IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Research Article
June 2020 Vol.:15, Issue:4

Climate Variables of the Uruçuí Preto-Piauí Hydrographic Basin, Brazil

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Raimundo Mainar de Medeiros*, Moacyr Cunha Filho, Ana Luíza Xavier cunha, Romildo Morant de Holanda, Manoel Vieira de França, Renisson Neponuceno de Araújo Filho, Victor Casimiro Piscoya, Gulherme Rocha Moreira, Gabriela Isabel Limoeiro Alves Nascimento, Raimundo Rodrigues Gomes Filho

Universidade Federal Rural de Pernambuco, Brazil

Submission: 20 May 2020

Accepted: 28 May 2020

Published: 30 June 2020

HUMAN JOURNALS

www.ijsrm.humanjournals.com

Keywords: Climatic Regimes; Relative Humidity; Air Temperature; Hydric Balance; Climate Changes

ABSTRACT

The knowledge of the climatic characteristics of the hydrographic basins, especially regarding the temporal and spatial distribution of rainfall, the relative humidity of the air and the maximum, minimum and average air temperatures, which should offer important subsidies to the management of water resources and agriculture. The irregular distribution of rainfall indicates instability in the entry of water into the hydrological system, exercising control over water availability in time and space, the relative humidity of the air influences animal and plant behaviors and the amount of water available in the atmosphere. The temperature, on the other hand, influences the evapotranspiration rates, indicating the energy availability of the environment and, consequently, the environmental water demand. The work characterizes the hydrographic basin of the Uruçuí Preto River (BHRUP), in terms of rainfall, relative humidity, temperature, climatological water balance and climatic regimes. Graphs of annual behaviors and seasonal regimes were prepared for 25 pluviometric stations distributed in the interior and around the basin, most of them in operation since the 1960s, followed by elaborations of average isoetes charts and the one of the rainiest semester, relative humidity of the air, isotherms of the maximum, minimum and average temperatures, and the letters of potential evapotranspiration, real evaporation and water deficit. The climatic types were appreciated due to the influence of the habitual behavior of the atmosphere on the potential, real environmental demand for water and also on the anthropic demand, impacting on climate changes.

INTRODUCTION

Climatic variations intervene in the availability and pending of water, conditioning the event of critical situations for society and the environment. There is a strong analogy of the volume, frequency and intensity of rainfall with the availability of surface, underground water and agriculture, since rain represents the most important phase of the hydrological cycle, being the primary source of most of the terrestrial freshwater. There is an almost direct proportionality between rain intensity and infiltration. When rains are regularly distributed, they may allow greater infiltration, as the speed of penetration into the soil follows the precipitated index. Torrential rains favor direct runoff, as the infiltration rate may be lower than the large volume of precipitated water in a short period of time. It is therefore important to assess the temporal dispersion of rainfall, which is normally very high in the tropical region.

The hydrological cycle is a closed sequence of natural phenomena that can be divided into two parts: the aerial branch, normally studied in the scope of Meteorology and the terrestrial branch, object of hydrology. The boundary surface of the phenomena pertinent to each of these branches is the globe-atmosphere interface. It is considered that the aerial branch of the hydrological cycle begins when the water is transferred to the atmosphere, in the state of vapor, ending when it is returned to the Earth's surface, in a liquid or solid state. The water vapor that appears at the globe-atmosphere interface mixes with the air by turbulent diffusion, being quickly transported by air currents. Afterwards, finding favorable conditions, it returns to the solid or liquid state inside the atmosphere itself, or somewhere else on the surface, in general, very distant from the place where it originated. For all these reasons, the concentration of water vapor in the air is quite variable, both in space and in time. This variation is, in general, all the greater the closer to the source surface the layer is considered. From a purely meteorological point of view, the variation in water vapor concentration in the air has no profound implications, as it significantly influences the energetics of the atmosphere (Peixoto, 1969).

Knowledge of the amount of water vapor in the air is essential in several other branches of human activity. It is known, for example, that ambient humidity is one of the factors that condition the development of many pathogenic microorganisms that attack cultivated plants and plant transpiration itself is closely related to the moisture content of the surrounding air. The influence of air humidity on longevity, fertility and the rate of development of many insect species is also known (Neto *et al.*, 1976). On the other hand, one of the parameters used to define the degree of environmental comfort for people and animals is also the atmospheric humidity prevailing in the place in question. Finally, in order not to make the list of examples boring, it should be noted that maintaining the optimum range of air humidity is an object of constant control during the storage of numerous products. It is recognized that this parameter is little explored in the current bibliography, which demonstrates the need to better understand its spatial and temporal variations for the area under study.

Temperature indicates the energy availability of the environment, playing an important role in the processes of photosynthesis, respiration and evapotranspiration. Temperature data are widely used to estimate evapotranspiration using simplified methods. Any climatic characterization on a regional scale must use temperature data, in view of the interactions of this element with other geoenvironmental variables.

The living beings that populate the planet live adapted to the energy of the environment. In addition to daily variation, the air temperature also varies throughout the year, depending on the layout of the relief and the latitude, which influences the distribution of solar radiation. Air temperature has a clear effect on the development of living beings since temperature is one of the most important meteorological elements, as it reflects the energetic and dynamic states of the atmosphere and consequently reveals the atmospheric circulation, being able to facilitate and/or block atmospheric phenomena (Dantas *et al.*, 2000). The living beings that populate the planet live adapted to the energy of the environment. In addition to daily variation, the air temperature also varies throughout the year, depending on the relief and latitude, which influences the distribution of solar radiation. Air temperature has a clear effect on the development of living beings since temperature is one of the most important meteorological elements, as it reflects the energetic and dynamic states of the atmosphere and consequently reveals the atmospheric circulation, being able to facilitate and/or block atmospheric phenomena (Dantas et al., 2000).

Knowledge of the behavior of climatic variables is of paramount importance for planning agricultural activities. And the air temperature stands out in the conduct of studies concerning agricultural ordering, land use, ecological zoning and climatic aptitude, sowing time, estimate of the crop cycle, among others. (Oliveira Neto et al., 2002).

In addition to the spatialization of temperature data, it is important to characterize its variation in time. In mathematical models for quantifying growth and predicting the proper sowing time, the average daily temperature is an important parameter both in the promotion (10°C to 30°C) and in the inhibition of growth and development of the crop (Aspiazu, 1971; Sierra & Murphy, 1973).

In the present study, rainfall, relative humidity, maximum, minimum and average temperatures, evaporation and evapotranspiration and water balance were studied from the point of view of their spatial and temporal irregularity. Graphs of annual behavior, seasonal and average isoietas regimes and the one of the rainiest semester, relative humidity of the air, isotherms of the maximum, minimum and average temperatures, and of the letters of potential evapotranspiration, real evaporation and water deficit were elaborated. The climatic types of the region were also considered due to the influence of the usual integrated behavior of the atmosphere on the potential and real environmental demand for water and even on the anthropic demand. In addition to the meteorological factors that cause rain or not in the region under study.

Only riverside lands and narrow areas close to urban agglomerations were used by small producers to develop subsistence activities. With the development and expansion of agricultural and livestock, large land areas are being used for the aforementioned purposes, and do not take into account some meteorological elements that can minimize the occurrences of damage from anomalous effects that may happen.

It is characterized by the high atmospheric moisture content, as a consequence of large flows of water vapor into the atmosphere, due to the high rates of evapotranspiration.

Knowledge of the wet season or wetter quarter is of fundamental importance for establishing the best planting time and growing season, particularly for rainfed agriculture. Studies of this nature have been developed for the Northeast of Brazil, based on temporal analysis of rainfall (Bastos & Azevedo, 1986).

Medeiros, *et al.,* (1989) delimited the relative humidity regimes in the Northeast of Brazil (NEB), using 64 climatological stations with more than 10 years of observations covering the region, which allowed the delimitation of three regimes for the Northeast of Brazil (NEB). Medeiros, *et al.,* (1992) studied the behavior of relative air humidity for some stations in the State of Piauí.

The pluviometry represents the fundamental attribute in the analysis of tropical climates, reflecting the performance of the main currents of the atmospheric circulation. In the southern region of the state of Piauí specifically, rainfall determines the regime of perennial rivers, streams, streams, levels of lakes and ponds, land occupation, and the knowledge of its dynamics is essential for planning any activity.

The factors causing rain for the studied area are the formation of lines of instability transported by the trade winds from the Southeast / Northeast, heat exchange, traces of cold fronts during their most active penetrations, formation of convective clusters, orography, training contributions cyclonic vortexes and local effects are factors that increase the transport of water vapor and humidity and consequently the cloud cover.

MATERIAL AND METHODS

CHARACTERIZATION OF THE STUDY AREA

The region is drained by the Uruçuí Preto River and by the tributaries Ribeirão dos Paulos, Castros, Colheres and Morro da Agua, and by the streams of Estiva and Corrente, both perennial. The Uruçuí Preto River basin is predominantly embedded in the Parnaíba River sedimentary basin, constituting one of the main tributaries on the right bank. It has a total area of approximately 15,777 km^2, representing 5% of Piauí's territory and covers part of the southwest region, projecting from the south to the north in the form of a spear (COMDEPI, 2002).

The total area of the basin is located between the geographic coordinates that determine the rectangle from 07° 18'16" to 09° 33'06" south latitude and 44° 15'30" at 45° 31'11' 'west longitude of Greenwich. In accordance with COMDEPI (2002), the hydrographic basin of the Uruçuí Preto River shows a unique set of regional relief forms, dominated by the tabular-plateau and plateau forms, characteristic of sub-horizontal sedimentary rocks.

Only the Plateau of the Parnaíba Sedimentary Basin is identified as a morphostructural unit in the region and in addition to being located in the central-eastern portion of the Piauí-Maranhão Sedimentary Basin, it is constituted by a sequence of sandy-clay sediments, composing the various sedimentary formations.

According to EMBRAPA (1986), the three most frequent classes of soils identified in the Uruçuí - Preto River basin are Yellow Latosols (predominant in the basin), Neossolos and Neossolos Quatzarêncios and Hydromóficos.

For COMDEPI (2002), the supply of groundwater in the Uruçuí - Preto river basin occurs through 04 (four) aquifers, Serra Grande, Cabeças, Poti / Piauí and Pedra de Fogo Formation. The Serra Grande Formation is mainly composed of coarse and medium sandstones, conglomerates and conglomerates at various levels (white cream), with flat cross stratification. In addition, although it is one of the most outstanding in the Northeast, it is also distributed throughout the Parnaíba Sedimentary Basin, it does not offer efficient exploration possibilities in the Uruçuí - Preto river basin due to the great depths.

According to COMDEPI (2002), the identification and description of vegetation in the region of the hydrographic basin of the Uruçuí - Preto river are found:

- from the top of the plateaus, with the typical vegetable community of the savannas constituted by a discontinuous stratum composed of shrub and tree elements characterized by tortuous trunks, thick bark, leathery leaves and an almost asymmetrical canopy. Among the most frequent species are barbatimão, broad-leafed earth stick and simbaíba, and the soil surface is covered by a grassy stratum of wild grass;

- starting from the slopes between the top of the plateaus and the flat stretch where the Uruçuí - Preto river flows. In this aspect, the cerrado develops in a more closed way, composed of larger species, among which the pau d´arco, Gonçalo Alves;

- The basin area is surrounded by 25 municipalities and 24 farms.

The study area of interest has a reduced and spatially poorly distributed network of meteorological stations, which makes it difficult to characterize the climatic conditions. Therefore, we used interpolated data, estimated and generated by multiple linear regression lines, using the estima_T software (Cavalcanti et al., 2006). For the analysis of the inter-municipal climatic behavior of the hydrographic basin of the Uruçuí Preto River, precipitation data acquired through the Northeast Development Superintendence (SUDENE) and from the Technical Assistance and Rural Extension Company of the State of Piauí (EMATERPI) were used for the period from 1960 to 1990, which comprises 49 rainfall stations located in the study area. The climatic classification was used according to the

Köppen systems, where two climatic types are distinguished in the Uruçui Preto river basin - PI, the Aw, hot and humid tropical, with rain in the summer and drought in the winter; Bsh, hot semiarid, with summer rains and dry winter. Medeiros (2013).

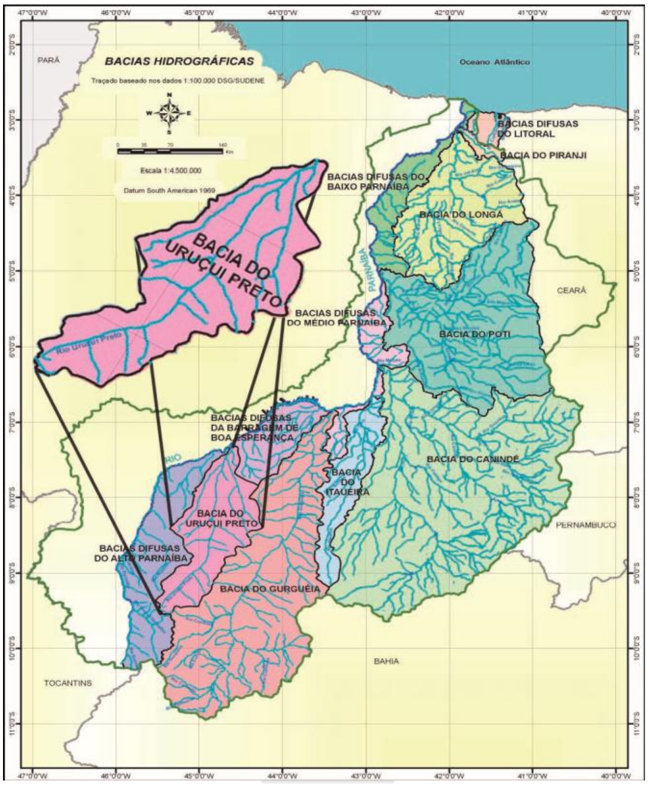

Figure No. 1: Location of the hydrographic basin of the Uruçuí Preto River - PI.

The precipitation regime that comprises the study area begins with the pre-season rains, starting in the second half of October. The characterization of the rainy season begins in the first days of the month of November and continues until the month of March, with the months of December, January and February as the rainiest.

The factors that provoke rain are predominant for the hydrographic basin of the Uruçuí Preto River, are the formation of lines of instability carried by the trade winds of the Southeast / Northeast, exchange heat, traces of cold fronts when their most active penetrations, formations of convective clusters, orography, contributions of formation of cyclonic vortices, conveyor belt, orography and local effects, are factors that increase the transport of water vapor and humidity and consequently the coverage of cloud cover.

Normally the rains have moderate intensity (of regular weather and around seven to eight hours of daily discontinuous rains), followed by irregularity due to the failures of the active meteorological systems. It should be noted that the occurrence of summer periods (occurrences of several consecutive days without rain during the rainy season) in the four-month period (December, January, February, March) is expected. Its magnitude is varied depending on the season and the disabled meteorological factors. There have been occurrences with summer periods exceeding nineteen (19) monthly days in the time interval that occurred within the four-month period. Medeiros, (2013).

The study of the spatial temporal behavior of rainfall relied on data provided by the Superintendency for the Development of the Northeast (SUDENE) and the Institute of Technical Assistance and Rural Extension of the State of Piauí - EMATERPI collected in 25 stations. Table 1 shows the municipalities with their pluviometric posts and their geographical coordinates.

Table No. 1: List of municipal rainfall stations and their respective geographical coordinates for the hydrographic basin of the Uruçuí Preto river.

MUNICIPALITIES / COORDINATES	LAT º ‘	LONG º ‘	ALT meters
Alvorada Gurguéia	08 25	43 46	281.0
Alto Parnaíba - MA	09 07	45 56	220.0
Avelino Lopes	10 08	43 57	400.0
Barreira do Piauí	09 55	45 28	500.0
Bom Jesus	09 04	44 21	220.0
Colônia do Gurguéia	08 10	43 48	200.0
Corrente	12 26	45 09	434.0
Cristalândia	10 39	45 11	600.0
Cristino Castro	08 48	44 13	240.0
Curimatá	10 02	44 17	350.0
Currais	09 00	44 24	320.0
Elizeu Martins	08 12	43 23	210.0
Gilbués	09 49	45 21	500.0
Julio Borges	10 19	44 14	389.0
Manoel Emídio	07 59	43 51	200.0
Monte Alegre	09 45	45 17	454.0
Morro Cabeça no Tempo	09 43	43 54	479.0
Palmeira do Piauí	08 48	44 18	268.0
Parnaguá	10 13	44 38	316.0
Redenção Gurguéia	09 30	44 36	365.0
Riacho Frio	10 07	44 57	400.0
São Gonçalo do Gurguéia	10 01	45 18	440.0
Santa Filomena	09 05	46 51	380.0
Santa Luz	08 55	44 03	340.0
Sebastião Barros	10 49	44 50	360.0

The data of precipitation, relative humidity of the air and the maximum, average and minimum air temperatures were worked on electronic spreadsheets and analyzed in order to identify patterns of temporal and spatial distribution. For climatic characterization, the climatic water balance of Thornthwaite (1948, 1955) was used, which is based on the comparison between potential evapotranspiration and rainfall. It is based on these variables that the humidity and thermal efficiency indexes are calculated. The first generates a scale that goes from dry to very humid. The second generates another scale, from the mega thermal to the ice cream. The climatic types for the hydrographic basin of the Uruçuí Preto river were identified considering only the spatial variations of the annual humidity, aridity and water index. The climatic classification was used by the Köppen method according to table 2.

Table No. 2: List of municipalities and their respective humidity indexes (UI), aridity indexes (IA), water indexes (IH) and climatic classification according to Köppen for the hydrographic basin of the Uruçuí Preto River.

COUNTIES	IU %	IA %	IH %	Köppen
Alvorada Gurguéia	0.46	48.32	-47.86	Bsh
Alto Parnaíba - MA	0.00	57.45	-57.45	AW
Avelino Lopes	0.00	47.35	-47.35	Bsh
Barreira do Piauí	14.02	40.27	-26.25	AW
Bom Jesus	3.91	43.11	-39.20	Bsh
Colônia do Gurguéia	0.11	60.62	-60.51	Bsh
Corrente	18.69	37.86	-19.17	AW
Cristalândia	15.79	38.24	-22.45	AW
Cristino Castro	3.02	46.41	-43.38	Bsh
Curimatá	1.77	43.44	-41.67	Bsh
Currais	4.44	44.47	-40.03	Bsh
Elizeu Martins	0.00	49.82	-49.82	Bsh
Gilbués	13.67	39.78	-26.12	AW
Julio Borges	14.83	40.09	-25.26	AW
Manoel Emídio	0.00	49.37	-49.37	Bsh
Monte Alegre	11.31	38.51	-27.20	AW
Morro Cabeça no Tempo	4.15	39.39	-35.24	Bsh
Palmeira do Piauí	0.07	49.77	-49.71	Bsh
Parnaguá	10.33	39.62	-29.29	AW
Redenção Gurguéia	1.78	46.51	-44.73	Bsh
Riacho Frio	9.51	37.76	-28.25	AW
S Gonçalo do Gurguéia	12.28	40.89	-28.61	AW
Santa Filomena	39.18	38.15	1.02	AW
Santa Luz	3.65	46.18	-42.53	Bsh
Sebastião Barros	16.28	37.64	-21.37	AW

RESULTS AND DISCUSSION

RAINFALL

The precipitation regime that comprises the area of the hydrographic basin of the Uruçui Preto River (BHRUP), located in the southern region of the state's precipitation regime, falls within the range of the isoeites from 478.7 to 1,413.3 mm, with a precipitation annual average around 916 mm.

Normally the rains have moderate intensity (of regular weather and around six to nine hours of daily discontinuous rains), followed by irregularity due to the failures of the active meteorological systems. It should be noted that the occurrence of summer periods (occurrences of several consecutive days without rain during the rainy season) in the four-month period (December, January, February, March) is expected. Its magnitude is varied depending on the season and the disabled meteorological factors. There have been occurrences with summer periods greater than eighteen (18) monthly days in the time interval that occurred within the four-month period.

The analysis of rainfall in the dry and rainy seasons allows us to perceive the variability in the spatial and temporal distribution of rainfall (Figure 2), due to a topographic barrier that significantly interferes with the passage of humid air from the traces of the cold fronts. In the rainy season, which extends from October to April, the average total rainfall of the study area varies between 53.8 to 180.8 mm. In the dry period, which extends from May to September, this area remains with total rainfall fluctuating between 0.8 to 22.0 mm. The variability of pluviometric indexes between the twenty-five stations fluctuates from 478.7 to 1.413.3 mm, this sudden fluctuations are due to the topographic barrier and the number of years of rain collections, that is, some municipalities such as Alvitrados do Gurguéia, Avelino Lopes, Colônia do Gurguéia and Manoel Emidio has a 17-year rainfall series. The predominant vegetation is the park and to a lesser extent, patches of cerrado and caatinga arboreal, which proves the occurrence of a relatively humid climate.

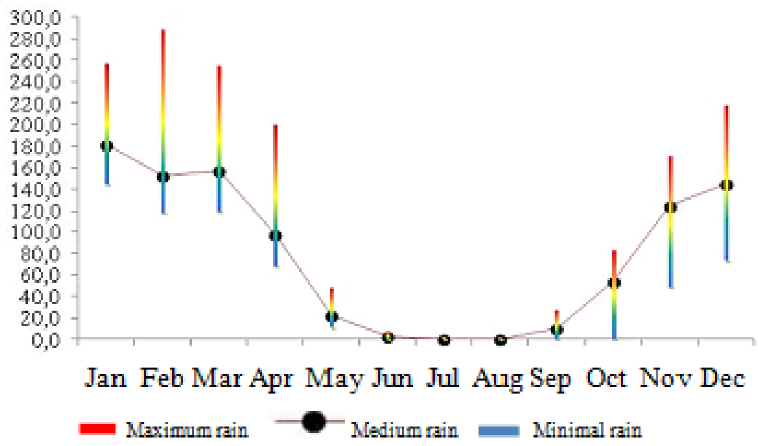

Figure No. 2: Graph of the spatial distribution of maximum, average and minimum annual rainfall for the hydrographic basin of the Uruçuí Preto River.

It is good to remember that the pluviometric indexes and their seasonal distribution are due to the combination between the dynamic mechanisms of the atmosphere, which have regional influence, therefore extrapolating the limits of the basin, and the static factors, of local influence. The configuration of the relief and the entrance traces of the cold fronts with greater activities are decisive factors for the spatial and temporal distribution of the rains and determinants for the thermodynamic processes in the entire study area.

In any case, considering that rainfall tends to increase from low to high altitudes, it is possible that on the tops of plateaus in the central area of the basin the rates are slightly higher compared to the valleys. The absence of data does not allow to confirm this possibility. This would not indicate greater water availability due to the high combination of soils as described, Soils with Latosol B horizon, present in the association LVd10; poorly developed soils occur in the R8 association; Quartz sandy soils, constituting the association AQd2; and tropical concretionary soils, forming part of the SCT5 association.

TEMPERATURES

The analysis of temperatures was carried out for the twenty-five municipalities that make up the hydrographic basin of the Uruçuí Preto River, highlighted their maximum and minimum values followed by the annual average value. Although it aggregates water characteristics of the cerrado with variations of AW (hot and humid climate) and Bsh (semi-arid climate), the spatial fluctuations of maximum temperatures range from 28.5 ºC to 39.0 ºC with an annual average of 32.2 ºC. Fluctuations in average temperatures vary from 23.4 ºC to 31.6 ºC with an annual average of 25.7 ºC, minimum temperatures vary and 16.9 ºC to 24.2 ºC with an annual rate of 19.9 ºC, Medeiros (2013). Naturally, in the valley bottoms, the values are higher and in the mountain regions they are lower. The major problem related to the study of the thermal behavior of the basin is the lack of meteorological and fluviometric stations. Figure 3 represents the variations of the maximum, average and minimum annual temperatures estimated by the method of multiple regression lines, Cavalcanti, (1994).

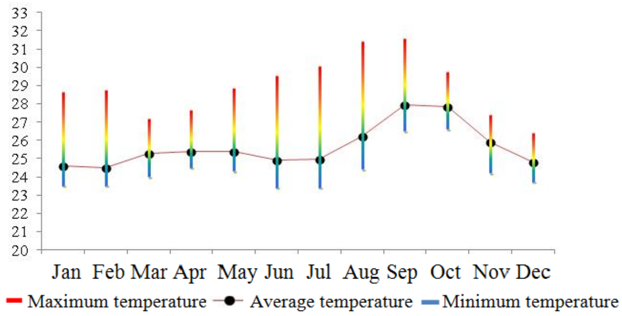

Figure No. 3: Graph of the spatial distribution of maximum, average and minimum annual temperatures for the hydrographic basin of the Uruçui Preto River.

RELATIVE HUMIDITY

The analysis of the relative humidity of the air in the study area is represented in Figure 4, the average of the region and its maximum and minimum values occurred in the annual value. The temporal and spatial fluctuations of the maximum relative air humidity range from 74.0% to 84.0%. Fluctuations in the average relative humidity of the air range from 49.1 to 77.7%, the minimum relative humidity of the air ranges from 41.0 to 73.0%. Figure 4 represents the maximum, average and minimum annual relative humidity variations.

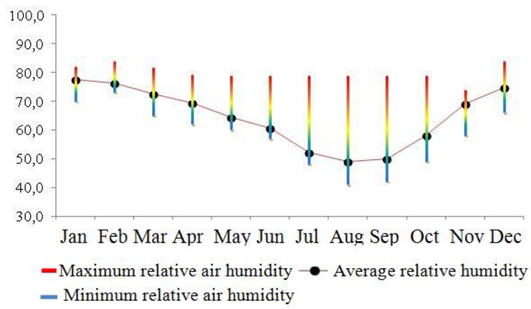

Figure No. 4: Graph of the spatial distribution of maximum, average and minimum annual relative humidity for the hydrographic basin of the Uruçuí Preto River.

CLIMATE WATER BALANCE

The most widely used technique for working with global water balance data from a climatological point of view is the water balance of Thornthwaite & Mather (1948,1955). By accounting for the natural supply of water to the soil, through rainfall (P), and atmospheric demand, through potential evapotranspiration (ETP), considering a maximum possible level of storage (CAD), the water balance provides estimates of actual evapotranspiration (ETR), water deficiency (DEF), water surplus (EXC) and effective water storage in the soil (ARM), which can be prepared from the daily to the monthly scale (Camargo, 1971; Pereira et al; 1997).

The climatological water balance is most frequently presented on a monthly scale and for an average year, that is, the cyclical water balance, elaborated from the climatological normals of average temperature and rain. According to Camargo and Camargo (1993), it is a useful and practical instrument to characterize the humidity factor of the climate, being its indispensable use in the climatic characterization (Vianello; Alves, 1991; Pedro Júnior et al. 1994) as, also, in the definition of the agricultural aptitude of the regions (Ortolani et al., 1970 and Camargo et al., 1974).

Figure 5 shows the regional water balance of Thornthwaite and Mather (1955) for the hydrographic basin of the Uruçu Preto River. It is observed that there is a water surplus only in the months of February and March. From April to November, the situation is handicapped. In the months of April, May, June, July, August, September, October and November the environmental water demand (evapotranspiration) is higher than the supply (rainfall). The storage is maximum in the months of February and March, that is, the soil remains with 100 mm of stored water. In fact, out of a total of 916 mm of precipitation per year (on average), only 87.3 mm is available to percolate or run off superficially and this occurs in the months of February and March.

Table No. 3: Regional water balance of Thornthwaite and Mather (1955) for the hydrographic basin of the Uruçuí Preto River.

Month	T oC	P mm	ETP mm	EVR mm	DEF mm	EXC mm
Jan	24.6	180.8	109.7	109.7	0.0	0.0
Feb	24.5	152.4	100.1	100.1	0.0	51.2
Mar	25.3	157.2	121.1	121.1	0.0	36.1
Apr	25.4	97.9	115.7	114.2	1.5	0.0
May	25.4	22.0	117.5	73.4	44.1	0.0
Jun	24.9	2.8	104.8	23.4	81.4	0.0
Jul	25.0	0.8	109.1	8.5	100.6	0.0
Aug	26.2	0.8	130.1	3.6	126.5	0.0
Sep	27.9	10.4	160.3	11.2	149.1	0.0
Oct	27.8	53.4	167.3	53.6	113.7	0.0
Nov	25.9	123.8	128.8	123.8	5.1	0.0
Dec	24.8	144.4	116.7	116.7	0.0	0.0
TOTALS	307.8	916.0	1481.4	859.4	622.0	87.3
AVERAGE	25.7	78.9	123.4	71.6	51.8	7.3

The graph below represents the cycle of deficiency, surplus, withdrawal and water replacement throughout the year for the hydrographic basin of the Uruçuí Preto River. It is observed that in the months of December and January there is a replacement of water in the soil, while in the months of February and March there are surpluses, withdrawals and water deficiencies throughout the months of April to November.

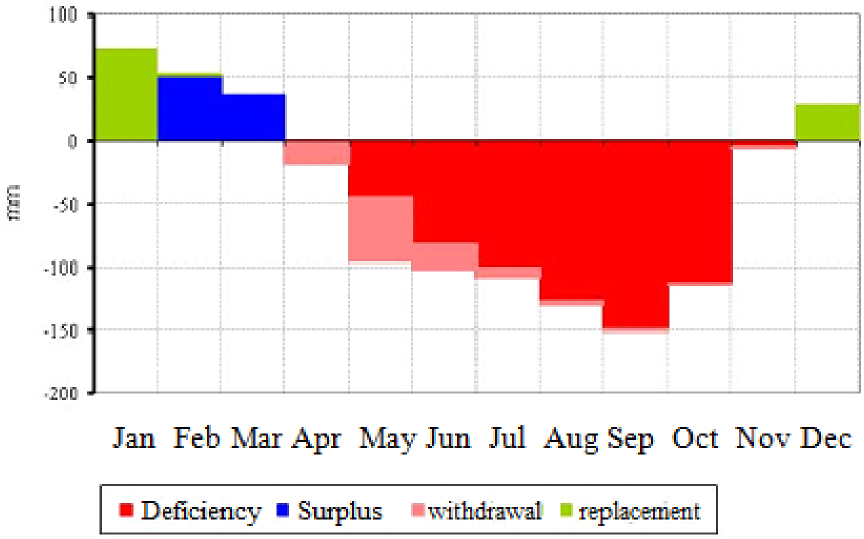

Figure No. 5: Graph of the water balance for the hydrographic basin of the Uruçuí Preto River.

Figure 6 represents the spatial variations of potential ETP for the hydrographic basin of the Uruçuí Preto River, the maximum monthly ETP fluctuations occur between 114.5 to 205.7 mm, whereas in the average ETP their fluctuations are between 93, 8 to 170.8 mm, and the minimum fluctuations in ETP occur between 70.7 to 130.2 mm. The average ETP of the study area is 1,483.9 mm.

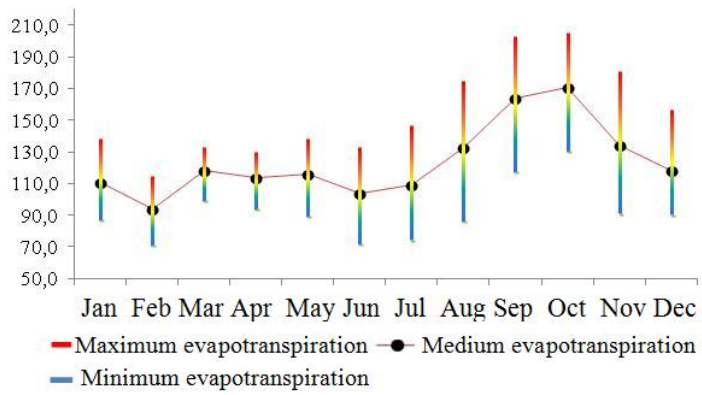

Figure No. 6: Graph of the spatial distribution of potential maximum, average and minimum annual evapotranspiration for the hydrographic basin of the Uruçuí Preto river.

Figure 7 represents the spatial variations of the actual evaporation (EVR) for the hydrographic basin of the Uruçuí Preto River, the maximum monthly EVR fluctuations occur between 159.0 to 289.7 mm, whereas in the average EVR their fluctuations are between 131, 7 to 242.0 mm, and the minimum fluctuations in EVR occur between 101.1 to 186.0 mm. The average EVR of the study area is 2,092.0 mm.

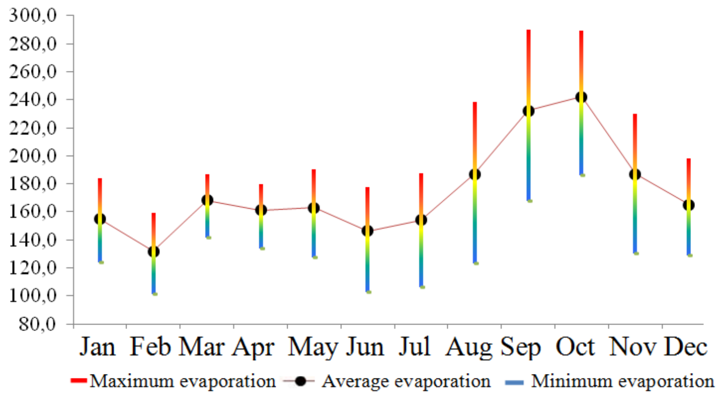

Figure No. 7: Graph of the spatial distribution of maximum, average and minimum annual evaporation for the hydrographic basin of the Uruçuí Preto River.

CONCLUSIONS

The establishment of the most humid regimes is important for studies of weather forecasting and mainly for agricultural planning, contributing to information to the rural man when preparing the land for planting, thus preventing him from planting at inappropriate times, avoid redundancies and losses, and still have the right conditions for profitability and agricultural income.

In addition to the control of diseases and pests of cultivated plants. In urban planning, it aims at extreme events of floods, flooding, floods, overflows of lakes and lagoons.

Such delimitations of the wettest quarters and information about the times of lowest relative humidity in the air served as a warning to federal, state and municipal authorities in addition to decision makers, for better planning.

The pluviometric scenarios better incorporate the spatial and temporal variability of the rains and are more compatible with the physical reality, allowing to make the classification and the regionalization of the climate dynamic and adjusted to the models of climate forecast in use in Brazil.

The climatic classification criterion of Thornthwaite and Mather (1955) is less restrictive than that of Thornthwaite (1948) since it recommends aridity and semi-aridity scales with greater amplitude.

The hydrographic basin of the Uruçuí Preto river. It presents significant climatic heterogeneity, which creates varied scenarios in relation to water availability and demand.

The climate factor acts dynamically along with other attributes of the physical and biotic environment and is decisive as to the occurrence of significant geo-environmental distinctions within the basin, including ecological differences and even influences on cultural patterns and ways of using natural resources.

Understanding the behavior of the parameters rain, temperature and other variables related to the climatological water balance, especially regarding temporal and spatial inconsistencies, can contribute to the understanding of the physical-natural dynamics of the hydrographic basin of the Uruçuí Preto River. In the present study, it was evidenced that the temperature variations (maximum, average and minimum) are relatively within the normal state standard, while rainfall, the temporal and spatial dispersion of monthly and annual totals is very high. In this regard, the existence of patterns of spatial and temporal distribution of rainfall was indicated.

The climatological water balance of the Uruçuí Preto river basin is favorable to various agricultural activities. In addition to the reduced amount of rain in the dry season, temperatures are high and the relative humidity of the air remains below the indication of OMM. For plants, the situation is greatly complicated during the dry period, as ETP remains high and the water supply depends on absorption from the deepest layers of the soil. In this case, it is good to remember that the soils in the region are not restricted, including with regard to groundwater capacity.

The results presented in the present work may collaborate for an optimization of agricultural activities and other water uses that require identification of situations in which the climate is the limiting factor. New alternatives for territorial use and occupation, in tune with the physical and environmental reality of the Uruçuí Preto river basin, must be evaluated and suggested.

REFERENCES

1. ASPIAZU, C. 1998. Prognósticos de fases em cultivos de mais dentado mediante sumas de temperaturas. **Revista de La Faculdad de Agronomia y Veterinária de Buenos Aires**. Buenos Aires, v. 19, n. 1-2, p. 61-69, 1971.
2. BASTOS, E. J. B. & AZEVEDO, P. V. 1986. Determinação da estação de cultivo e época de plantio para as variedades de arroz, milho e sorgo no Estado da Paraíba. **I Congresso Interamericano de Meteorologia e IV Congresso Brasileiro de Meteorologia**. Brasília – DF, (pp 22-27).
3. CAMARGO, A. P. 1971. Balanço hídrico no Estado de São Paulo. Campinas: IAC, 28p. (**Boletim Técnico, 116**).
4. CAMARGO, A. P; PINTO, H. S; PEDRO JUNIOR. Aptidão climática de culturas agrícolas. In: SÃO PAULO. 1974. **Zoneamento Agrícola do Estado de São Paulo**. São Paulo: Secretaria de Estado da Agricultura, v.1, p.109-149.
5. CAVALCANTI, E. P.; SILVA, V. DE P. R.; SOUSA, F. DE A. S. Programa computacional para a estimativa da temperatura do ar para a região Nordeste do Brasil. Revista Brasileira de Engenharia Agrícola e Ambiental, Brasil, v. 10, n. 1, p. 140-147, 2006.
6. CAVALCANTI, E. P., SILVA, E. D. V. 1994**.** Estimativa da temperatura do ar em função das coordenadas locais. IN: **Congresso Brasileiro de Meteorologia. 8.** Belo Horizonte, Anais... Belo Horizonte: SBMET, 1994, v.1, 154-157pp.
7. COMDEPI. (2002). Companhia de desenvolvimento do Piauí. Estudo de viabilidade para aproveitamento hidroagrícola do vale do rio Uruçuí Preto. Teresina, 2002.
8. DANTAS, R. T.; NÓBREGA, R. S.; CORREIA, A. M; RAO, T. V. R. 2000. Estimativas das temperaturas máximas e mínimas do ar em Campina Grande - PB. In: **Congresso Brasileiro de Meteorologia; Rio de Janeiro,** 11. Rio de Janeiro. Anais... Rio de Janeiro. SBMET. p. 534-537.
9. EMATERPI, Empresa de Assistência Técnica e Extensão Rural do Estado do Piauí.
10. EMBRAPA. Levantamento exploratório-reconhecimento de solos do Estado do Piauí. Vol. SNLCS. Rio de Janeiro. 1986.
11. KÖPPEN, W.; GEIGER, R. “Klimate der Erde. Gotha: Verlag Justus Perthes”. **Wall-map** 150cmx200cm. 1928.
12. MEDEIROS, R. M., CAVALCANTI, E. P. E AZEVEDO, P. V. 1989. Variação anual da umidade relativa do ar para o Nordeste do Brasil. **Anais do VI Congresso Brasileiro de Agrometeorologia.** Alagoas - Maceió. 383-390 pp.
13. MEDEIROS R. M. E SILVA, C. O. da, Variação média mensal e anual da umidade relativa do ar para o Estado do Piauí. 1986. **Trabalho apresentado no XIV Congresso Brasileiro de Meteorologia Florianópolis - Santa Catarina – Brasil.**
14. MEDEIROS, R. M., NETO, F. R. R. 1992. Perfil médio anual da umidade relativa do ar para algumas estações climatológicas do Estado do Piauí. **Boletim Hidroclimapi. V.2. N.8**. anexo: 31-4.
15. MEDEIROS, R. M. **Estudo agrometeorológico para o Estado do Piauí**. março. 119 pp. 2018.
16. NETO, S. S.; NAKANO, O., BARBIN, D.; VILA NOVA, N. A. 1976. **Manual de Ecologia dos Insetos**. Ceres, São Paulo.
17. OLIVEIRA NETO, S. N.; REIS, G. G.; REIS, M. G. F.; LEITE, H. G.; COSTA, J. M. N. Estimativa de temperaturas mínima, média e máxima do território brasileiro situado entre 16 e 24º latitude sul e 48 e 60º longitude oeste. **Engenharia na Agricultura**, Viçosa, MG, v. 10, n. 1-4, p. 57-61, 2002.
18. ORTOLANI, A. A; PINTO H. S; PEREIRA, A. R; ALFONSI, R. R. 1970. Parâmetros climáticos e a cafeicultura. **Instituto Brasileiro do Café**, 27p.
19. PEDRO JÚNIOR, M. J; MELLO, M. H. A; PEZZOPANE, J. E. M. 1994. Caracterização agroclimática da microbacia Alto Curso do Ribeirão São Domingos (Pindorama). Campinas: **Instituto Agronômico, 27p. (Boletim Técnico, 150).**
20. PEIXOTO, J. P. 1969. **Curso de Meteorologia**. Serviço Meteorológico Nacional, Lisboa.
21. PEREIRA, A. R.; VILLA NOVA, N. A.; SEDIYAMA, G. C. 1997. Evapo(transpi)ração. Piracicaba: **FEALQ**, 183p.

22. SIERRA, E. M.; MURPHY, G. M. 1973. **Aspectos bioclimáticos del cultivo del sorgo**. Viedna: IDEVI, p. 28-54. (Série Técnica, 3).
23. SUDENE. **Dados pluviométricos mensais do Nordeste: estado do Piauí**. Recife, 1990.
24. THORNTHWAITE, C. W. 1948. An approach toward a rational classification of climate. **Geographical Review**, New York, v.38, n.1, p.55-94,
25. THORNTHWAITE, C. W.; MATHER, J. R. 1955. The water balance. **Publications in Climatology** – Drexel Institute of Technology. New Jersey, v.8, n.1, p.1-86,
26. VIANELLO, R. L; Alves, A. R. 1991. Meteorologia básica e aplicações. Viçosa: **UFV**, 449p.