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TÍTULO: AN ANALYSIS OF SPATIAL VARIATION OF PRECIPITATION OVER THE AMAZON BASIN IN BRAZIL

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AN ANALYSIS OF SPATIAL VARIATION OF PRECIPITATION OVER THE AMAZON BASIN IN BRASIL

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INTRODUCTION

Water being one of the prime requirements for life, it has been a matter of study from early times. In this view several aspects of rainfall distribution in space and time have been studied {Riehl (1954, 1947), Monteiro (1969, 1971) and Dean (1971)}. Stidd and Leopold (1951) made extensive studies in analysis of Hawain rainfall. They found that mean monthly rainfall as well as rainfall in individual months for all stations in those islands can be represented by a straightline on a diagram of monthly against annual rainfall. Success of such a formalisation makes it possible to treat a great variety of climatic problems in a very simple manner. The straightline fit they have used is of the form:

$$y = a\ (x - R) + b$$

where y is the monthly rainfall, x, the annual rainfall, a, a constant determining the slope of the line and 'b' its intercept with some selected annual rainfall value (R), 'b' can be interpreted as rainfall blanket of uniform thickness over the whole area. That is essentially the contribution derived from rainstorms. It is now easy to see that R should stand for mean annual rainfall over the area. Hence $\Sigma\, b_j = R$ where b_j is the value of 'b' corresponding to month 'j'. The purpose of this study is to find such a set of formulae for the rainfall distribution over the Amazon basin.

Data and Method of Analysis

The area in the basin whose rainfall data is analysed below is mainly the area in Brasil lying between equator and 16°S latitude and between 50°W and 70°W longitudes. The region is shown in Fig. 1. Monthly and annual mean rainfall values have been picked out for all grid points at 2° interval of latitude and 2° interval of longitude from the Atlas Climatológico do Brasil (1969). In all therefore 74 grid points values in the area are used for the following analysis. The annual mean rainfall over this region is 2213 mm.

A regression line of monthly against annual rainfall has been fitted by the method of least squares to each month's data using the 74 sets of values. Correlation co-efficients were also computed. The correlation co-efficients, the regression co-efficients and the intercept on the selected y-axis are given in Table. Correlation co-efficients were tested for significance. For this purpose $Z = \frac{1}{2} \log_e \left(\frac{1+r}{1-r}\right)$ were calculated and are included in the table. Z is known to be approximately normally distributed with a standard deviation σ_z $(= \frac{1}{\sqrt{N-3}})$ where N is the number of pairs of observation used in the analysis. σ_z for 71,(N-3) degrees of freedom works out to be o.113. It will be seen that all the values of Z are more than three times their standard error and are highly significant. That is, our hypothesis that the spatial distribution of rainfall in Amazon basin can be represented by

$$y = a_j(x - R) + b_j$$

where a_j is the slope of the line for the month j, and

b_j the average rainfall over the area in that month is valid.

The 'y' values corresponding to the selected value of R, that is the mean annual rainfall, of 2213mm are given in column 5 of table. The monthly values total to 2190mm, where as the actual annual is 2213mm. The difference is due to errors in interpolation from the charts. The isohyetals are drawn at intervals of 250mm for the annual and 50mm for the monthly charts. So the difference of 23mm (one percent) between the value calculated from annual chart directly and those computed from monthly means, is not considered to be significant.

The dot-diagram together with the regression line are shown for two representative months in Fig. 2, and the March of raintorms precipitation (col. 5 of Table) as well as the slope of the line are plotted in Fig. 3.

Discussion

The March of rainfall (Fig. 3b) through the year clearly brings out the variation of rainfall in the basin month by month. The rainfall has a maximum in the period January to March and a minimum during June to August. The region has a summer rainfall and dry winter. The rapid and continuous change from summer to winter and vice versa are also clearly brought out by the figure. The rainfall in the region is associated with the position and activity of I.T.C.Z. which shifts south of the equator during southern summer and north during northern summer.

The slope (Fig. 3a) which can be interpreted as the positional effect of a station in the area has a positive value in all the months. The stations with higher annual rainfall in general receive higher rainfall in each month of the year. It has an average value of 0.082 in the rainy months of January to March and 0.057 in the nonrainy three months. There is however a sudden large change in its value in April (0.133) and a similar but smaller increase in September. In other months its value lies between 0.06 and 0.07. The positional effect therefore has a higher value in the rainy months and lower values in non rainy months. Its value however seems to increase in the first month after two seasons.

Summary

The study seems to indicate that spatial distribution of rainfall in the upper Amazon and middle Amazon region of Brazil can be adequately represented by three parameters a, b and R. The annual march of rainfall is also clearly brought out. It has a periodicity of one year with a maximum round about January and a minimum about July.

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REFERENCES

1 - Atlas Climatológico do Brasil 1969 Ministério da Agricultura Rio de Janeiro

2 - Carlos Augusto de Figueiredo Monteiro 1969 "A Frente Polar Atlântica Z com chuvas de inverno na fachada sub-oriental do Brasil" - Universidade de São Paulo, São Paulo

3 - Carlos Augusto de Figueiredo Monteiro 1971 "Climatologia" 2, Universidade de São Paulo, Instituto de Geografia, São Paulo.

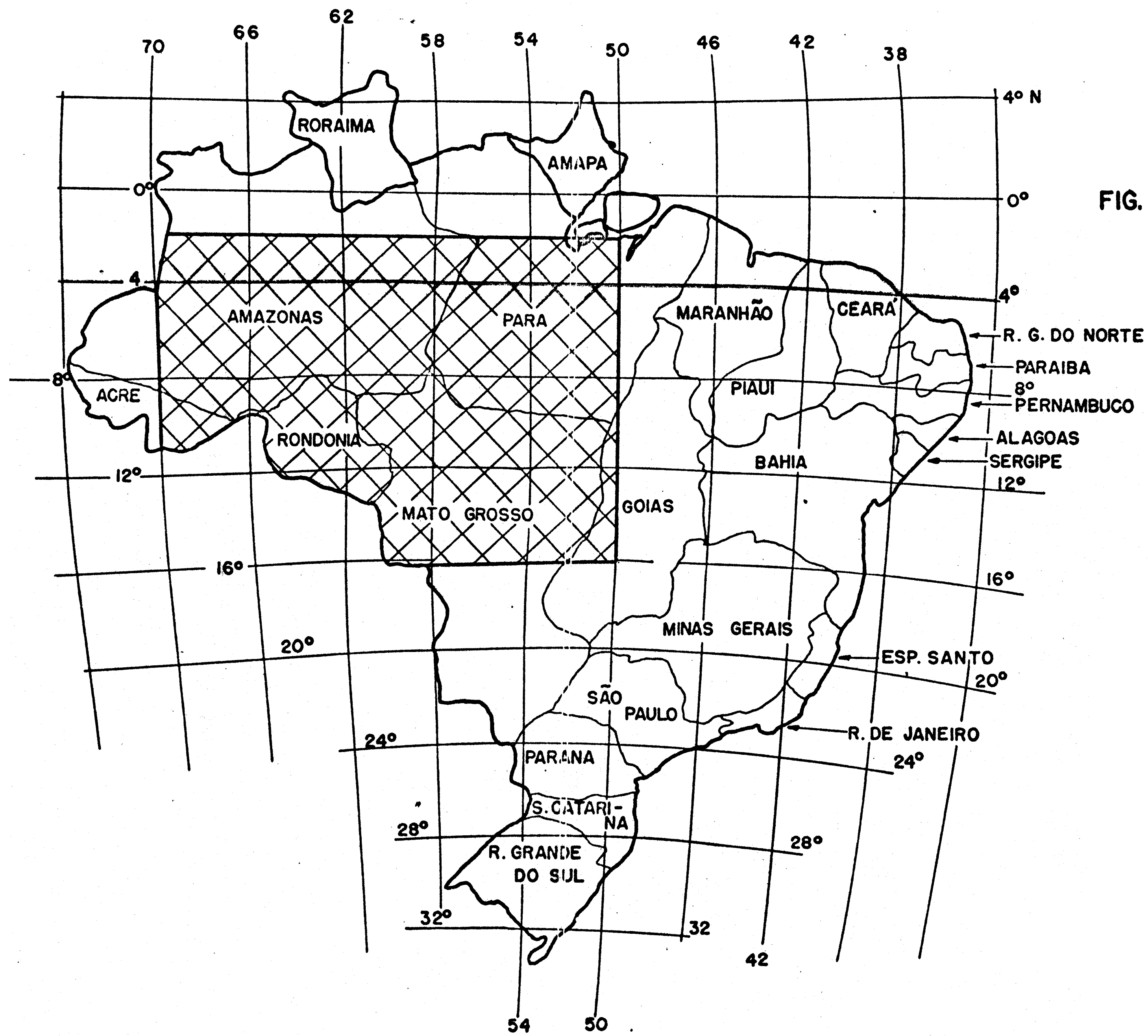
4 - Stidd, E.K. and Leopold L.B. 1951 Am. Met. Soc. Mon. 3, P.24-

5 - Riehl, H. 1954 "Tropical Meterology" McGraw-Hill Book Co., New York.

TABLE

S.NO	MONTH	Correlation co-efficient(r)	$Z = \frac{1}{2}\log_e \left[\frac{1+r}{1-r}\right]$	Regression co-efficient	y(x = 2213mm)
1	January	.579	.661	.084	319.459
2	February	.501	.551	.093	317.432
3	March	.581	.665	.069	311.554
4	April	.756	.986	.133	237.973
5	May	.364	.381	.074	134.324
6	June	.359	.376	.056	61.959
7	July	.329	.341	.050	43.108
8	August	.566	.641	.064	45.270
9	September	.804	1.109	.077	100.338
10	October	.599	.692	.065	163.851
11	November	.385	.407	.062	212.094
12	December	.411	.437	.060	242.567
			$\sigma_z = 0.113$		

FIG. 1



70
66
62
58
54
50
46
42
38
4° N
0°
4°
8°
12°
16°
20°
24°
28°
32°
4
32
42
54
50
RORAIMA
AMAPA
AMAZONAS
PARA
MARANHÃO
CEARA
R. G. DO NORTE
PARAIBA
PERNAMBUCO
ALAGOAS
SERGIPE
ACRE
RONDONIA
PIAUI
BAHIA
MATO GROSSO
GOIAS
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R. DE JANEIRO
PARANA
S. CATARI-NA
R. GRANDE DO SUL

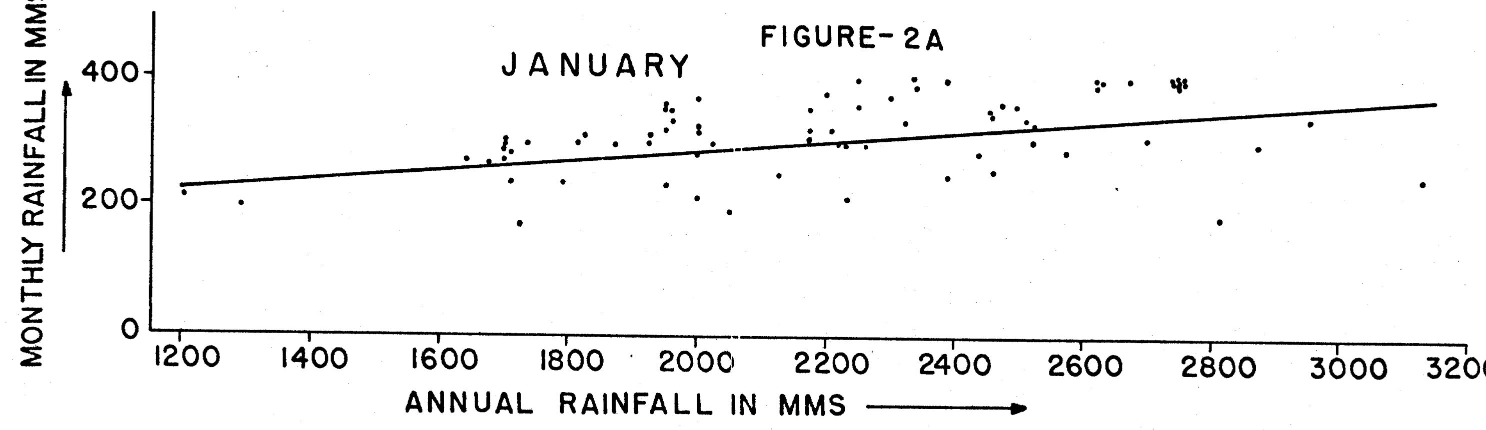

FIGURE-2A

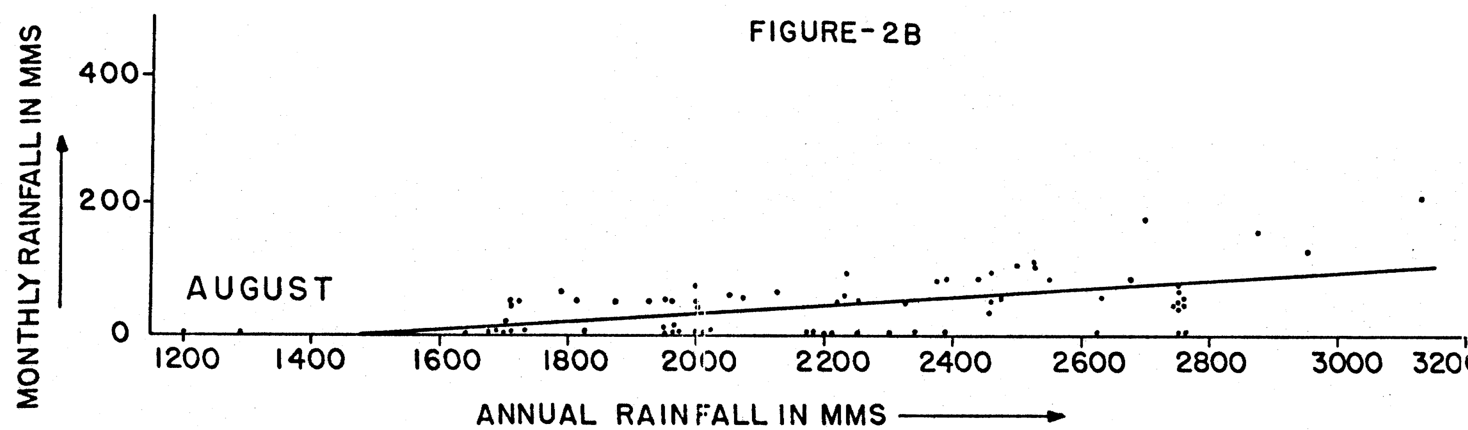

FIGURE-2B

FIGURE-3A

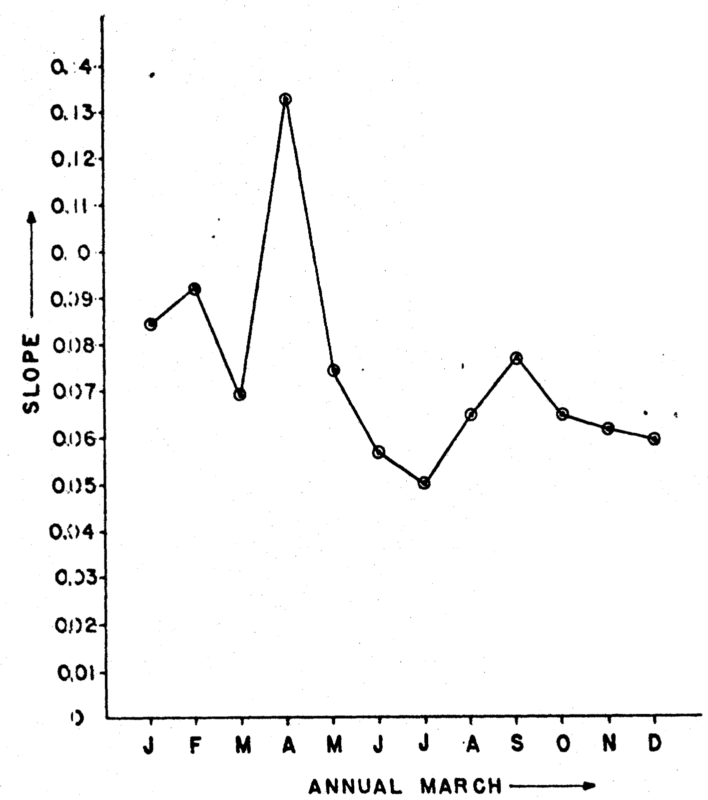

FIGURE-3B