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CLIMATOLOGICAL WATER BALANCE AND MANAGEMENT OF WATER RESOURCES IN THE CERRADO BIOME AS A SUBSIDY FOR IRRIGATION IN INCRA SETTLEMENTS

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1 RESUMO

A gestão dos recursos hídricos e o Balanço Hídrico Climatológico são parâmetros importantes para auxiliar na tomada de decisão para elaboração de projeto e manejo de irrigação. Objetivou-se com esse trabalho calcular o balanço hídrico climatológico (BHC) mensal do Bioma Cerrado. Para elaboração do mapa de BHC utilizou-se de dados da temperatura e precipitação média mensal referente ao período de 2020 a 2021, com auxílio do software Rstudio®. As maiores taxas de armazenamento de água no solo, foram nos meses de dezembro a abril, favorecendo a formação do excedente hídrico. O período de deficiência hídrica ocorreu entre os meses de julho a outubro, no qual foram identificadas as menores taxas de armazenamento de água. Com o mapa do Balanço Hídrico Climatológico no Bioma Cerrado é possível que os assentados do INCRA possam realizar o planejamento da irrigação.

Palavras-chave: clima no cerrado, disponibilidade hídrica, excedente hídrico.

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2 ABSTRACT

The management of water resources and the climatological water balance are important parameters for assisting in decision-making related to project design and irrigation management. The objective of this work was to calculate the monthly climatological water balance (BHC) of the Cerrado Biome. To prepare the BHC map, temperature and average monthly precipitation data for the period from 2020 to 2021 were used with the aid of RStudio® software. The highest rates of water storage in the soil occurred from December to April, favoring the formation of a water surplus. The water deficit period occurred between July and October, when the lowest water storage rates were identified. With the climatological water balance map in the Cerrado Biome, it is possible for INCRA settlers to carry out irrigation planning.

Keywords: climate in the Cerrado, water availability, water surplus.

3 INTRODUCTION

Water scarcity is a problem that has become increasingly common in several regions where irrigation becomes necessary, and the effectiveness of using this resource is highly important (Vicente *et al.*, 2015). Climatic and hydrological conditions become fundamental for assessing the water availability of a region, thus enabling strategies to be established for the management of agricultural and livestock production. Therefore, it is important to determine the climatological water balance of the region.

The climatological water balance (BHC) is widely used for climate characterization and for identifying the water demand for irrigation in a given region. BHC data have been applied in several areas of study, such as climate classification studies, agricultural planning, and hydrological characterization, and are becoming useful tools in the management of water resources (Dourado-Neto *et al*., *2010*).

According to Oliveira (2019a), the model proposed by Thornthwaite and Mather (1955) for climatological water balance is used to determine and monitor the water storage content in the soil. This method considers the physical texture of the soil, the depth of the roots and the inflow, precipitation (pluviometric) and outflow (evapotranspiration) of water in a given region.

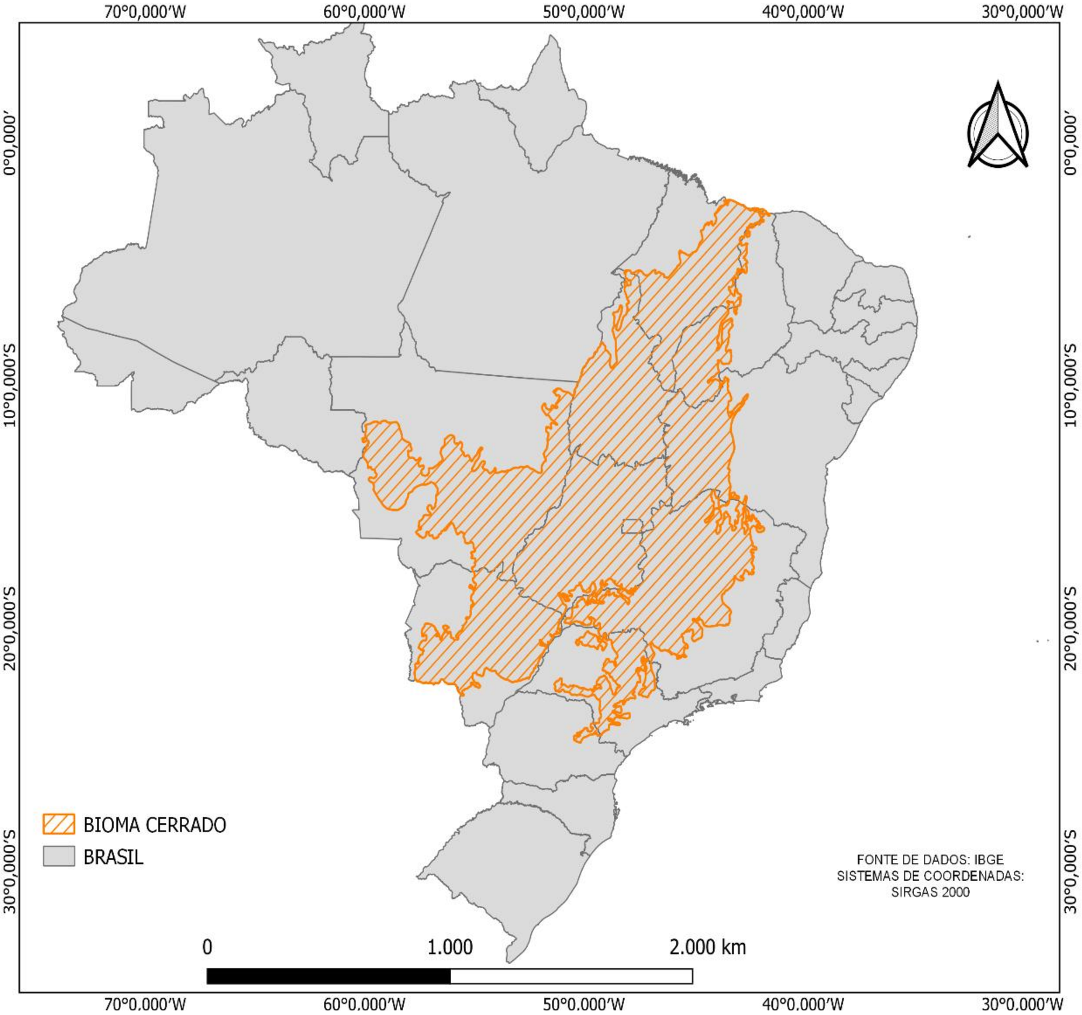
In this context, the climatic parameters of the BHC have become a great tool for monitoring water storage in the soil, which is highly important for helping to make decisions about agricultural cultivation and for planning and managing irrigation systems. This tool allows the classification of a specific climate in a region, the period of surplus water, and water deficiency in the soil (monthly and annual), in addition to contributing to irrigation control (Lopes Sobrinho *et al.*, 2020; Pereira; Angelocci; Sentelhas). , 2002).

Therefore, this information will be important for rural settlers of the National Institute of Colonization and Agrarian Reform (INCRA), who will be able to use these data to plan irrigation. Thus, the objective of this work was to map the climatological water balance as a subsidy for irrigation management for INCRA's rural settlements in the Cerrado Biome.

4 MATERIALS AND METHODS

The climatological water balance (BHC) was determined in the Cerrado Biome as a subsidy for irrigation management in INCRA settlements (Figure 1).

Figure 1. Location map of the Brazilian Cerrado Biome.



Source: SIEG (2021).

To perform the BHC, RStudio software was used, according to the methodology described by Filgueiras *et al.* (2021).

To do this, it was necessary to download the TerraClimate images and then install the package via GitHub. In this case, the average results of images from 2020 to 2021 were used. The next step was to select the area of interest, which in the case of this work was the Cerrado Biome, and then, the rasters were downloaded.

Once we had downloaded images, it was necessary to plot the maps and calibrate the TerraClimate images for Brazilian conditions using all the automatic meteorological stations of the National Institute of Meteorology (INMET-Brazil).

With the calibrated images, it was possible to generate monthly averages of temperature and precipitation that were used to calculate the average monthly air temperature based on the period from January 1, 2020, to December 31, 2021.

With the aforementioned information obtained, it was possible to calculate the water balance parameters based on the available water capacity (AWC), which in this case was 100 mm. This was possible by executing the waterDemand function. This AWC value (100 mm of water per cm of soil) was used because it is normally used for climate classification (Vianello; Alves, 2012).

The BHC parameters for this function were ARM - storage; ALT – storage change; ETR – real evapotranspiration; DEF – water deficit; EXC – water surplus; REP – replacement; RET – loss; and CAD_arm – percentage of storage in relation to available storage capacity.

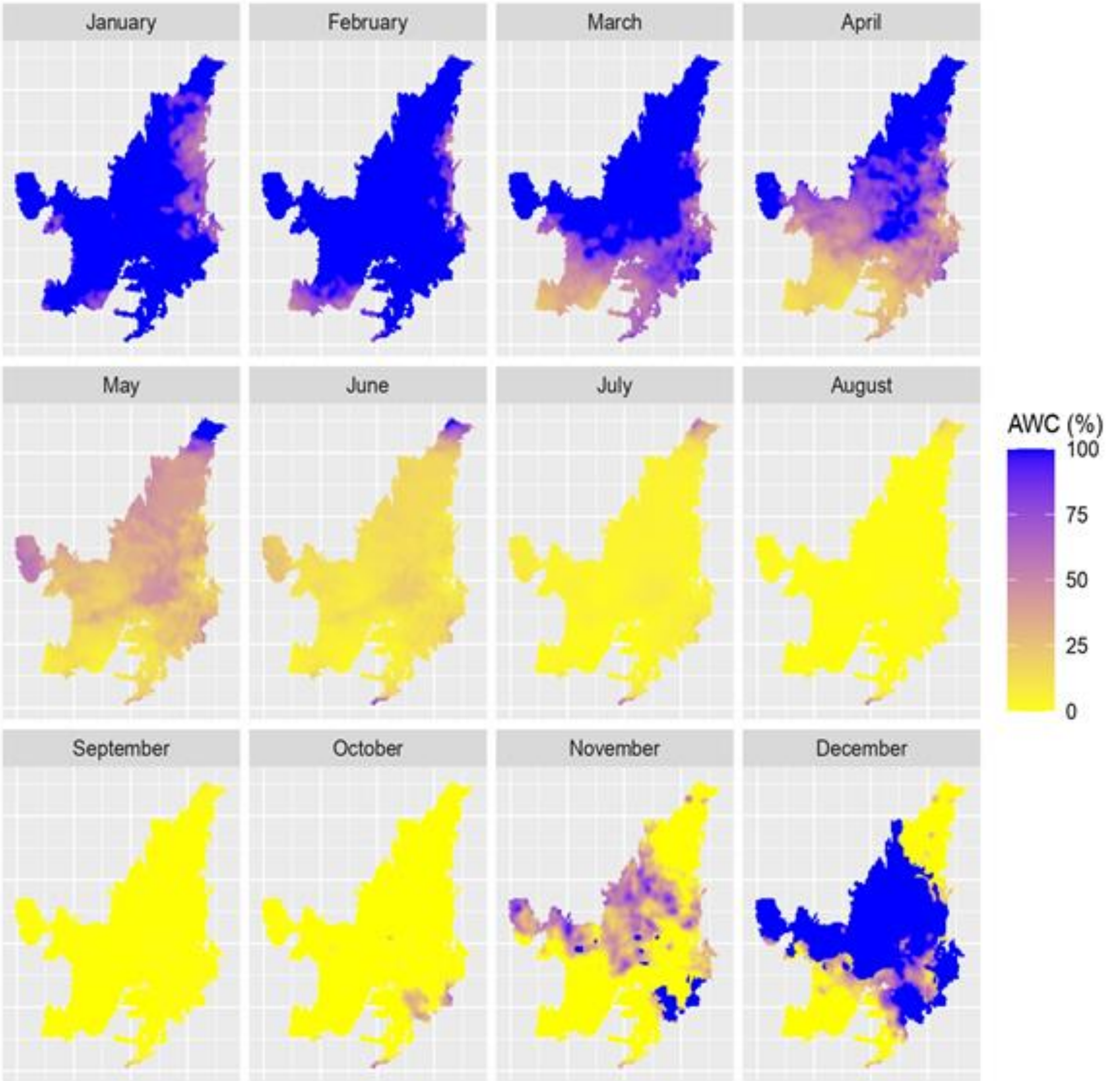
Finally, maps of the results of the climatic water deficit (percentage of storage in relation to available storage capacity) were plotted.

5 RESULTS AND DISCUSSION

When studying the atmospheric dynamics and characteristics, variability and climatic typologies of the Brazilian Cerrado, Nascimento and Novais (2020) showed that the main climatic characteristic of the Cerrado is strong seasonality, resulting in a rainy period during spring and summer, which is interspersed with a dry period throughout autumn and winter. With the influence of variations in latitude and longitude, the northern region of the biome has the highest temperatures.

Therefore, according to the climatological water balance map of the Cerrado Biome for the years 2020 to 2021 (Figure 1), the months from December to April presented the lowest climatic risks to the water supply, with values above 75%. In March, greater risks began to occur in the western region. As the months progressed, the areas with the greatest risks increased, reaching practically the entire Biome in the months of August to October, reaching values between 0 and 25%.

Figure 2. Average climatological water balance of the Brazilian Cerrado Biome for 2020 and 2021.



Source: Author.

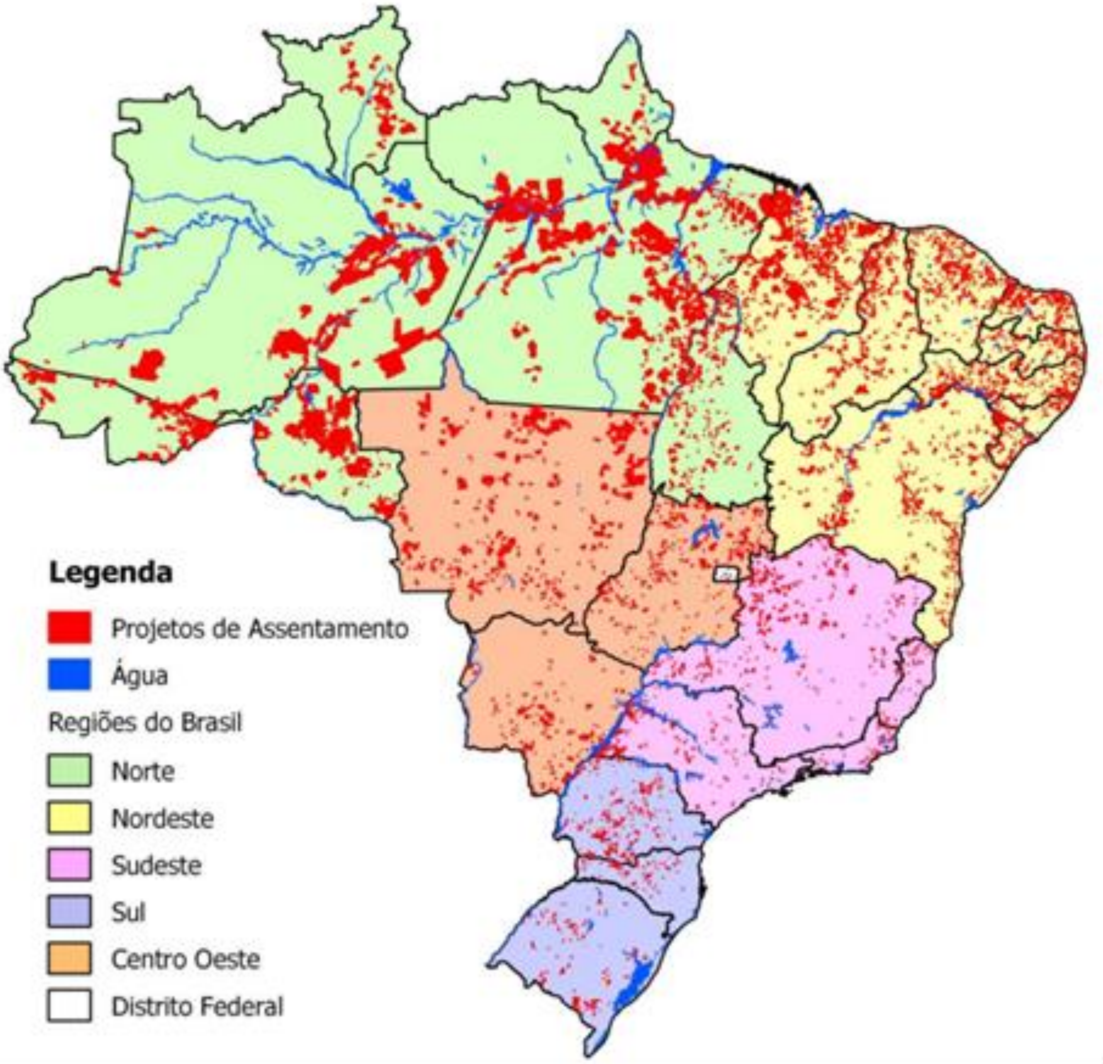
The highest rates of water storage in the soil were observed from December to April, during which the water surplus increased. During this period, the soil has the capacity to maintain the growth and development of agricultural crops. Planning for the planting of the main crops (soybeans and corn) becomes necessary since periods of greater water availability are ideal for sowing due to the maximum water requirement of the crop in the initial stages of its development to avoid occurring during periods of water deficiency in the soil (Oliveira, 2019) (2).

The period of water deficiency occurred between July and October, when the lowest water storage rates were identified, corresponding to the dry period in the region. In this scenario, the water stored in the soil is not enough to meet the demands of agricultural crops, necessitating the adoption of an irrigation system since crops need water in the initial development phase (Cassettari; Queiroz, 2020).

During the dry period, irrigation is characterized as a tool that allows for an increase in food production during the off-season; this approach can be a significant alternative for rural settlements (Figure 3) according to the National Institute of Colonization and Agrarian Reform (INCRA) in addition to enabling the diversification of production (Cassetari; Queiroz, 2020). To this end, sustainable irrigation management is recommended, observing the availability of water to meet the water demand of crops with the concern of how, when and how much to irrigate (Sobrinho *et al.*, 2020).

When studying the climatology of the State of Tocantins, Roldão and Ferreira (2019) reported that the rainfall in the state of Tocantins is concentrated from November to April, up to an average of 1,404 mm, which is equivalent to 85% of the annual rainfall. In addition, January had the highest average rainfall in the state, totaling 265.0 mm. These are important months for settlers to be able to implement their crops.

Figure 3. Spatialization of rural settlements in Brazil.



Source: GoSch, 2020.

For the Cerrado, agriculture began to expand during the 1970 s, mainly due to agricultural credit policy and the implementation of regional infrastructure through federal programs such as the Cerrado Area Development Program (POLOCENTRO). Additionally, responsible for the development of Cerrado areas, the Brazilian Agricultural Research Corporation (EMBRAPA) provided the foundations for “modern” agriculture or the “green revolution” (Alves *et al.*, 2021).

Given this, even with this great agricultural expansion in the Cerrado Biome, the vast majority of settlers lack financial resources and require assistance from public management and/or private partnerships. In this sense, the abovementioned information will be highly important for proper cultivation via irrigation.

6 CONCLUSIONS

The Cerrado Biome has two well-defined climatic seasons: rainy, from December to April; and dry, from July to October. Therefore, the most suitable months for planting crops are from December to April, which is the period of greatest water availability in the Cerrado Biome.

From July to October, water replacement through irrigation is necessary. In this sense, it is possible to use data on the water available in the soil during this period for irrigation management.

With the climatological water balance map in the Cerrado Biome, it is possible for INCRA settlers to carry out irrigation planning.

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