Quantitative and Spatial Assessment of Precipitation in the Brazilian Amazon (Legal Amazon) – (1978 to 2007)

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SUMMARY

Encompassing 9 countries in South America the Amazon region has the largest hydric potential in the world. The region is vitally important for the global climate, as well as having rich biodiversity, and relevant economic, social and environmental aspects. It covers an area of approximately 7.5 million square kilometers, which corresponds to around 7% of the planet's solid surface. This study performs a quantitative and spatial assessment of precipitation occurring in the Brazilian Amazon over a period of 30 years (1978 to 2007). The treatment was based on a non-parametric Mann-Kendall test, considering data consistency, density of spatial distribution for the stations, the historical series and climatic phenomena. The results show that in terms of precipitation in the Brazilian Amazon, over the 30-year period there was a trend towards the decreasing rainfall in the southwest quadrants of the region where the arc of deforestation is found, while in the northern quadrants there was a slight increase that was not significant.

Keywords: *Precipitation, Brazilian Amazon, Rainfall data, Climate Trends, El Niño/ La Niña, Isohyets.*

INTRODUCTION

At a global level the climate change issue is noticeably becoming increasingly perceptible in society (UNFCCC, 1992; CORFEE MORLOT and HÖHNE, 2003; TOL et al., 2003;). In this regard, there has been intensified study by the scientific community and by society in general, at both the public/governmental and private level in a search for solutions to those problems.

In this scenario, the rainfall regime is one of the major elements of climate, which is essential for the existence of life on Earth and related to economic, social and environmental issues; since water obtained from rainfall feeds a multitude of activities, such as agriculture, ranching hydroelectricity and others. Additionally, rainfall and air humidity contribute in transferring heat from one region of the planet to another (MOLION, 1987), a very important natural process, given that the rise in Earth temperatures is the best-known and most sensitive climate change.

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The region known as the Greater Amazon or continental Amazon has an area of approximately 7,584,421 Km² (ARAGÓN, 2002), which corresponds to about 7% of the solid surface on the planet and includes territory from eight countries (Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela) and from French Guyana (an overseas Department of France located inside the Amazon environment). Brazil accounts for around 5 million Km2 (FISCH et al., 1998; FEARNSIDE, 2003), approximately 66% of the Amazon region area, which is known as the Brazilian Amazon, Legal Amazon or Amazon Region, and corresponds to the States of Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima, Tocantins and part of the State of Maranhão.

The region has abundant water resources. Its network of rivers includes the world's largest, the Amazon River, which arises in the Andes Mountains in Peru and empties into the Atlantic Ocean on the coast of Brazil, for a total extension of 6,000 Km (PNRH, 2006). Including participation of discharges from its tributaries it has an average final flow rate estimated at 209,000 m^3/s (MOLINIER et al., 1995). In it are the world's largest contiguous river basins, the Amazon, Xingu, Tocantins and Madeira, besides the potential of underground reservoirs and some of the world's highest rainfall rates.

In this context, it is worth noting that the water volume precipitated per year on the planet is 577,000 Km^3, of which only 20% is precipitated on the continents and the remainder into the oceans (SHIKLOMANOV, 1998; ABREU et al., 2005; REBOUÇAS et al. 2006). That being the case, it is presumed that a large share of the volume that falls on the continents occurs in the Amazon, given that, besides having an enormous territorial extension, it has one of the highest rainfall rates on earth, on average 2,300 mm/year (FISCH et al., 1998; REBOUÇAS, et al. 2006; CORREIA et al. 2007).

In this regard, our research sought to study the spatial variability of rainfall occurring over the last 30 (thirty) years (1978 to 2007) in the Brazilian Amazon, correlating that variability with the years in which El Niño and La Niña occurred, since these are climate phenomena that influence precipitation in this region (ACEITUNO, 1988; RAO and HADA, 1990; MARENGO et al., 1998; POVEDA and MESA, 1997; BRAGA et al., 2011).

The study on the spatial and temporal variability of rainfall has intensified in different regions of the world, as presented in the research of some authors, Rao and Hada (1990), Liebmann and Marengo (2001), Marengo (2004), Archer and Fowler (2004), Zhang et al. (2009), Augustine (2010), Hartmann et al., (2012), which contribute towards the management and planning of water resources.

In the study region there is an accessible network of pluviometers whose data can be treated and systematized, which made the study possible. The spatial variability of rainfall over the 30 year period was studied in terms of its volumetric distribution, according to the characteristics found in the isohyet maps, which were followed according to the data obtained, in other words, describing the rainfall hydrological phenomenon and establishing quantitative grandeurs within a defined geographical space.

These results will be of great importance for informing and expanding the data base and enabling an understanding of subsequent studies of rainfall patterns, as well as for policy decision-making regarding water resources in the region.

METHODOLOGY

Collection and treatment of rainfall data.

Data were systematized based on information recorded at the official pluviometric monitoring posts located in the Legal Amazon, made available by the Agência Nacional de Águas - ANA (HidroWeb base), through spreadsheets in which the monthly and annual rainfall values for each pluviometric station were tabulated.

Of the total of 1490 pluviometric stations in the study area, 234 were selected that presented a 30-year series (1978-2007), the value recommended for reliability in a climate characterization for a region (WMO, 1994; TUCCI, 2003).

In analyzing data from the pluviometric stations it was noted that some stations had inconsistent data in their series, either through mistakes, errors in reading or in transcription. These were corrected through regional weighting and regional weighting with linear regression, taking into account the region's homogeneity through the Köppen classification. Data consistency validation was performed through the double mass method, which compares the annual accumulated values for the season that was corrected with the values from the closest neighbor and with the largest data series. It should be noted that both of these usual methods are consolidated in the literature (TUCCI, 2003; OLIVEIRA et al., 2010);

Preparation of the isohyet maps

The isolines or isohyets (curves that define parts of the space with the same height of water depth) were prepared according to the values of the rainfall heights found in the monitoring posts (TUCCI, 2003).

Based on the disposition of these curves, associated with the heights of the water depths, spatial and quantitative distribution of rainfall was verified for the region using SURFER software and the cubing method (by extreme areas or sections; prism and prismoidal formulas, heights of points, contours) for volumetric quantification of those data (UREN and PRICE, 1978; BORGES, 1992).

The methods utilized for interpolating rainfall include Inverse Distance Weighted (IDW), Polynomial Global and Local Interpolation, Radial Base Functions or Kriging (Simples; Ordinary linear; Universal and Cokriging). In this work we used Ordinary Linear Kriging, since it is one of the most recommended procedures for situations with regionalized tendencies, as is the case in the Amazon, according to Isaaks & Srivastava (1989). This method is associated with B.L.U.E. (Best Linear Unbiased Estimator).

Mann–Kendall Test

The Mann–Kendall test, recommended by World Meteorological Organization-WMO (MITCHELL et al., 1966) is a non-parametric test for assessing trends in time series data (MANN, 1945). This test compares each value of a time series with the other remaining values in sequential order. This test is based on the statistic“ ” defined per Yue, et al. (2002), Liu et al. (2009); Silva, et al. (2010) as:

$$S = \sum_{i=2}^{n} \sum_{j=1}^{i-1} \operatorname{sgn}(x_i - x_j) \tag{1}$$

where ’x_j’ are the sequential data values, ’n’ is the length of the data set, and ’sgn(x_i-x_j)’ is -1 for ’sgn(x_i-x_j)<0’, ’sgn(x_i-x_j)’ is 0 for ’sgn (x_i-x_j)=0’ and 1 for ’sgn(x_i-x_j)>0’. The mean ’E(S)’ and variance ’Var(S)’ of statistic ’S’ may be given as:

$$E(S) = 0 \tag{2}$$

$$Var(S) = \frac{n(n-1)(2n+5) - \sum_{p=1}^{q} t_p(t_p - 1)(2t_p + 5)}{18} \tag{3}$$

where ’q’ is the number of tied groups and ’t_p’ is the number of data points in the ’p^{th}’ group. Considering the null hypothesis and absence of ’q’ the variance ’Var(S)’ may be given as:

$$Var(S) = \frac{n(n-1)(2n+5)}{18} \tag{4}$$

The standardized test statistic Z_{MK} is given as:

$$Z_{MK} = \begin{cases} \dfrac{S-1}{\sqrt{Var(S)}} & \text{se } S > 0 \\ 0 \quad \text{se} & S = 0 \\ \dfrac{S+1}{\sqrt{Var(S)}} & \text{se } S < 0 \end{cases} \tag{5}$$

A time series has a clear trend, defined as a level of significance of 5%, if $|Z_{MK}| > |Z_{\alpha/2}| = 1.96$. A positive Z_{MK} indicates an increasing trend in the time series, while a negative Z_{MK} indicates a decreasing trend (Yu, et al., 2002).

Spearman Test

According to Detzel et al. (2011, Yue et al. (2002), is a non-parametric test. In study, Müller et al. (1998) highlighted the consistency of Spearman test in comparison with other methods. In the spearman test the hypothesis tested:

- H0 - The series is homogeneous (no trends);
- H1 - The series is not homogeneous (trends)

where the statistical test of Spearman is given by Siegel and Castellan Jr. (2006):

$$r_s = 1 - \frac{6\sum_{i=1}^{N} d_i^2}{N^3 - N} \tag{6}$$

Where $d_i = X_i - Y_i$ the difference in the point of the two variables, and N is the number of elements in the sample.

For large samples, verifying the null hypothesis, the distribution is calculated in t, Detzel et al. (2011), as:

$$t = N\sqrt{\frac{N-2}{1-r_s^2}} \tag{7}$$

Where the value calculated in (7) is compared with the tabulated value, in relation to a level of significance, allowing the conclusion about the null hypothesis.

Calculation of volume of rainwater precipitated in the Legal Amazon over the 30 years.

The volume of rainwater precipitated in the study region was calculated through isoline tracing, applying the method of cubic footing by contours. To do this the isohyet maps prepared with help from SURFER were exported.

Considering the enormous dimensions of the study area and in order to better understand and visualize the dynamics of volumes at macro and meso-rainfall scales, the region was divided into four quadrants, in an attempt to maintain equity among the areas or surfaces of each quadrant. The following coordinates were used as references: Latitude 06ºS and Longitude 57ºW. The quadrants were named Northeast (NE), Southeast (SE), Northwest (NW) and Southwest (SW), Figure 1.

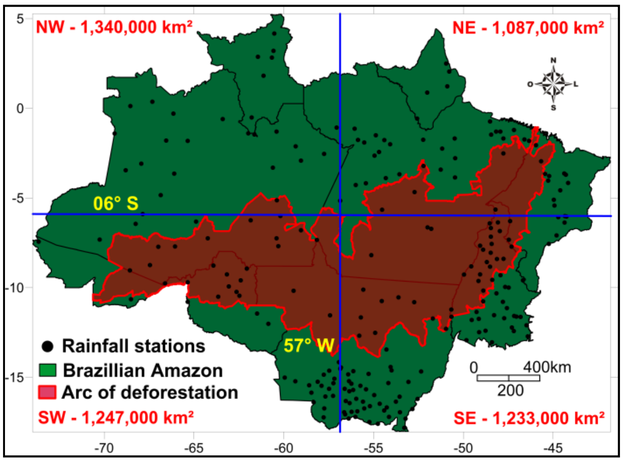

Figure 1 - Proposed subdivision for more detailed study of precipitation in areas of the Amazon Region, with identification of the arc of deforestation.

With the rainfall volumes calculated, one may assess the dynamics of precipitation spatiality in the study area for the period (1978 to 2007), by observing the average precipitation values in each one of the quadrants. One can also correlate them with climate phenomena, specifically El Niño and La Niña, phenomena caused by warming or cooling in the Pacific (MARENGO 2004), which significantly interfere in precipitation in the Amazon; and also with human activities such as the arc of deforestation that began in the 1980s. Simulation studies on deforested areas in the Amazon have confirmed microclimatic and hydrological modifications in the region (FISCH et al., 1998; COSTA et al., 2007; SAMPAIO et al., 2007; COE et al., 2009).

The dry and rainy periods over the 30 years are presented using an order 3 moving average and its correlation with a strong intensity El Niño (1982, 1983, 1990, 1993, 1997 and 1998) and La Niña (1988, 1989 and 2007) , which may directly interfere in rainfall dynamics in the region (INPE/CPTEC, 2009 and NOAA/CPC, 2010).

RESULTS

Collection and treatment of rainfall data.

Of the total of 1490 pluviometric stations registered in the region, after analysis of the series, 234 were collected that contained data from the 30-year period (1978 to 2007) defined for this study.

It should be noted that of the 234 stations, 177 had to be submitted to correction or filling in of missing data that varied from months to years. For stations that presented only monthly corrections of up to 6 months, the regional weighting with linear regression method was used, and for periods longer than that regional weighting was adopted; in both, three neighboring stations with data consistent with the correction period were used as references.

Based on isotropic or anisotropic variogram omnidirectional, chosen by the utility Model, the theoretical models: exponential, spherical, Gaussian and power (linear and quadratic) being selected to adjust the data set, the power (linear). The maps selected, it was found type geometric anisotropy, which was more evident direction 45o, as (2).

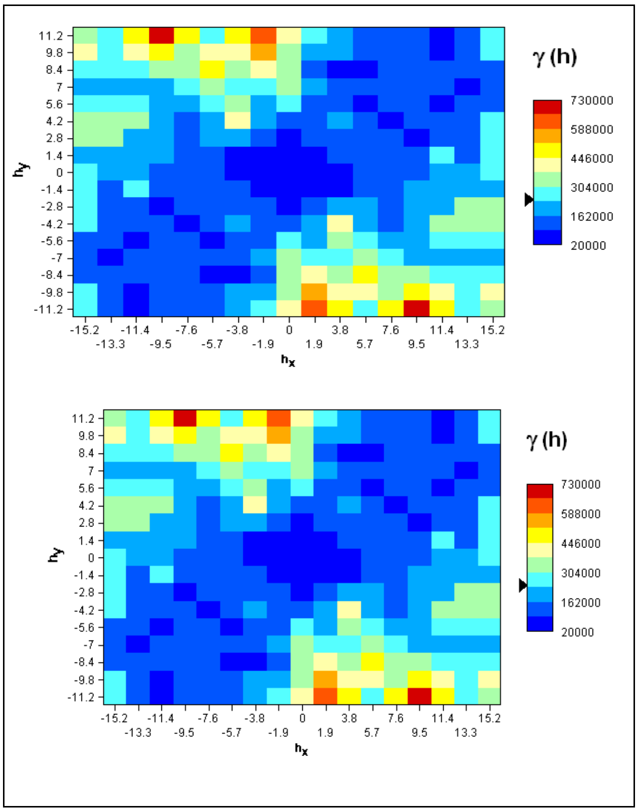

Figure 2 - Variograma para as direções de 45º.

Preparation of the isohyet maps

Before plotting the isohyets using the Ordinary Linear Kriging method, variographic analyses were made for each one of the years, so that the variograms with the models best adjusted to the rainfall data presented were selected.

With the variograms obtained the isohyets may be traced with the Ordinary Linear Kriging Method. Figures 3, 4 and 5 present the isohyet maps for the Legal Amazon with rainfall from 1978, annual averages for the 30 years and for 2007, respectively.

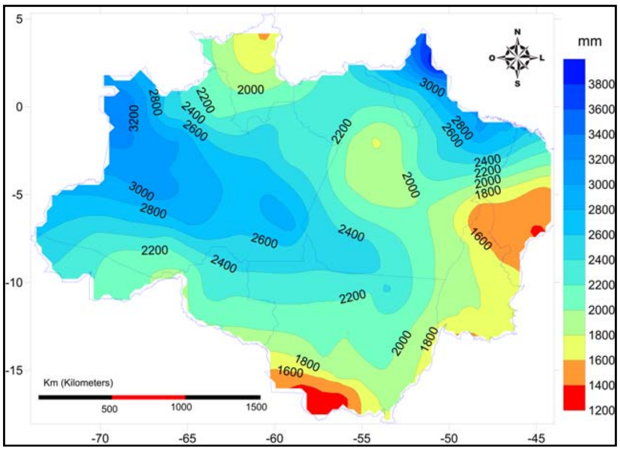

Figure 3 - Precipitation map for 1978 in the Legal Amazon.

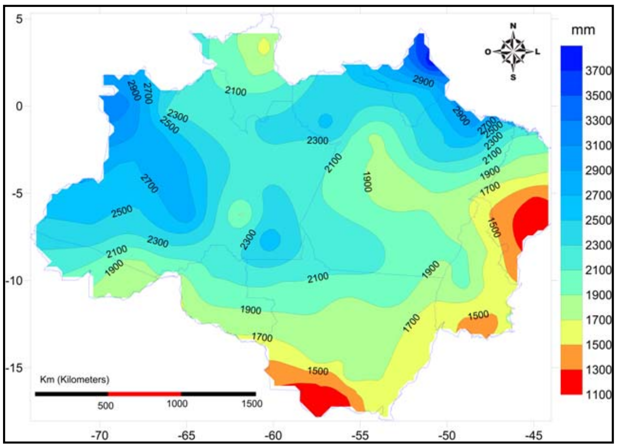

Figure 4 - Average annual precipitation map (1978-2007) for the Legal Amazon.

One may observe from the map that the highest rainfall rates occurred in the far north of the region, mainly in the State of Amapá, with more than 4000 mm per year, with noteworthy precipitation also falling on the coast of the State of Pará and in the Northwest of the State of Amazonas in the region known as the “dog’s head.” Additionally, in comparison with isohyet maps from other studies (SALATI, 1978; HIEZ et al., 1992; MARENGO, 1995; MOLINIER et al. 1995), one may perceive that these regions have the areas with highest and lowest rainfall in common, with similarities in the values for water depths in the same areas being observable.

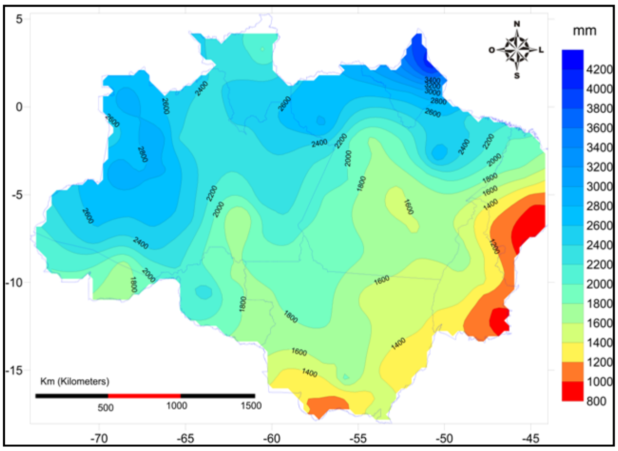

Figure 5 - Precipitation map for 2007 in the Legal Amazon.

As for the regions with rates below 1800 mm per year, the northern part of Roraima and the eastern and extreme southern part of the Legal Amazon that includes a major part of the States of Maranhão, Tocantins and Mato Grosso are noteworthy.

In these areas, the low rainfall rates may be related to characteristics of the vegetation (cerrado-type savanna), as well as the current scenario of the arc of deforestation. According to data from INPE (2008), the Legal Amazon had already had 713,000 Km² of forests devastated by 2008, corresponding to around 13.7% in relation to the total area, twice the size of Japan.

Calculation of the volume of rain falling in the Legal Amazon over the 30 years.

After preparation of the isohyet maps one may calculate the annual volume precipitation over the Legal Amazon area during the last 30 years. SURFER was used for this calculation.

The average depth is obtained by dividing the volume precipitated over the area respective to that volume, and one can compare the quadrants with the most and least rainfall in the Legal Amazon, as well as the annual variations in the respective areas (Table 01). Evaluating the time series of annual precipitation totals for the different quadrants, Northeast (NE), Southeast (SE), Northwest (NW) and Southwest (SW), it was verified that the maximum of minimum values of of rainfall and the variability in relation the average largely occurred during periods of El Niño and La Niña, respectively, as verified in 1983 and 1989 (Table 02).

Table 01 - Average annual depth (mm) per quadrants.

Years/ Average depth (mm)	NE	NW	SW	SE	MÉDIA
1978	2265.8	2562.4	2270.2	1953.8	2269.4
1979	2092.4	2340.1	2134.2	1873.8	2115.6
1980	2036.4	2184.6	2062.5	2015.3	2078.2
1981	1742.4	2372.8	2153.0	1651.7	1996.3
1982	2141.9	2467.5	2257.1	1795.8	2173.4
1983	1483.3	2113.7	1888.0	1706.4	1814.3
1984	2534.4	2587.7	2198.7	1634.5	2237.6
1985	2696.2	2294.8	2227.8	2062.7	2308.4
1986	2317.1	2535.8	2200.2	1715.2	2196.0
1987	1825.3	2187.8	2044.9	1656.5	1937.7
1988	2585.9	2635.3	2219.9	1878.2	2328.6
1989	2678.1	2558.4	2216.4	2006.9	2359.3
1990	2103.4	2387.7	2117.7	1574.8	2051.9
1991	2142.7	2192.3	2072.8	1756.0	2041.4
1992	1626.0	2051.6	1980.0	1826.7	1882.6
1993	2083.9	2745.2	2060.9	1629.8	2144.7
1994	2451.2	2373.0	2077.1	1874.0	2189.8
1995	2260.7	2132.1	1984.1	1901.0	2064.9
1996	2415.3	2473.5	2072.6	1727.2	2171.3
1997	1885.9	2035.6	2036.8	1776.1	1937.6
1998	2018.1	2228.4	1910.7	1591.4	1941.0
1999	2410.5	2601.0	1958.7	1697.9	2168.6
2000	2614.0	2460.7	1960.0	1885.3	2222.9
2001	2262.8	2424.2	2200.6	1751.3	2162.6
2002	2142.0	2437.0	1995.5	1650.9	2062.0
2003	2127.4	2288.4	2079.8	1729.3	2059.2
2004	2263.1	2409.8	2031.7	1867.6	2145.0
2005	2305.4	2459.1	1827.9	1711.6	2076.8
2006	2355.8	2615.2	2001.2	1795.5	2195.8
2007	2182.5	2463.0	1963.5	1501.1	2032.3
AVERAGE	**2201.7**	**2387.3**	**2073.5**	**1773.3**	**2112.2**
STANDARD DEVIATION	**295,19**	**184,32**	**115,91**	**138,26**	**131,87**
COEFFICIENT OF VARIATION	**0,13**	**0,08**	**0,06**	**0,08**	**0,06**
RANGE	**1212,89**	**709,62**	**442,26**	**487,93**	**545,03**
RANGE/AVERAGE	**55%**	**30%**	**21%**	**28%**	**26%**

Table 02 - The values assigned for minimum and maximum rainfall per quadrants and relation with average of annual precipitation.

Quadrants	Precipitation				Variability/average (%)	
	Maximum (mm)	Year	Minimum (mm)	Year	(+)	(-)
NE	2696.2	1985	1483.3	1983	22.46	32.63
NW	2745.2	1993	2035.6	1997	14.99	14.73
SE	2062.7	1985	1501.1	2007	16.32	15.35
SW	2270.2	1978	1827.9	2005	9.49	11.84
Total Area	2359.3	1989	1814.3	1983	11.70	14.10

The results demonstrate that the northern quadrants have higher precipitation rates, notably the Northwest region with its average annual rainfall on the order of 2387.28 mm, whereas in the Southeast region is considerably smaller, at 1773.28 mm. This makes it the only quadrant presenting average annual precipitation below 2000 mm; that may be associated with the fact that this region is part of the Cerrado Biome and also next to the Northeastern portion of the country, known as the driest region of Brazil, as well as being in the zone known as the arc of deforestation, which has a strong interference with precipitation.

Figure 6 presents the average behavior of the annual precipitation volume in the Legal Amazon over the last 30 years. One should note that in this historical series there were some significant variations in the annual average, mainly during the El Niño and La Niña years.

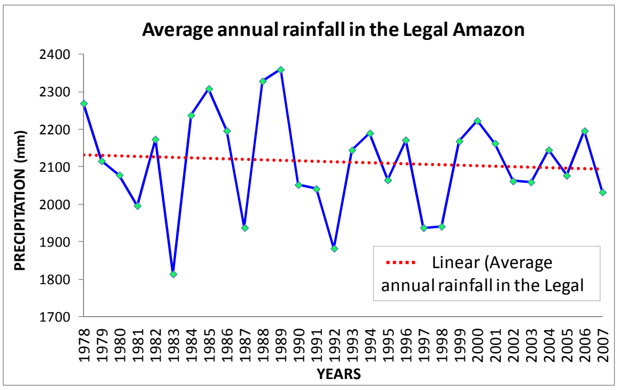

Figure 6 - Behavior of average of the volume annual of precipitation in the Legal Amazon.

Figure 7 presents the behavior of volume annual of precipitation in each quadrant of the Legal Amazon over the last 30 years.

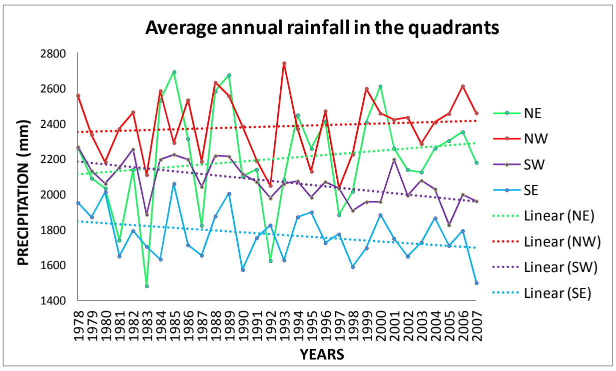

Figure 7 - Behavior of the volume annual of precipitation per quadrant in the Legal Amazon.

Utilizing annual precipitation averages occurring in the Brazilian Amazon through an order 3 moving average, we observe the dry and rainy periods over the last 30 years. In the graph we see that the dry periods coincide with the strong El Niño years, whereas the rainy periods coincide with the occurrence of La Niña, showing that these climate phenomena have a direct influence on precipitation in the Brazilian Amazon (Figure 8).

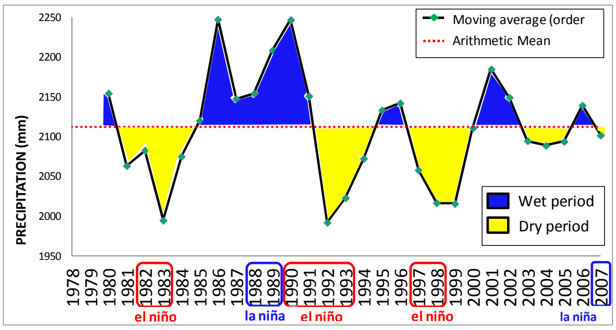

Figure 8 - Dry and rainy period utilizing an order 3 moving average.

Archer and Fowler (2004) identified similar links analyzing precipitation in the Upper Indus Basin, but the connections for that period were with NAO phenomena (North Atlantic Oscillation).

Observing the behavior of the precipitation and calculating the amount precipitation per region, we applied the Mann-Kendall test to the precipitation series to assess the behavior of the trend per region, as presented in Table 03.

Table 03 - Results of the Mann-Kendall for the significance level (± 1.96) range and spearman for the significance level (5%), with occurrences of El Nino and La Nina.

Precipitation per Region (1978-2007)	Region	Test Mann Kendall (Z_{MK})	Spearman	Trend
Precipitation	(NE)	0.874	0.181	no tendency
Precipitation	(SE)	-1.338	-0.270	no tendency
Precipitation	(NW)	0.089	0.109	no tendency
Precipitation	(SW)	-3.229	-0.580	negative tendency
Total Precipitation in the Legal Amazon		-0.696	-0.143	no tendency

When analyzing behavior of rainfall in the previously established quadrants one may observe that it in the Northeast and Northwest it has not significantly increased, while in the quadrants to the Southeast and Southwest one may observe a marked decrease in precipitation; however, it is only significant in the southwest. It is highly likely that this reduction can be correlated to the existence of the arc of deforestation and an intense alteration in land use and occupation in those regions. Studies such as those by Fisch et al. (1998), Costa et al. (2003), D'Almeida et al. (2006), Costa et al. (2007), Sampaio et al. (2007), Coe et al. (2009), have concluded, using simulations and modeling, that the intense deforestation in the Amazon rainforest directly influences environmental imbalance, principally in the hydrological cycle, producing a significant decrease in evapotranspiration and precipitation.

Table 04 - Present research on rainfall trends in the Amazon basin

Authors	Publication year	Main results and conclusions about the precipitation in Amazonia
Marengo & Valverde	2007	In Amazonia, yet that deforestation has in the last years significant tendency were not detected in the rainfalls or streamflow in this region. In the regional scale, the rainfall in Amazonia presents a weak negative tendency while the rain in Amazonia of the South presents a pronounced positive tendency. In the Amazonia, though the various models can present trends of increasing or decreasing, the consensus would be reduced rainfall, particularly in the eastern Amazon.
Marengo	2004	Negative precipitation trends were identified for the entire Amazon basin, while the regional level, there is a negative trends in northern Amazonia and positive trends in the southern Amazon in the Climate Research Unit (CRU), raingauge-based dataset, while the CMAP dataset shows negative trends. The drier period after 1975 is consistent with the presence of stronger and more frequent El Niño, which occurred during the years 1983, 1987, 1991-93, and 1998, which tend to produce less rainfall in northern Amazon. Shown a systematic increase in convection about the northern Amazonia after 1975, that could indicate an increase of rainfall in the region.
Chu *et al.*	1994	A small increase was consistently observed in most of the convection in the Amazon Basin (1974-90), with changes that were statistically more significant in the Western Amazon, along the slope of the Andes.
Liebmann and Marengo	2001	The annual mean precipitation in the Brazilian Amazon. Ranging from less than 2000 mm in the south, east, and extreme north, to more than 3000 mm in the northwest, period 1976 - 97.

The average precipitation in Brazilian Amazon, defined in Table 02 was 2,112.17 mm, corresponding to 5.9 mm/day-1. Other research obtained the values presented in Table 05.

Table 05 - Daily precipitation average in the Amazon Basin (Marengo, 2004)

Index	Mean (mm day^{-1})
Chen *et al.* (2001, 2003)	8.1
Russell and Miller (1990)	5.5
Vorosmarty *et al.*, (1989)	6.2
Matsuyama *et al.*, (1992)	5.9
Marengo *et al.*, (1994)	7.9
Xie and Arkin, (1998)	5.0
Costa and Foley, (1998)	5.9
Zeng, (1999)	5.6
Climate Research Unit (CRU)	5.9
National Centers for Environmental Predictions (NCEP)	5.8

Source: adapted from Marengo, 2004

The trends presented in this paper partially converge with previous studies, especially regarding the small reduction in rainfall in the Amazon as a whole. However, it appears that there are divergences concerning the distribution of spatial variability, and an increase to the north (in the two quadrants), even if not very significant, and reduction to the south (two quadrants), strongly significant in the southwest.

The average precipitation calculated in this paper shows itself to be absolutely compatible with the 10 studies surveyed (Table 05), which range from 5.0 to 8.1 mm day-1 with an average of 6.2 mm day-1, i.e. only a 5% variation.

However, most studies employed a different approach in their analyses, dealing with the entire Amazon basin, while the present paper is limited to the Brazilian Amazon.

DISCUSSION AND CONCLUSIONS

The total volume precipitated over the Brazilian Amazon over a period of 30 years was 310,834.9 Km^3 or 310,834,900,000,000,000 liters, with an annual average of 10,361.16 Km^3, a volume that has remained approximately constant, accounting for around 2% of all global precipitation (577,000 Km^3) and 9% of precipitation on the solid surface of the planet (119,000 Km^3).

The results of the non parametric Mann-Kendall and Spearman test indicate that only in the southwest region is there a significant and decreasing trend in changes in the behavior of precipitation, which is to some degree attenuated by the constant behavior constant of the other quadrants. Therefore one cannot affirm that there has been a significant reduction of precipitation in Legal Amazon over the 30-year study period. This can is associated with the natural variability of the phenomena.

This work focuses on the quantitative study for description and characterization on the precipitation in the Brazilian Amazon over a period of 30 years, based on real and measured data , using neither simulations, modeling or predictions and hypothetical scenarios, and not seeking to identify a cause-effect relationship for the phenomenon, but the paper may contribute to or inform other research needed for understanding of this phenomenon in the region, which is so vital to the entire planet.

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Avaliação Quantitativa e Espacial da Precipitação na Amazônia Brasileira (Amazônia Legal) – (1978-2007)

RESUMO

Abrangendo 9 países da América do Sul, a Amazonia tem o maior potencial hídrico do mundo. A região é de importância vital para o clima global, tendo uma rica biodiversidade e aspectos econômicos, sociais e ambientais relevantes. Cobre uma área de aproximadamente 7,6 milhões de quilômetros quadrados, que corresponde a cerca de 7% da superfície sólida do planeta. Este estudo realiza uma avaliação quantitativa e espacial da precipitação que ocorre na Amazonia Brasileira num período de 30 anos (1978 a 2007). O tratamento foi baseado no teste não-paramétrico de Mann-Kendall, considerando a consistência de dados, densidade da distribuição espacial dos postos, séries históricas e fenômenos climáticos. Os resultados mostram que, em termos de precipitação na Amazonia Brasileira, durante o período de 30 anos, houve uma tendência no sentido da diminuição da chuva nos quadrantes de sudoeste da região, onde é encontrado o arco de desmatamento, enquanto que, nos quadrantes norte houve um pequeno aumento que não foi significativo.

Palavras chave: *Precipitação, Amazônia Brasileira, Dados de Chuva, Tendências climáticas, El Niño/La Niña, isoietas.*