LAND-COVER ANALYSIS USING LANDSAT IMAGERY AND DEFORESTATION INFLUENCE ON RAINFALL IN RONDÔNIA STATE, BRAZILIAN AMAZON

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ABSTRACT

Deforestation rate in the Brazilian Amazon has reached 15% in the last century and its influence on the regional climate is a matter of concern. In Rondônia State, large-scale rainforest was cut in the last thirty years, due to the colonization projects. In the present paper, time variations of observed rainfall of Rondônia State was analyzed during the period of 1976 to 2001.

As a result, 51% of the observation stations presented a decreasing trend of rainfall. The decreasing rate since the beginning of observation was up to 500 mm, whereas the increasing rate was within 200 mm. In addition, remote sensing analysis on land-cover showed an average of 30% deforestation, and in some critical areas, decreasing trend of rainfall was clearly noted. This fact suggests that deforestation has a significant impact on the rainfall of that region.

1. INTRODUCTION

Deforestation is taking place all over the world, as a result of conversion by the national projects, in many developing countries. Forests are known as a terrestrial ocean, as it provides rain clouds by evapotranspiration. In the Brazilian Amazon, more than 50% of the rainfall results from these clouds (Nobre et al., 1991). However, deforestation is affecting the local climate, turning the region drier, specially in the states of the deforestation arch. The present study tried to show in figures, the decreasing trend of rainfall in Rondônia State, analyzing the rain gauge data of ANA (Agência Nacional de Águas = National Water

Agency), and also the deforestation rate calculated from the imagery analysis of Landsat MSS, TM and EM+ taken in 1986 to 2003, in the critical areas of deforestation in that state.

2. STUDY AREA

Rondônia State is in the Southwestern Brazilian Amazonia and its geographical coordinates are Latitude 7°58'S - 13°43'S and Longitude 59°50'W - 66°48'W. It is limited to the North with Amazonas State, to the Northwest wit Acre State, to the West with Bolivia and to the East and South with Mato Grosso State. The area of Rondônia State is 243,044 km², the variation of heights varies within 70 to 600 meters and most part of the state is plain with moderate undulation. It is mountainous in limited area.

According to the climate classification of Köppen, the climate of Rondônia is Am (Equatorial) and Aw (Tropical). The feature of Rondônia's climate is rainy and hot, and the variation of temperature throughout the year does not exceed 6°C. Yearly average temperature is around 24°C with relative humidity between 80% to 85%. Rainy season begins in October and lasts until June. Yearly average rainfall varies between 1750 mm/year to 2759 mm/year. Insolation is about 1908 hours/year (SEDAM, 1996). July to September is burning season and it concentrate usually in the endo of dry season, in September. During this season, traffic accidents become frequent on the roads, airport is suspended for several days and many people get sick, because of the smoke.

The soil type of Rondônia is represented by many groups, being the most common the latosol followed by podzol, quartz sand, plinthite, cambisol, little humic glei, lithosol, indiscriminate hydromorphic, alluvial, leveling rock, luvisol (terra roxa), planasol, humic glei and ground water. In Rondônia, only small portion of the area is considered good for farmlands composed of "terra roxa", the Luvisol. This area is located along the BR-364 highway just between Seringal Nova Vida and Ouro Preto d'Oeste and some of other 23 villages created for settlement.

3. MATERIALS AND METHODS

Hydrological data was taken from the ANA (Agência Nacional de Águas = National Water Agency) of Brazil. Among 69 Rain gauge observation station points of Rondônia, 33 points were used for multi-temporal analysis in the period 1970 to 2000, when development projects took place in that region.

The imagery analysis of deforestation was carried out using the scenes from the Tropical Rain Forest Information Center, Center for Global Change and Earth Observations of Michigan State University.

001/67	2002-08-19	ETM+
001/67	1986-07-30	MSS
232/67	2003-05-20	ETM+
232/67	1984-06-24	TM
233/67	2002-05-24	ETM+
233/67	1986-07-07	MSS

4. MULTI-TEMPORAL ANALYSIS OF DEFORESTATION BASED ON LANDSAT DATA FROM 1986 TO 2003

In the present study, deforestation was detected using the variation of digital numbers of bands corresponding to the NIR of different sensors. Band four was used to compare images of different years to detect deforestation, as vegetation presents strong reflectance between 0.7 and 1.3 μ m. Also, NDVI was also used for analysis to check the biomass variation throughout the years 1986 to 2003.

$$NDVI = (band\ 4 - band\ 3)/(band\ 4 + band\ 3)$$

Tasseled cap conversion was also done to make clear visualization of the images.

5.RESULTS

5.1 RAINFALL TREND

Decreasing trend was observed in 17 points located in the deforested areas of Rondônia (Fig.1, Fig. 2).

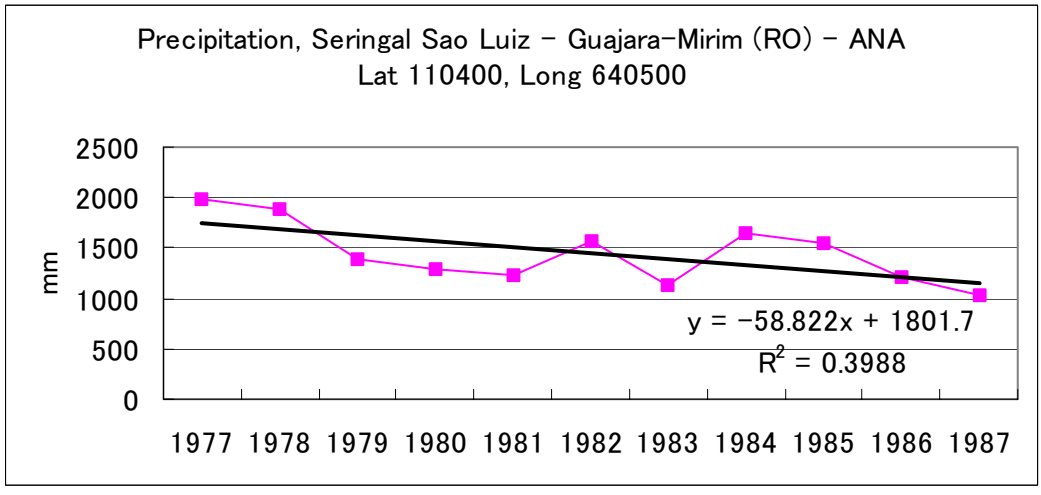

Fig. 1 Precipitation at Seringal São Luiz – Guajará-Mirim, Rondônia

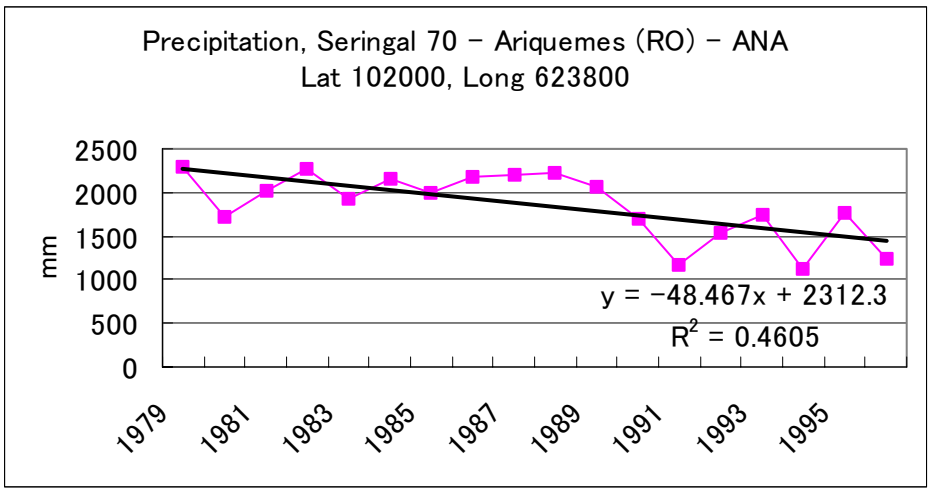

Fig. 2 Precipitation at Seringal 70 – Ariquemes, Rondônia

Increasing trend was observed in 16 points located in the regions covered with natural forest. Some increasing points were in the deforested areas, however they showed a decreasing trend over the years 1979 to 1986 and 1995 (Fig.3).

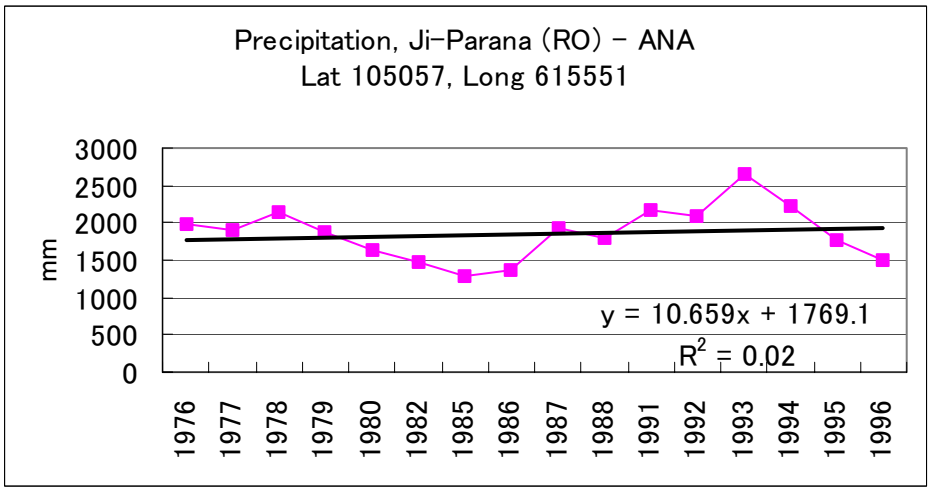

Fig. 3 Precipitation at Jiparaná – Jiparaná, Rondônia

5.2 SATELLITE IMAGERY DATA ANALYSIS

All the studied images showed an average deforestation > 30% and in the cities along the highways, deforestation was more intense, reaching 70% to 90% in several critical areas (Fig. 4). This fact coincides with the colonization projects carried out in that region, reflecting an increase of 30.000 families each year, since the 1970's.

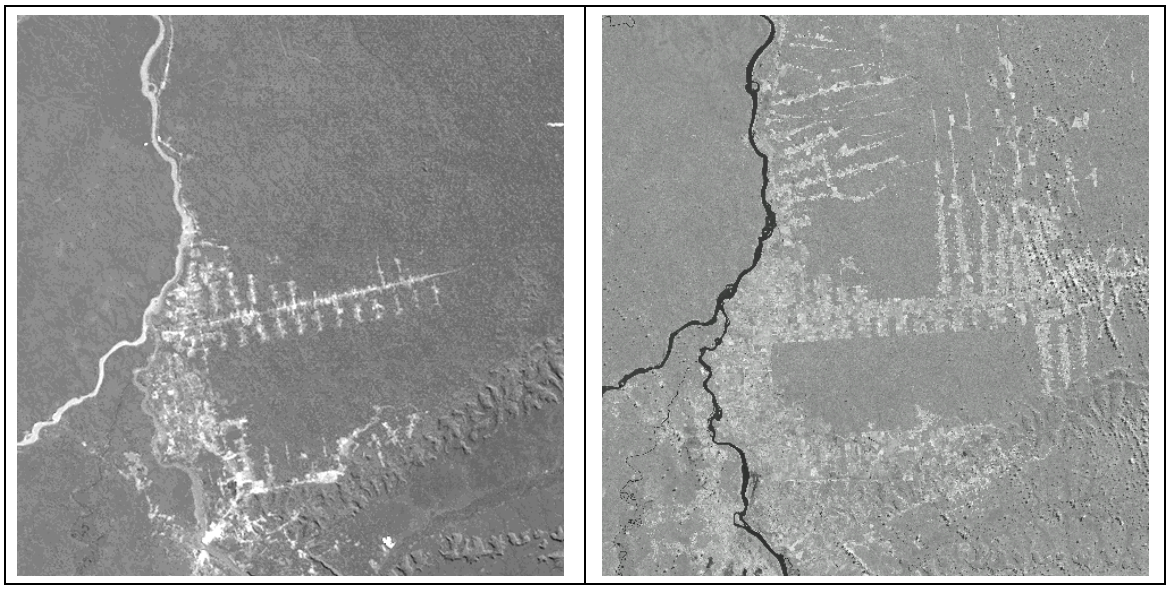

Fig. 4. On the left, Landsat MSS Band 4 imagery, showing the cities of Guajará-Mirim (in the middle, bottom) and Vila Nova (upstream of Mamoré River, at right bank), 1986. On the right, Landsat 7 ETM+ Band 4 imagery, 2002, showing the same area of Rondônia State.

5. CONCLUSIONS

Relationship between the anthropological influence and rainfall during the period of the Amazonian development projects was studied in the present study. Also, the present research, was carried out taking into account the ENSO (El Niño Southern Oscillation) influence. In some observation stations, the ENSO influence was clearly noted, with decreasing trends on rainfall in the critical years, however in some others not. The critical positive ENSO years were: 72~73, 76~77, 82~83, 86~87, 91~92, 93, 97~98, 02~03 with significant or not significant influence on the rainfall regime in the Amazon region (Malhi et al. 2004), (Aceituno, 1988) and (Richey et al. 1989). Overall, decreasing trend of rainfall was noted in 52% of the analyzed spots. In increasing spots, however, during the development period of 70's to 90's, rainfall showed a decreasing trend including the positive ENSO years. Due to the complexity of meteorological features on the Amazon Basin environment, other different aspects have to be analyzed, however, the rainfall trend in Rondônia is likely to receive the deforestation influence in a regional scale. Remote Sensing analysis showed a large scale deforestation in that region during the last thirty years and decreasing trend was clear in both cases: vegetation cover and rainfall.

6. References

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