DISTRIBUTION OF AVAILABLE SOIL MOISTURE IN THE STATE OF PERNAMBUCO

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Introduction

Soil moisture is an important parameter in agriculture, forestry and hydrology. It plays a significant role in plant growth and in determining crop yields. It is impractical to measure soil moisture on the time and space scales required for agroclimatological studies and several models have been developed in the past for its estimation. (Thornthwaite and Mather 1955, Baier and Robertson 1966, De Jong and Shaykewich 1981, Holmes and Robertson 1959). Results of a study of available soil moisture in Pernambuco State are reported in this paper.

Materials and Methods

Temperature and precipitation data at 40 stations selected from different parts of the state is used in this study. Daily potential evapotranspiration values are obtained based on Thornthwaite´s procedure (Thornthwaite 1948, Thornthwaite and Mather 1955) and these together with daily precipitation values are used to compute daily values of available moisture content for all the years of the study periods at the stations.

The relation between actual evapotranspiration (AE) and potential evapotranspiration (PE) has been written in the form (Nappo 1975):

$$AE = PE \cdot M(\eta)$$

$$M(\eta) = 1-e^{-56.6.\eta}$$

Where η is the gravimetric soil moisture in grams of water per gram of soil and M (η) is a moisture availability function.

Mintz and Serafini (1984) suggested the following expression for M(η).

$$M(WC.AWC) = 1- e^{-\alpha \frac{(WC)}{(AWC)}}$$

Where WC is the available moisture content and AWC is the available moisture capacity of the soil root zone. This equation with α equal to 6.81 is used in the present study to compute daily values of available soil moisture. The computations are started after a large precipitation event so that the initial value of WC can be put equal to AWC.

Mintz and Serafini(1992) have shown that AWC is about 0.15 $\pm$ 0.03 g/cm^3 for all types of soils except fine sand. This corresponds to a mean value of 150 mm for AWC if we assume a root zone of 1 meter depth.

This value of AWC is used in this study for all the selected stations.

At each station daily values of WC are computed for a minimum period of twenty five years. From these values mean monthly values are derived for all the stations .

Results

Mean monthly values of available soil moisture content at the selected stations are presented in Table 1. A strong dependence of soil moisture content on longitude is noticed and the moisture content during the six wettest months being high around 35^{0}W with a decreasing tendency towards the west. The period of the year with high moisture content also varies in the east-west direction, stations around 35^{0}W having the maximum moisture content in July and stations between 36 – 41^{0}W two to three months earlier.

At most of the stations the variation during the year of soil moisture is much different from that of precipitation. Ten-day values of soil moisture are compared with corresponding precipitation values. The three consecutive 10-day periods with maximum moisture content occurred much later than that of maximum precipitation, the time lag varying between twenty days to three months. This feature, noticed at numerous stations suggests that agro-climatic studies based on precipitation data alone may lead to erroneous conclusions.

It is generally assumed that for favourable crop growth and yield the soil must hold at least half of its maximum loading capacity (Robertson, 1989). Data presented in Table 1 thus provides a preliminary estimate of growing periods at the stations. However reliable evaluation of crop growing periods needs study of soil moisture variations from year to year and the probabilities of dry and wet spells (Robertson, 1985).

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Table 1. Mean monthly values of available soil moisture content at the selected stations.

Localidade	January	Feb.	March	April	May	June	July	August	Sept.	October	Nov.	Dec.
C. do Roberto	33.25	45.18	56.97	66.90	33.77	10.43	2.09	0.26	0.90	7.54	12.62	26.93
S. Bento	21.65	28.22	38.08	42.64	25.26	7.58	4.21	0.72	0.53	3.74	2.98	13.86
S. J. do Egito	12.96	28.45	51.58	69.72	60.06	34.41	19.24	7.09	1.91	0.65	0.89	4.45
Ipueira	26.91	47.30	79.05	79.14	47.98	15.32	2.54	0.79	0.72	3.06	3.51	15.16
S. J. do Belmonte	37.46	65.16	99.23	101.77	77.65	37.59	13.71	2.40	0.41	2.28	5.86	13.47
Carnaíba	23.40	47.29	82.98	91.73	81.89	61.98	41.08	18.09	4.16	0.72	2.38	6.72
Machados	17.38	22.61	50.85	79.29	110.65	129.82	143.05	132.20	111.00	73.15	20.21	9.29
Bom Jardim	17.69	20.36	39.16	66.62	90.56	112.88	130.82	119.04	93.76	50.40	10.31	6.90
Algodão do Manso	7.28	11.60	25.17	40.16	48.43	53.60	78.25	71.55	36.96	13.06	1.76	2.83
Timbaúba	10.17	22.69	45.70	66.90	86.45	107.54	108.41	86.79	54.92	18.68	4.72	6.61
Aliança	8.29	12.60	37.10	69.10	91.67	114.17	125.59	113.58	87.27	39.15	7.87	3.22
Icaicara	29.36	36.30	53.31	69.90	35.89	9.15	2.37	0.64	0.61	5.29	4.25	18.08
Salgueiro	19.56	44.26	70.50	58.17	33.85	11.36	2.66	0.81	0.52	2.08	8.13	13.43
Boa Vista	27.21	49.79	75.89	89.61	57.80	18.83	3.92	0.52	0.61	2.02	2.14	14.04
Quixaba	26.51	45.95	64.08	77.91	55.30	29.26	15.83	4.31	1.40	3.44	2.38	12.21
Tauapiranga	22.11	51.34	73.94	81.27	61.89	28.79	11.67	3.29	0.89	1.98	1.69	11.80
Caiçara	23.33	38.91	49.15	58.46	50.93	24.61	11.23	3.22	1.80	3.35	3.85	8.22
Algodões	22.65	22.98	43.78	50.55	29.89	15.62	5.90	2.81	0.37	1.92	3.78	16.36
Xilili	21.27	41.77	62.06	76.60	55.21	31.51	22.46	12.49	2.36	5.52	3.96	9.58
Alagoinha	19.08	41.43	54.73	73.16	69.63	61.94	59.74	42.64	20.91	8.62	4.54	8.67
Cachoeirinha	8.57	16.13	29.41	45.02	58.39	60.85	71.67	60.63	37.64	13.45	2.07	1.67
Cumaru	13.56	22.53	36.47	52.29	69.50	98.96	114.35	105.35	72.22	30.02	7.28	8.38
Bezerros	9.18	15.47	29.50	51.95	60.63	55.94	65.47	64.65	35.85	10.84	2.17	4.71
Caruaru	8.88	12.58	12.18	13.01	20.99	39.53	51.61	41.75	18.90	4.28	2.30	2.15
Cortes	28.29	46.99	76.74	104.82	135.67	142.71	146.82	142.85	128.35	93.70	43.19	25.13
Vitoria de S. Antão	9.82	15.35	29.20	49.98	72.13	94.78	97.34	83.61	56.22	16.24	4.61	5.19
Cabrobo	16.33	22.22	32.83	36.69	21.79	6.15	1.62	0.45	0.16	0.55	6.75	12.10
Soares	19.60	22.97	39.29	42.77	25.88	10.38	6.21	2.94	1.04	5.44	3.03	10.20
J. dos Candidos	16.10	23.78	35.20	46.00	33.16	14.31	8.67	3.29	1.45	1.47	2.74	9.25
Ponta da Vargem	17.93	24.47	34.51	58.02	47.26	36.24	31.42	19.36	7.06	4.28	3.55	10.75
Itaiba	22.14	36.53	43.24	54.74	61.06	67.85	78.76	62.66	26.50	6.63	4.25	14.96
Saloa	20.13	36.42	47.74	57.42	81.02	97.86	108.23	103.58	83.50	49.49	11.47	11.31
S. Bento do Una	12.20	22.22	42.23	55.11	58.21	64.21	69.78	59.92	30.68	9.36	10.66	7.51
Jucati	19.29	34.54	48.48	67.58	79.86	91.46	102.10	93.27	71.57	38.58	30.99	10.07
Palmares	8.30	13.61	27.99	74.48	112.25	131.22	140.83	138.78	116.17	60.99	12.86	7.19
Maraial	25.54	29.70	48.24	77.70	114.75	131.36	140.22	142.98	127.14	92.45	37.05	18.87
Rio Formoso	19.44	26.67	56.84	114.26	140.31	145.01	146.72	145.33	134.26	94.24	39.03	18.72
Tacaratu	24.27	37.21	53.44	65.55	68.90	76.01	92.59	87.86	53.88	16.74	4.44	17.27
Quati	11.28	20.95	29.34	37.22	54.41	63.20	74.31	74.90	52.23	23.91	4.27	4.64