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TEMPORAL ANALYSIS OF NDVI AND PRECIPITATION DATA OF SELECTED VEGETATION COVERS OF AMAZONIA

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ABSTRACT

Maximum NDVI composites of NOAA-AVHRR GAC data and monthly precipitation records from the ground network of weather stations (August 1981 to January 1985) of vegetation covers of the Amazonia region were analyzed to verify the relationship between NDVI and precipitation at different climatic/vegetation classes selected. NDVI mean values for Dense Forest was 0.452, for Open Forest 0.442, for "Cerrado" 0.417, and for Transition Forest 0.390. The amplitude of the means of these NDVI associated with the seasonal effect of climate on the vegetation cover varied about 39%. Although a quantitative relationship between NDVI and precipitation was not significant, NDVI values seem to follow the seasonal variation in precipitation with some lag depending on the vegetation type. Several weather anomalies, such as the El Niño event of 82/83 is reflected in both NDVI and precipitation data sets.

1. INTRODUCTION

Amazonia is a very large region of Brazil (~5,000,000 km^2). The knowledge of its hydrologic cycle is very important because the precipitation distribution is not homogeneous throughout the year. In consequence, floods and dry seasons occurs. Understanding the distribution of precipitation is of the great importance to the people of the region.

Considering that is too expensive to expand and maintain an array of ground weather stations in Amazonia, orbital remote sensing can be a powerful tool to help understanding the precipitation distribution .

NOAA Advanced Very High Resolution Radiometer (AVHRR) with its high temporal resolution is particularly appropriated for monitoring such huge areas. With one channel sensible to visible and another to the near infrared radiation, it is possible to monitor green vegetation response to climate variation.

Vegetation index combines information of two spectral bands: visible and near infrared. This index have been found to be well correlated with various vegetation variables (Baret et al., 1991).

Hielkema et al. (1986) have found good correlation between vegetation index and precipitation in the Democratic Republic of Sudan.

This study will compare precipitation data acquired by the Instituto Nacional de Metereologia (INEMET) with the Normalized Difference Vegetation Index (NDVI) derived from the NOAA-AVHRR for different vegetation covers.

2. VEGETATION CLASSES

The vegetation classification presented is based on the classification used in RADAMBRASIL Project and adopted by Fundação Instituto Brasileiro de Geografia e Estatística (IBGE, 1991):

- Dense Forest
Located in firm land areas, with perennial species of compact canopy. The several levels of the canopy form a dense layer that absorbs most of the incident radiation. It's constituted of big trees on alluvial terraces and tertiary plateaus. It occurs in "ombrothermic" climates (warm and rainy, without any biologically dry period during the year).

- Open Forest
Similar to Dense Forest but with open spaces and more than 60 dry days during the year.

- Transition Forest

It's known as "transition area" between Amazonia and outer amazon space, forest physiognomy composed of spaced trees, with a shrubby stratum, with "phaneriphitos" and lianas. It occurs in climates with three dry months.

- "Cerrado"

Formation where the grass stratum is continuous and occasionally interrupted by trees and shrubs. The grass stratum is burnt almost every year and the growth patterns are closely associated with alternating wet and dry seasons of six months each.

3. METHODOLOGY

3.1. Study Area

The study area corresponds to the entire area of Legal Amazonia. It's formed by Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima, Tocantins and part of Maranhão state (west of 44°). An area with 5 million square kilometers, including forests, "cerrados" and some areas with human activities (Alves et al., 1992).

3.2. NDVI Data

The data set used is from the Global Inventory Monitoring and Modeling Studies group (GIMMS) of NASA's Goddard Space Flight Center (GSFC), in PCI format.

A program was developed to extract the NDVI digital number of the image, convert them into -1 to +1 values and put them in ASCII files.

3.3. Meteorological Data

The precipitation data set used were extracted from the INEMET publications, Agriculture Ministry, for the period of August 81 to January 85. It was created an ASCII precipitation file.

3.4. Data Integration

An Excel spreadsheet was used to build precipitation x months and NDVI x months graphics for different types of vegetation covers.

4. RESULTS AND DISCUSSION

It was chosen areas that had a complete set of information for the period of August 81 to January 1985. With the help of an vegetation map at 1:5,000,000 scale (IBGE, 1988) the main vegetation covers of each area were located.

Specific areas around the weather stations were selected based on the data sets previously organized (Table 1).

Figures 1 and 2 show NDVI and precipitation for Dense Forest. It was found a mean NDVI of 0.452.

Figures 3 and 4 show NDVI and precipitation for Open Forest. It was found a mean NDVI of 0.442.

Batista et al. (1993) analyzing vegetation types from August 1981 to June 1991 have found average NDVI value of 0.5 for Dense and Open Forest and 0.3 for "Cerrado".

Table 1 - Coordinates and Vegetation Classes of Selected Areas

02°38' S 56°44' W	Parintins	Dense Forest
03°2' S 64°41' W	Tefé	Dense Forest
06°38' S 51°58' W	São Félix do Xingu	Open Forest
09°58' S 67°49' W	Rio Branco	Open Forest
02°49' S 60°39' W	Boa Vista	Cerrado
08°58' S 48°11' W	Pedro Afonso	Cerrado
00°59' S 62°55' W	Barcelos	Transition Forest
08°15' S 49°17' W	Conçeição do Araguaia	Transition Forest

Figures 5 and 6 show NDVI and precipitation for "Cerrado". It was found a mean NDVI of 0.417.

Santos e Shimabukuro (1993) working in "Cerrado" region from January 1990 to December 1990 have found average values of 0.321 for shrub/grass savanna and 0.399 for woodland savanna.

Generally, the annual integration of monthly NDVI composites shows a sinusoidal behavior throughout the wet and dry season.

Figures 7 and 8 show NDVI and precipitation for Transition Forest. It was found a mean NDVI of 0.390.

Analyzing these graphics, it seems that the NDVI follows the precipitation distribution, although close correlation values were not found between them.

NDVI values were usually high for the months with high precipitation. For months with low precipitation the NDVI value tended to be low as well.

5. CONCLUSION AND RECOMMENDATIONS

Much of the data set from INEMET was incomplete for the period studied. From January 83 to June 1984 many data were missing what suggests that any analysis of the data for this period could contain errors.

By this initial study, it seems that the data set have some mistakes. It's necessary to look for better meteorological data set in order to have conclusive results.

When low NDVI values in rainy months are found, it's important to check the precipitation distribution for that month. The region analyzed could have been covered by clouds.

6. REFERENCES

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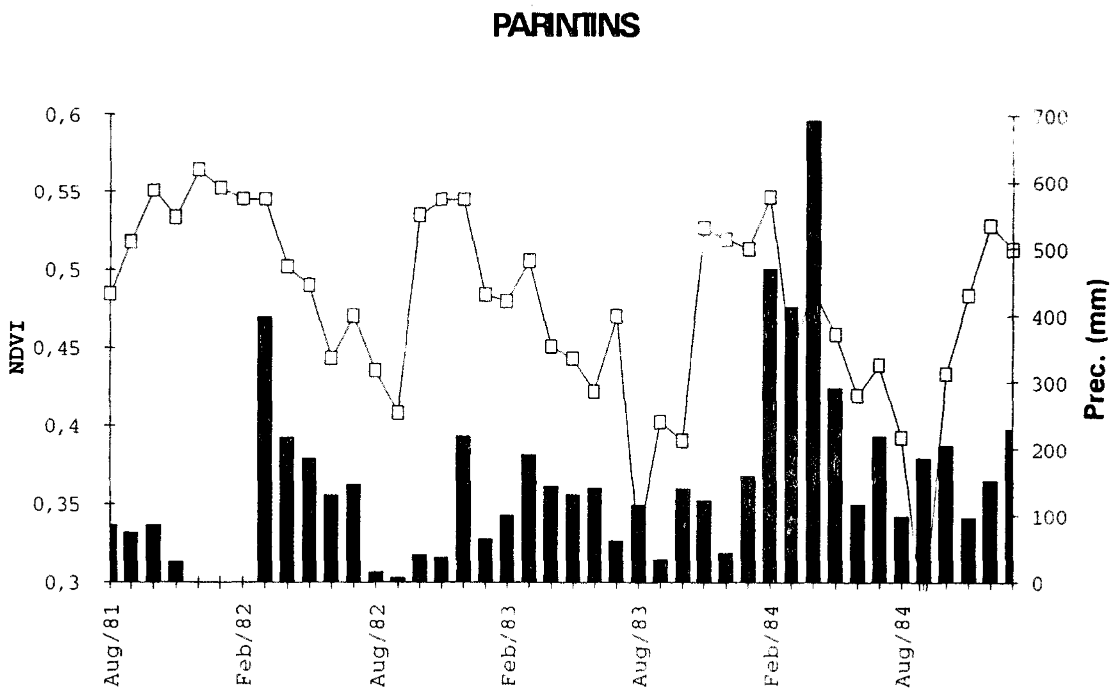

Fig. 1 - NDVI and precipitation values for Dense Forest - Parintins*.

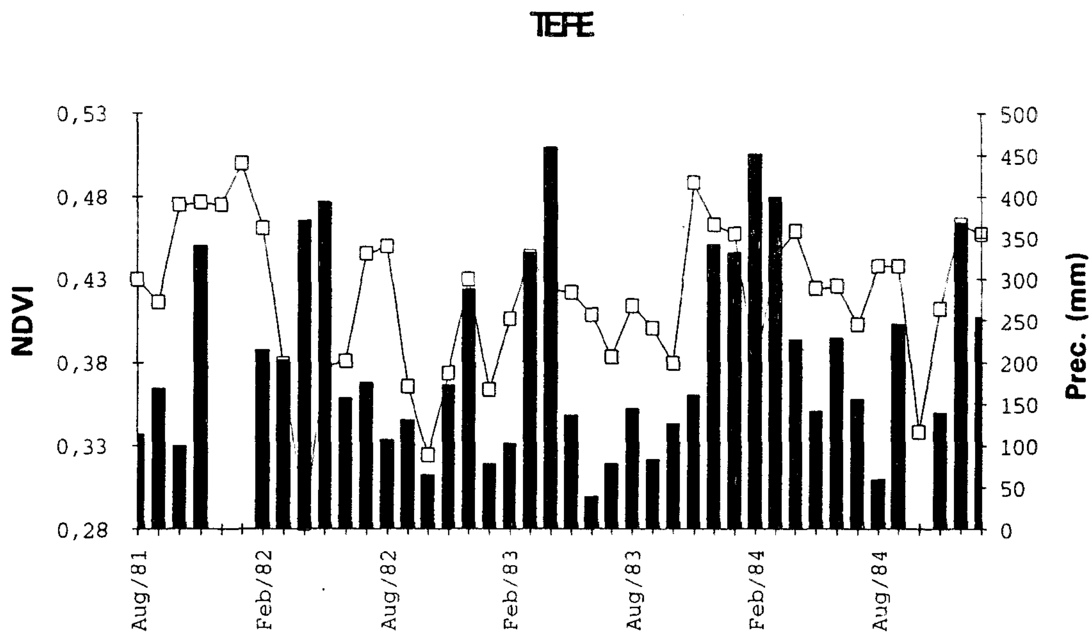

Fig. 2 - NDVI and precipitation values for Dense Forest - Tefé

* **The legend for all figures (1 through 8) is:**

-□- NDVI -■- Precipitation

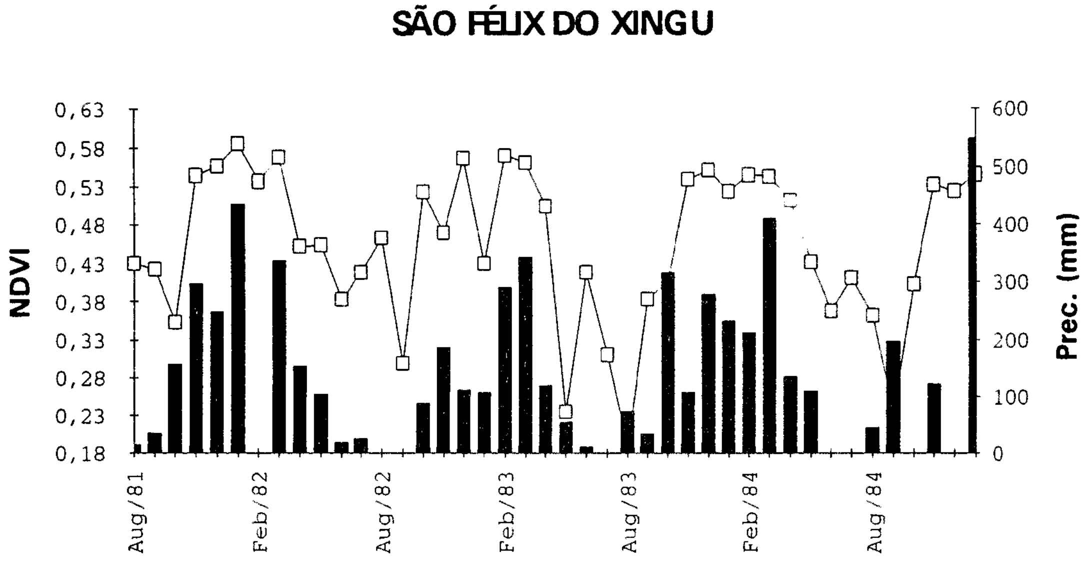

Fig. 3 - NDVI and precipitation values for Open Forest - São Félix do Xingu

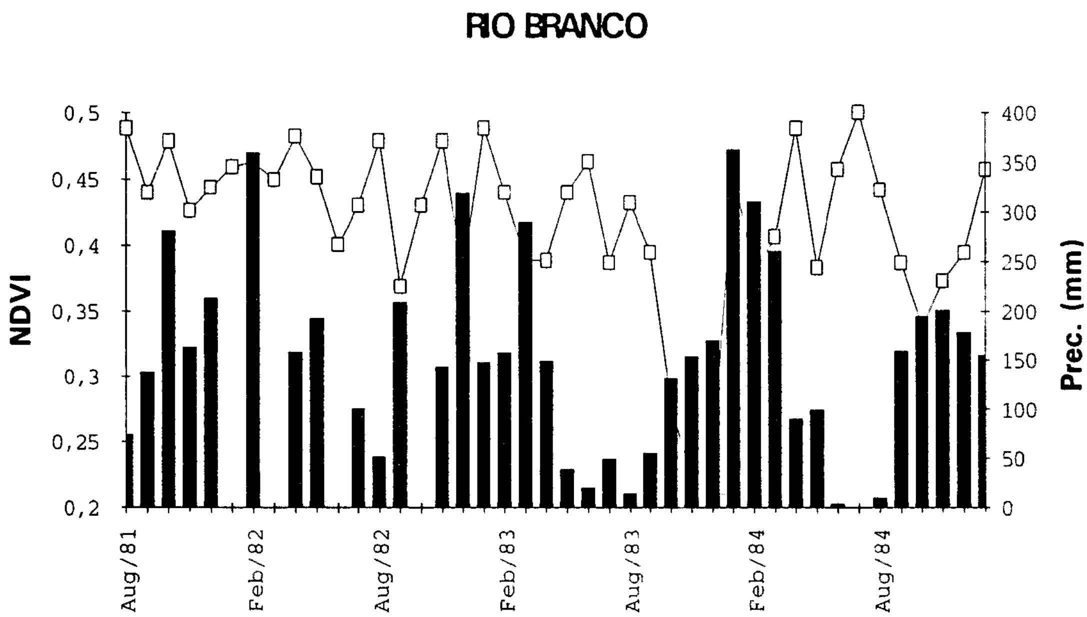

Fig. 4 - NDVI and precipitation values for Open Forest - Rio Branco

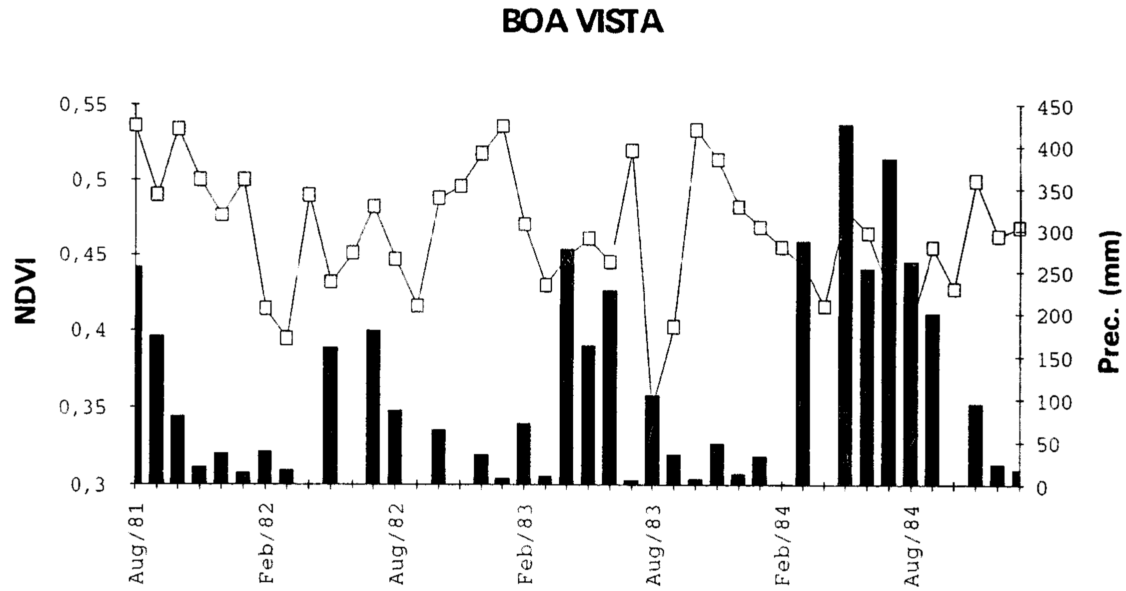

Fig. 5 - NDVI and precipitation values for "Cerrado" - Boa Vista

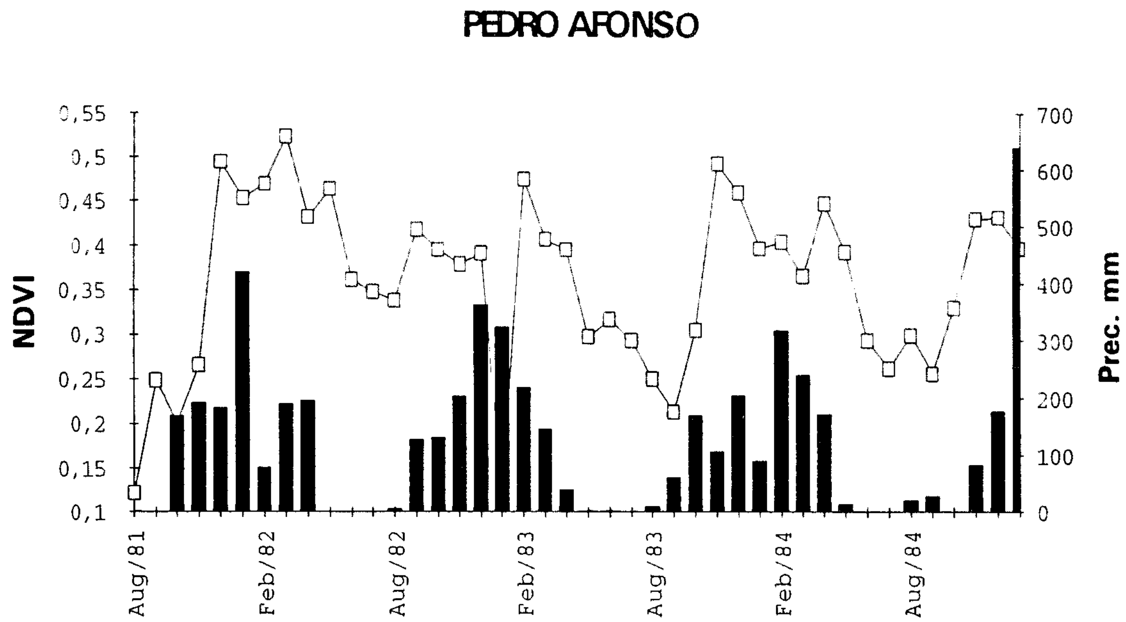

Fig. 6 - NDVI and precipitation values for "Cerrado" - Pedro Afonso

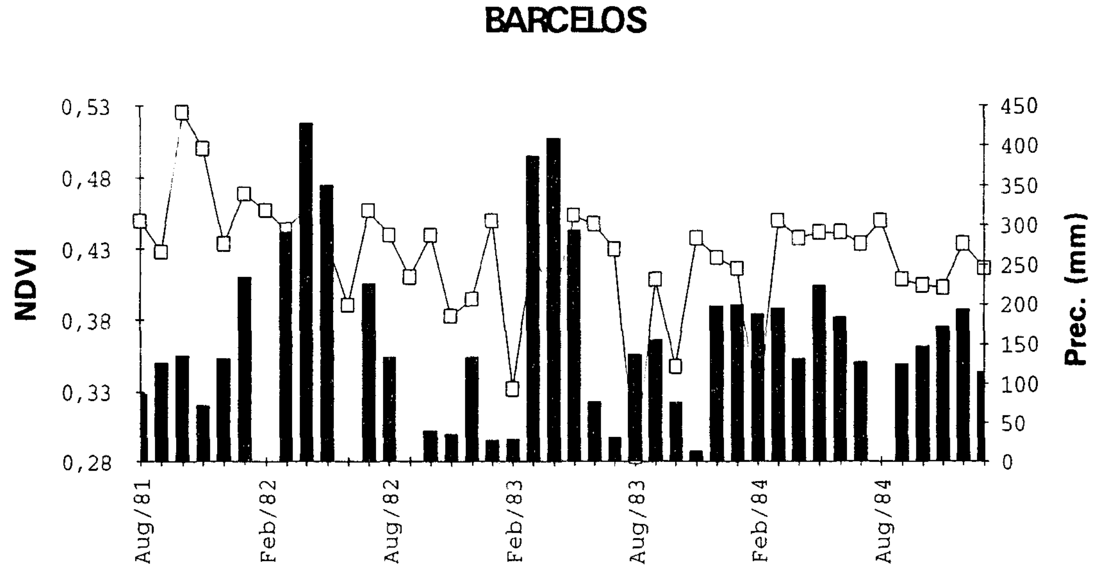

Fig. 7 - NDVI and precipitation values for Transition Forest - Barcelos

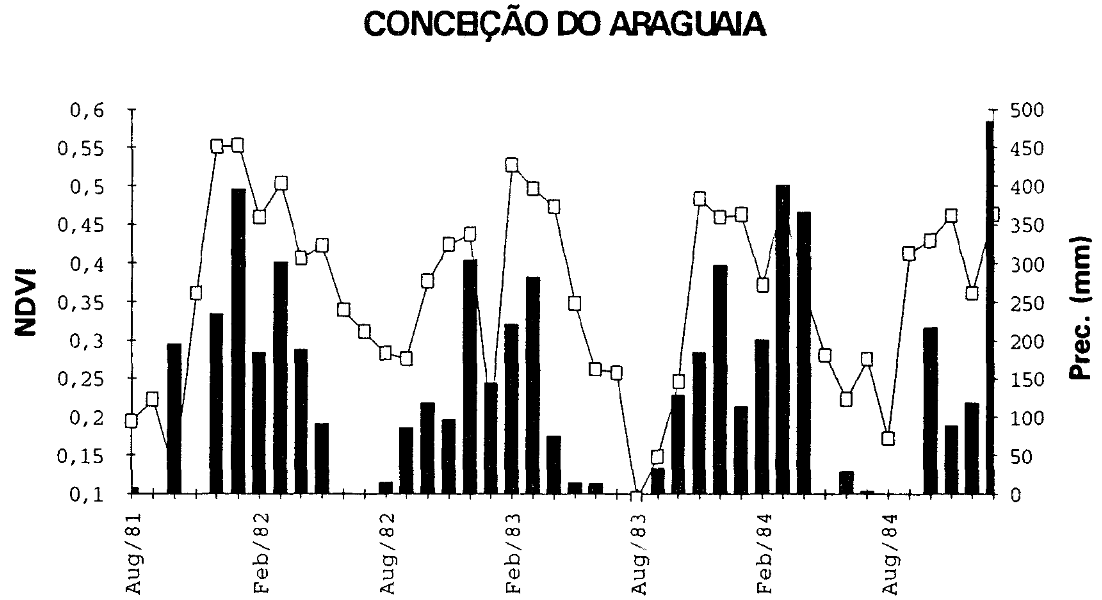

Fig. 8 - NDVI and precipitation values for Transition Forest - Conceição do Araguaia