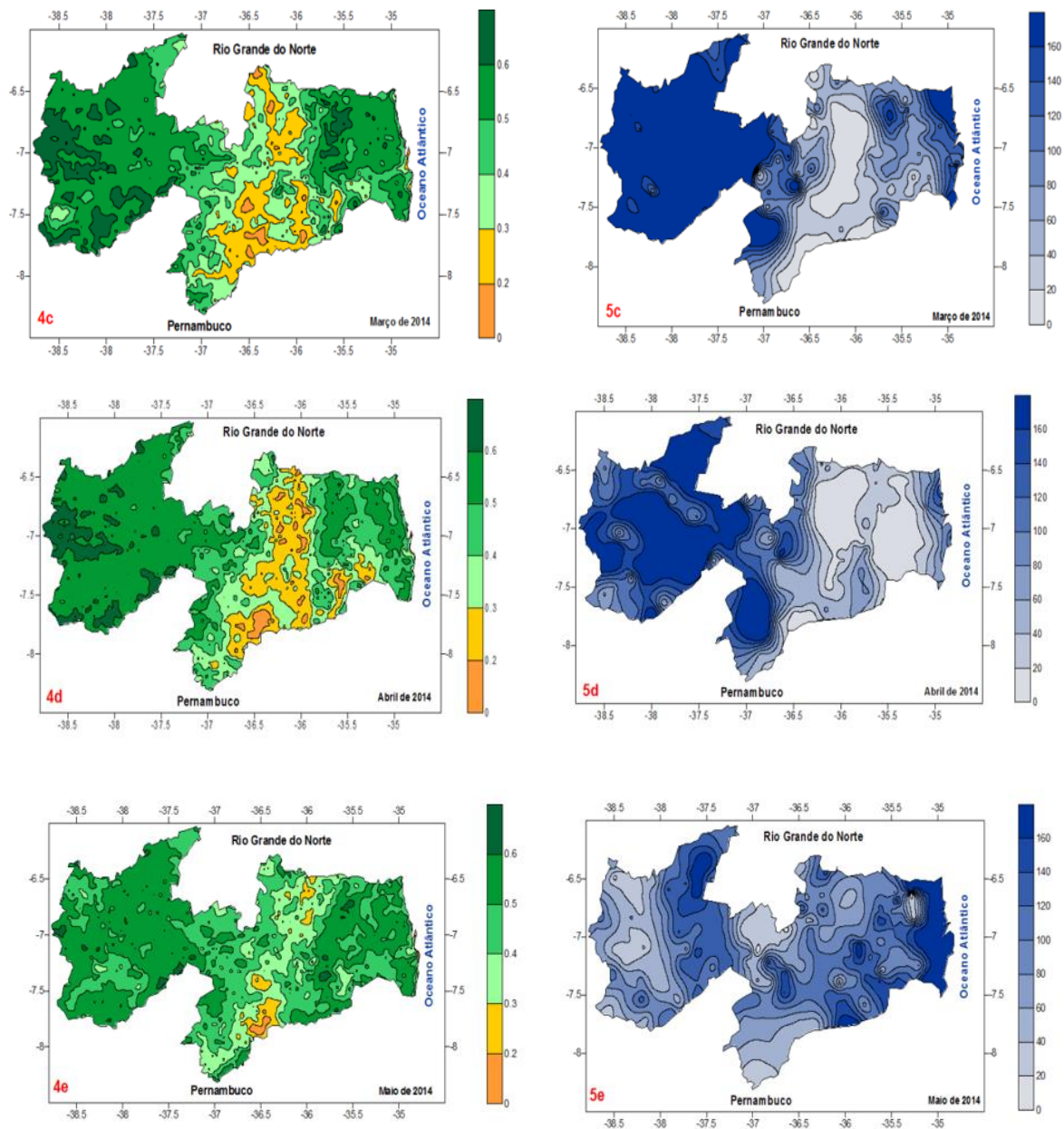
state, with the highest rates inside. In May (Figures 4e, 5e), the vegetation grows enough of Agreste region of the East of State, with NDVI values > 0.3 in Agreste region and $NDVI > 0.5$ in the East. Rainfall for this month were greater than 80 mm in almost every state. In June (Figures 4f and 5f), a reduction of rainfall from the the Agreste region to the Sertão, with rainfall below 40 mm (Figure 5f). Litoral monthly rainfall was more than 240mm. The most developed vegetation is in the Sertão and Coast Paraíba, with index higher than 0.5 (Figure 2f).

In July with the decrease in rainfall in the previous month, the NDVI decreases (Figure 5g). The lower rates with values below 0.3 are in the central part of the State. Already in the east NDVI reaches up to 0.6. From July to rain decreases (Figure 5g) in the east, hence NDVI begins to decline throughout the state (Figure 4g). In August the rains are scarce in and NDVI decreases sharply. From September to December this year there was almost no rainfall in the State as shown on the maps of rainfall and NDVI. (Figure 4 i, j, k, l and 5 i, j, k and l).



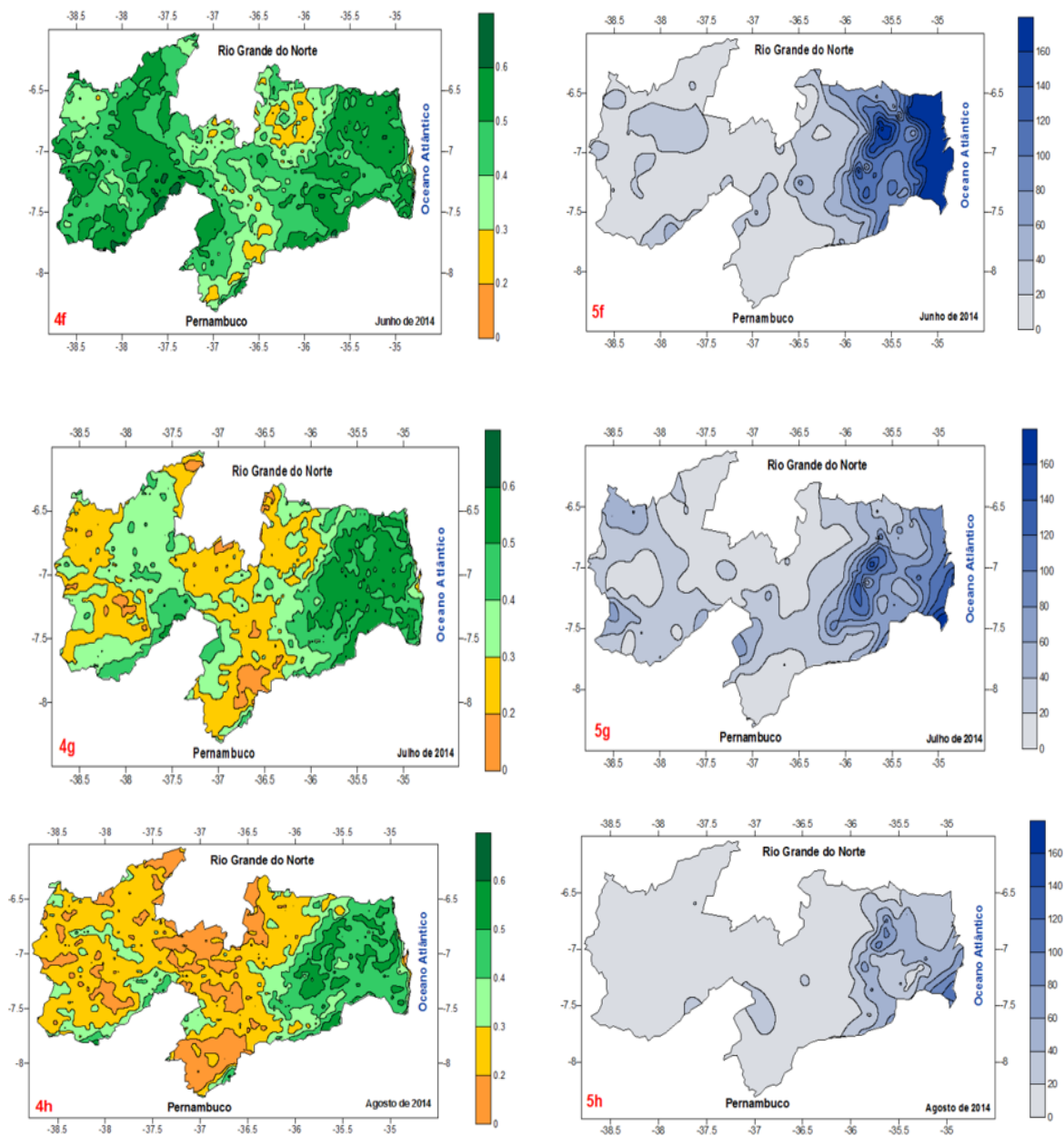
Figures 4 - Spatial distribution of NDVI for the state of Paraíba of January 2014 to December 2014 (4a, 4b, 4c, 4d, 4e, 4f, 4g, 4h, 4i, 4j, 4k, 4l) and monthly rainfall of Paraíba state in the months from September to December 2014 (5a, 5b, 5c, 5d, 5e, 5f, 5g, 5h, 5i, 5j, 5k, 5l).

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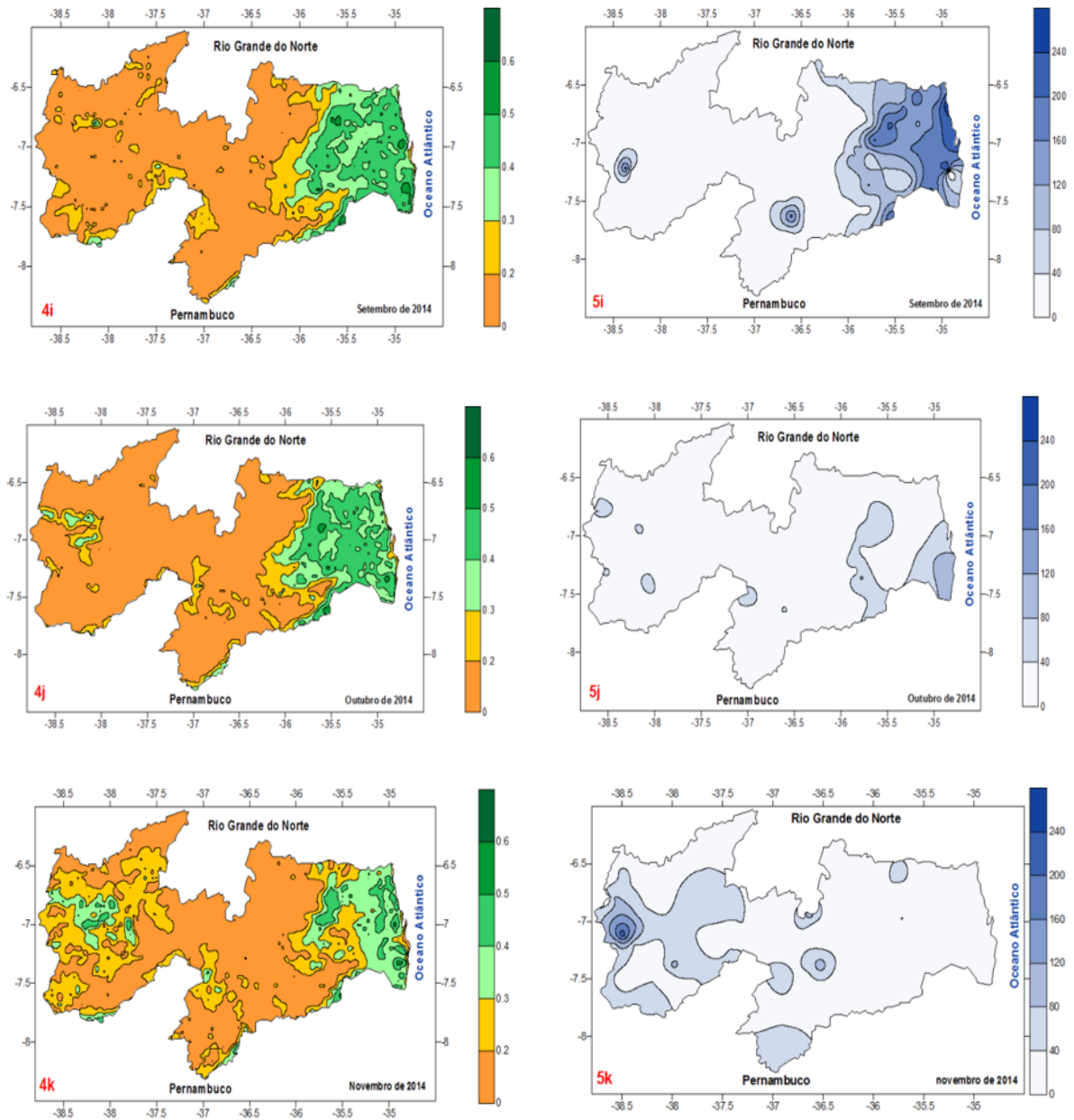
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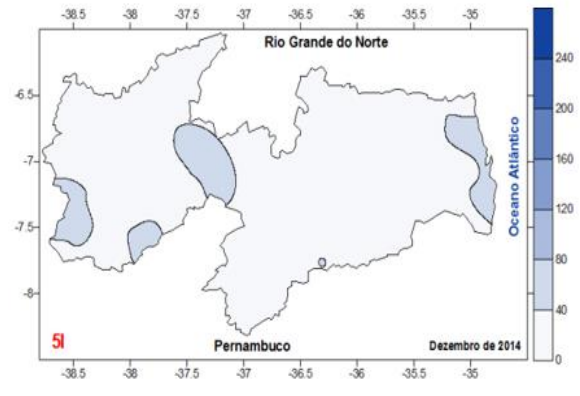
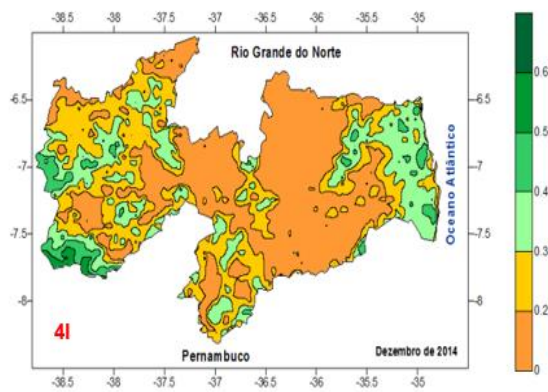


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In short it is observed that the study of the monthly variability of vegetation in relation to rainfall in the Paraíba State in the years 2013 and 2014, showed that the NDVI is a good indicator of the presence of precipitation. Although these years studied precipitation occurs below the climatological average (AESAs, 2015) mainly in the wettest quarter of the western State (February, March, April), it was found that even NDVI is high in the East (Brejo, Zone Forest and Litoral) and the Araripe located in the Paraíba border (with southern Ceará and north of Pernambuco). For the East it is associated with

the type of vegetation (atlantic forest, mangrove, etc.) and close to the ocean that are influenced by the weather systems and orographic (Rao et al. 1993; Menezes et al., 2008). In the saw may be related to landscape and predominant type of vegetation that is mostly large (Atlas Climatológico da Paraíba, 1984) favoring the further development of vegetation. Although these two years have been below the climatological average rainfall, in general the year 2014 was even drier than 2013. This study corroborates in part to studies by (Dantas et al., 2014; Sousa et al., 2014).

4. Conclusions

Considering the spatial variability of NDVI in the Paraíba State in relation to rainfall in the years 2013 and 2014 can be concluded that despite the low rainfall occurred in these two years (rainfall below the climatological average), overall the year 2014 was still drier than in 2013 as illustrated in rainfall maps above.

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