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RUNOFF COEFFICIENT AND ITS RELATION TO PHYTOGEOGRAPHY IN BRAZIL

Felix Carriello[1]*
João Vianei Soares[1]
Nelson Jesus Ferreira[2]
Daniel Andrés Rodriguez[2]

[1]Instituto Nacional de Pesquisas Espaciais (INPE) - Divisão de Sensoriamento Remoto
Av. dos Astronautas, 1758 - CEP 12227-010, C.P. 515, São José dos Campos, SP Brazil
[2]Centro de Previsão de Tempo e Estudos Climáticos
Rodovia Presidente Dutra, Km 40, SP-RJ CEP:12630-000, Cachoeira Paulista, SP, Brasil
e-mail: {felix, vianei, @ltid.inpe.br ; {nelson, dandres}@cptec.inpe.br

1.INTRODUCTION

This work analyses the relation between coefficient runoff and vegetation trough NDVI (Normalized Difference Vegetation Index) in the Brazilian sub-basins during 1982 to 1999 period to study the behavior of different vegetation physiognomies in Brazil and Runoff Coefficient - RC.

RC is the ratio between river flow to precipitation, and could be used as a measure of the availability of freshwater.

RC maps of basins could be a valuable analysis tool for water production assessment being influenced by Climate Forcing, Geology, Soil and Land Cover at large basins. These variables modify the water's residence time in the basin.

Carriello (2004) has studied the RC over the 74 sub-Brazilian basins (that together cover the political llimits of Brazil) and found high values in western Amazon and average values in central Amazon ($\geq$ 0.5). Low values in the center-south and southeast (0.3), and very low in the Northeast semi-arid of Brazil and in the west of Centro-Oeste region ($\leq$0.3).

Ichii et al. (2002); Almeida (1997) and Shultz and Halpert (1995) investigated the relationship between NDVI and precipitation in their works. In this work we analyses NDVI and RC, annually averages to study vegetation and RC.

2. METHODOLOGY

RC of each sub-basin was carried out using river flow from the "Fluviometric Station Inventory," (Ministério de Minas e Energia 1997), and from Agência Nacional de Águas - (ANA 2003) the dataset is in daily averages and was converted into monthly and annual averages to

*Corresponding Author Adress: Felix Carriello, INPE – Instituto Nacional de Pesquisas Espaciais Av. dos Astronautas, 1758 - CEP 12227-010, C.P. 515, São José dos Campos, SP Brazil, email: felix@ltid.inpe.br

calculate the annual runoff for each basin. Observed precipitation data were compiled and interpolated by the Tyndall Center for Climate Change Research (New et al. 1999; 2000 and 2002). The interpolator chosen was the "Thin-plate spline," (New et al. 1999) which considers polynomial operators and uses point data to adjust a surface, given a set of points. The data are available in grids of 0.5º x 0.5º for the whole terrestrial globe for the period from 1970 to 2000. After calculating RC, it was transformed in grid values and corresponds to the entire sub-basin.

NDVI (Normalized Difference Vegetation Index) was calculated using AVHRR (2004) (Advanced Very High Resolution Radiometer) imagery from NOAA satellites (7, 9, 11 e 14) and was obtained from channels 1 and 2 (red and infra-red channels) from 1982 to 1999 period.

The correlation coefficient between RC and NDVI was calculated for each sub-basin. To asses the accuracy of the correlation was developed some statistical tests. At first were calculated the confidence limits for each correlation coefficient, using the Fischer's z transformation. In addition, the r=0 (correlation coefficient in table 1 - appendix) hypothesis was tested for each sub-basin, using the Student's t test.

3. Results

Sub-basins in regions located in semi-arid regions of Northeast in Brazil presented the highest correlations coefficient (>0.31) among all sub-basins, and sub-basins in Amazônia region have the lowest correlation coefficient as can be observed in figure 1.

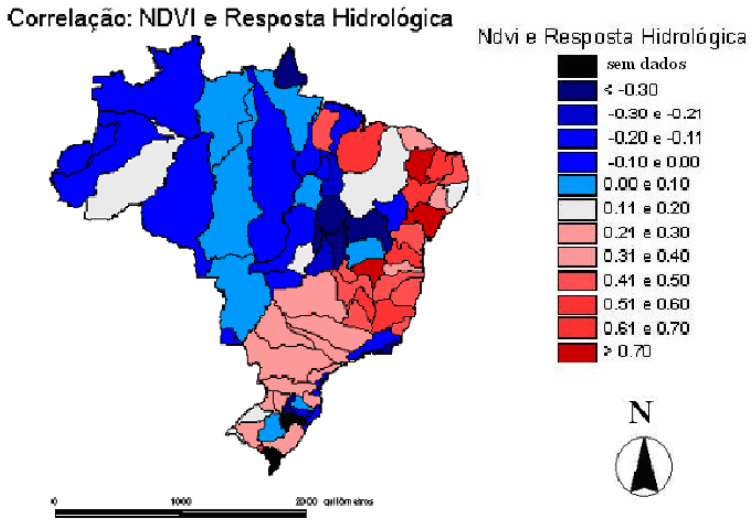

figure 1: correlation between NDVI and runoff coefficient. Carriello, 2004.

From the Student's t test it could be concluded that the basins 10 to 29 present no significant correlation between NDVI and RC (r and T – table 1 - appendix). On the other hand, and taking into account the confidence limits (r1 and r2 – table 1 - appendix), the sub-basins 31, 33, 34, 37, 38, 44, 48, 50, 51, 53, 55 e 56 showed a positive correlation between NDVI and RC. These sub-basins are located at arid and semi arid regions of Northeast region in Brazil.

Caatinga vegetation is present in arid and semi-arid region of northeast of Brazil, with high seasonality. Its leaves respond quickly to precipitation, and when water is available photosynthesis is produced at higher levels increasing the NDVI values. In years of higher RC, the soil becomes humid, there are more evapotranspiration taxes, runoff and NDVI are higher than in normal years. In the other hand, years of drought there is little water to vegetation, soil becomes dry and photosynthesis diminishes and so NDVI. Ichii et al. 2002 found positive correlation between NDVI and precipitation in south hemisphere regions, mainly in arid and semi-arid regions, among these, Northeast region of Brazil.

The lowest correlation coefficient occurs in Amazonian sub-basins where the runoff coefficients have average values, between 0.3 to 0.5. In this region, even in years with low precipitation levels, there is sufficient water to vegetation, and photosynthesis occurs in high levels and so NDVI presents higher values. Radiant energy is abundant and evapotranspiration occurs also at high levels and runoff is, then lower, so correlation coefficient between NDVI and runoff are lower, sometimes negative. Shultz and Halpert (1995) found negative correlations or near zero between NDVI and precipitation in rain forest.

In regions of Savana the correlations coefficients are lower than in northeast of Brazil but higher than in Amazônia. Years of higher RC, there are higher NDVI; years of lower RC, NDVI is lower too.

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5.Appendix

Table 1 – SB: sub-basin; r = correlation coefficient; r1 e r2 are the bottom and top confidence limits. The N in the fifteth column indicate that the Ho: r=0 hypothesis is accepted at 95% confidence level.

SB	r	r1	r2	T	SB	r	r1	r2	T
10	-0.12	-0.55	0.37	N	20	-0.33	-0.69	0.16	N
11	-0.23	-0.63	0.26	N	21	0.19	-0.30	0.60	N
12	-0.21	-0.61	0.29	N	22	-0.35	-0.70	0.14	N
13	0.13	-0.48	0.66	N	23	-0.25	-0.64	0.24	N
14	-0.07	-0.52	0.41	N	24	-0.03	-0.49	0.44	N
15	-0.14	-0.57	0.35	N	25	-0.43	-0.75	0.05	N
16	-0.04	-0.60	0.55	N	26	0.05	-0.44	0.52	N
17	0.00	-0.48	0.48	N	27	0.34	-0.19	0.71	N
18	-0.11	-0.55	0.38	N	28	0.07	-0.42	0.53	N
19	-0.20	-0.61	0.29	N	29	-0.12	-0.57	0.38	N

SB	r	r1	r2	T
30	-0.28	-0.67	0.23	N
31	0.54	0.10	0.81	
32	0.04	-0.43	0.50	N
33	0.69	0.33	0.87	
34	0.56	0.12	0.81	
35	-0.27	-0.65	0.23	N
36	-0.28	-0.98	0.93	N
37	0.58	0.15	0.82	
38	0.57	0.15	0.82	
39	0.38	-0.52	0.88	N
40	0.53	0.08	0.80	
41	0.40	-0.08	0.73	
42	0.60	0.18	0.83	
43	0.38	-0.10	0.72	N
44	0.51	0.06	0.79	
45	-0.17	-0.59	0.32	N
46	-0.44	-0.75	0.03	N
47	0.29	-0.21	0.66	N
48	0.67	0.30	0.87	
49	0.35	-0.20	0.73	N
50	0.63	0.18	0.87	
51	0.58	0.16	0.82	
52	0.17	-0.32	0.59	N
53	0.49	0.03	0.78	
54	0.17	-0.32	0.59	N
55	0.62	0.20	0.85	

SB	r	r1	r2	T
56	0.55	0.09	0.81	
57	0.32	-0.17	0.68	N
58	-0.02	-0.48	0.45	N
59	-0.60	-0.83	-0.19	N
60	-0.06	-0.56	0.47	N
61	0.19	-0.31	0.60	N
62	-0.12	-0.56	0.36	N
63	0.40	-0.08	0.73	N
64	-0.14	-0.57	0.35	N
65	0.45	-0.04	0.77	N
66	0.34	-0.17	0.71	N
67	0.44	-0.03	0.75	N
70	0.24	-0.31	0.67	N
71	0.31	-0.18	0.68	N
72	0.08	-0.40	0.53	N
73	0.15	-0.34	0.57	N
74	0.00	-0.47	0.47	N
75	0.36	-0.15	0.72	N
76	0.29	-0.22	0.67	N
77	0.40	-0.09	0.73	N
80	0.31	-0.22	0.70	N
81	-0.08	-0.62	0.52	N
82	0.18	-0.33	0.61	N
83	-0.13	-0.56	0.36	N
84	0.21	-0.28	0.62	N
85	0.20	-0.31	0.62	N
86	0.54	0.08	0.81	