

## PLUVIOMETRIC VARIATIONS AS SUBSIDIARY INFORMATION FOR AGRICULTURAL PLANNING IN THE AMAZON

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### Abstract

The area of interest for this study lies in the Western part of the Amazon. Monthly and annual meteorological data from 12 places were used, with daily data from eight rain gauges and daily rainfall intensity records. Data were presented from tests of water infiltration into the soil performed in the region. The results showed that the Northwest part of the region was the rainiest, attaining annual means of 3,333 mm at Iauaretê. In the Southern part, beginning at 5°S, the mean values reached 1,952 mm, at Rio Branco. Mean annual rainfalls ranged from 2,500 mm to 2,200 mm, in the region. The lowest pluvial total was 1,365 mm, which occurred at Parintins in 1983, and may be associated to the effects of a strong El Niño (82-83). In years when La Niña was strong, rainfalls were above the average and when El Niño was strong, they were below the average. The rainiest period was from December to April with means above 160 mm and the least rainy was from May to September, August being the month with the lowest rainfall. Close to Humaitá, annual rainfalls were less than 2,000 mm.

Additional Keywords: rainfall, soil erosion, erosive potential, Brazilian Amazon

### Introduction

The rate of expansion of the agricultural frontier in the Brazilian Amazon region has increased in the last few years, especially in the lands located along the main highways, currently driven by soybean cultivation. Recently, Peres and Coutinho (2004) spatialized the areas with the greatest anthropic pressure, whose occupation process begins by clearing the timber, followed by implementing pastures and later by cultivating soybean crops. However, large areas of land are currently abandoned, since they did not take into account the diversity of the socio-environmental characteristics of the region and the risk to which they are exposed, associated with the productive process.

Thus, in its almost 6 million Km<sup>2</sup>, the Amazon basin, located between latitudes 5° N and 10° S, undergoes the influence of large, medium and small-scale atmospheric processes, which confers on it characteristics typical of a tropical and equatorial climate. These variations account for the interest of various research groups, connected for instance to Universities, to the National Institute of Space Research (INPE - Instituto Nacional de Pesquisas Espaciais), to the National Institute of Amazon Research (INPA - Instituto Nacional de Pesquisas da Amazônia), the Brazilian Company of Agricultural and Livestock Research (EMBRAPA - Empresa Brasileira de Pesquisa Agropecuária), the Brazilian Institute of Geography and Statistics (IBGE - Instituto Brasileiro de Geografia e Estatística), to the European Working Group on Amazonia (EWGA), in projects such as the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA), Anglo-Brazilian Climate Observation Study (ABRACOS), with a view to understanding the dynamic processes in the Amazon, connections and their interrelationship with topics such as climate, flora, water resources, carbon cycling and land use.

The main interest of this group was to evaluate the pluvial regime, the most variable meteorological element in the region, and the infiltration of water into the soil, in the South Region of the Amazon state, especially in the area close to the municipality of Humaitá, with a view to evaluating edaphoclimatic aspects regarding limitations of land use, as to risks of erosion, soil compaction and water deficits and excesses.

### Materials and Methods

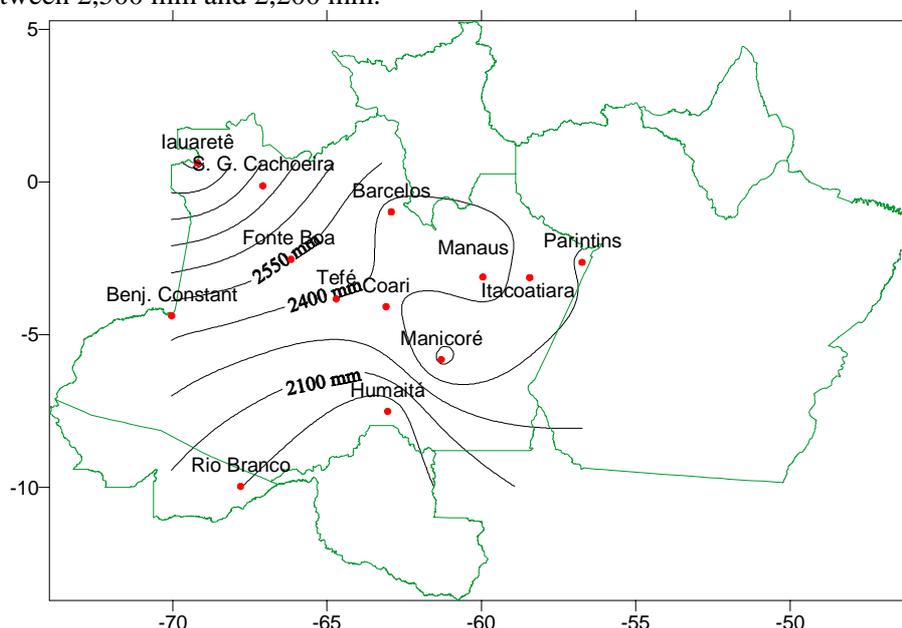
Three data series were used. The first one, with meteorological data collected from (Instituto Nacional de Meteorologia) in 12 localities in the Western part of the Amazon, for the 1971-2000 period. The second series has data from eight rain gauging stations from ANEEL (Agência Nacional de Energia Elétrica) for the 1993-1998 period. However, all localities were analyzed considering the period from 1993 to 1998 to evaluate the behavior of rainfall in the region, during the six years of data available close to Humaitá. The third series of data comes from the base used by Nechet (1994k 1998) and covers the period from 1978 to 1996 in the localities of Porto Velho, RO

and Jacareacanga, PA, where the quantity and duration of the rainfall events were evaluated. The statistical analyzes were performed in the Statistical Analysis System (SAS).

## Results and Discussion

The region presents mean annual temperatures that vary from 27.4°C (Parintins) to 24.9°C (Rio Branco). The extreme temperatures in mean annual terms varied from maximum of 31.9°C to 30.9°C to minimum of 20.1°C to 23.2°C. The mean annual relative humidity of air presented values from 84% (Benjamim Constant) to 90% (Fonte Boa). As to mean annual pluvial totals, there is clear variability, and this element is presented in greatest detail in this study.

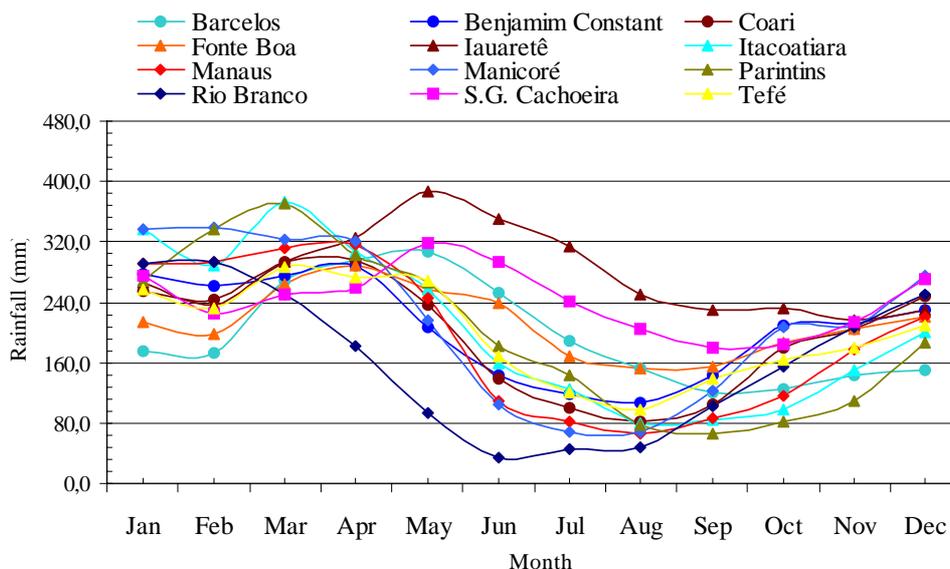
The isohyets shown in Figure 1 indicate that the highest annual pluvial totals occur in the Northwest portion, reaching 3,333 mm at Iauaretê. These values can be associated to the penetrations of frontal systems from the southern region, which interact and organize local convection. Thus, rainfall at Iauaretê may be associated with the orographic rise effects of humidity transported by trade winds from the east of the Convergence Intertropical Zone (ZCIT), described by Figueroa and Nobre (1990), Carvalho (1989). The rains diminish from 5°S with annual means on the order of 1,952 mm (Rio Branco). It was found that mainly the Western portion of the Amazon receives mean annual rainfalls between 2,500 mm and 2,200 mm.



**Figure 1. Mean annual isohyets (mm) in the western part of the Amazon, Brazil**

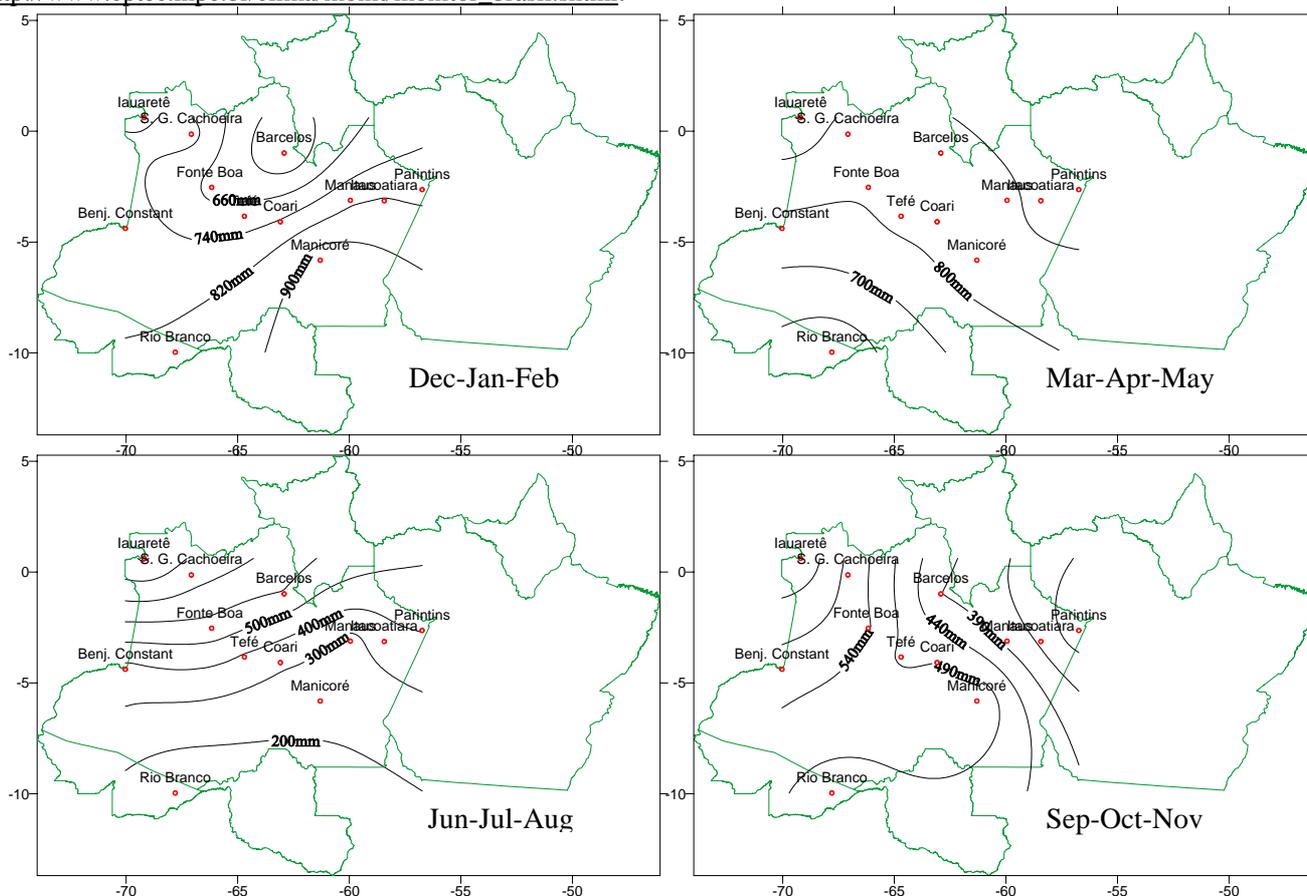
As to extreme pluvial totals, it was observed that the maximum rainfalls occurred at Iauaretê, reaching 5,279 mm in 1971, and the minimum rainfalls at Parintins, totaling 1,365 in 1983. Precipitation anomalies in Brazil may be associated with the phenomenon called El Niño-Southern Oscillation (ENSO), which provokes major alterations in the atmospheric flow on a global scale (Kousky e Cavalcanti, 1984, Kousky, 1985). In 1983 the rains were approximately 57% below the mean at Parintins and 75% at Fonte Boa and Coari. Carvalho (1989) mentions that this phenomenon diminished the convective activity and rains in the Amazon. This event was considered of strong intensity in [http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/lanina/cold\\_impacts.html](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/cold_impacts.html). In statistical analysis of the annual pluvial totals, no significant tendencies were found at any of the localities, but random fluctuations occurred around the mean.

As to the monthly rate, in most places the events increased in volume from December to April, with monthly totals higher than 160mm, diminishing from May to November (Figure 2). This behavior is similar to that presented by Figueroa and Nobre (1990).



**Figure 2. Mean monthly rainfall rate in the Western part of the Amazon (1971-2000)**

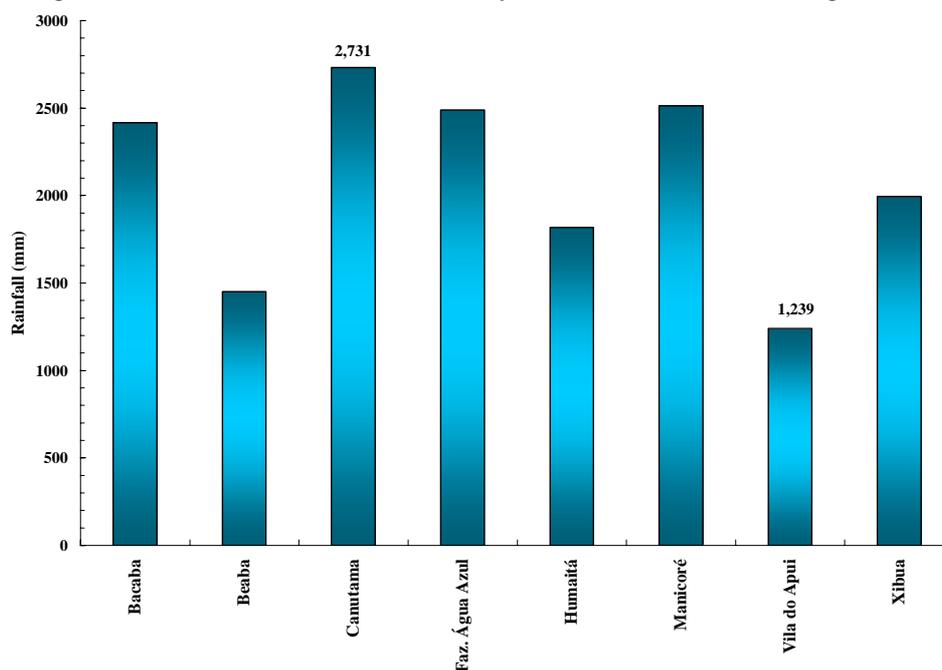
Evaluating the quarterly progression, there is a clear variability of the rainfall offer, and in the December-February period, accumulated rainfalls were around 700mm to 900mm and diminish to values on the order 200mm to 700mm, in the Jun-Jul-Aug quarter (Figure 3). These values are similar to those available at [http://www.cptec.inpe.br/clima/monit/monitor\\_brasil.shtml](http://www.cptec.inpe.br/clima/monit/monitor_brasil.shtml).



**Figure 3. Mean quarterly pluviometric precipitation in Western Amazon (1971-2000)**

In the area of greatest interest for this study, it was observed that at Humaitá, Beaba and Vila do Apui the mean annual values were below 2,000 mm (Figure 4). It should be pointed out that, at Humaitá, the annual mean was 1,818 mm with extremes of 2,651 mm (1997) and 730 mm (1998). That year (1998) the rains were around 40% below the average at Humaitá. Coelho et al (1999) cite that during strong/moderate episodes of El Niño, in summer

in the North Region of Brazil, the negative anomalies are between –50mm and –300mm, and in winter there are positive anomalies of 100mm. These indicators may be considered relevant for agricultural planning, since in years when La Niña is strong the rains are above the mean and in years when El Niño is strong, below climatic means.



**Figure 4. Mean annual rainfall in the region of Humaitá, in Western Amazon (1993 –1998).**

To give an idea of the erosive potential of rainfall in the region, it is mentioned that at Jacareacanga, in 1983, rains occurred with a 43 mm/h intensity, and at Porto Velho there were records of 83.5 mm/h (June, 1980) and 60.1 mm/h (December, 1978).

### Conclusions

Close to Humaitá the mean annual rainfalls were less than 2,000 mm.

Years of strong La Niña presented rainfalls above the average and in years of strong El Niño, rainfall was below the climatic mean values.

### Acknowledgements

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