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Analysis of the Pluviometric Regime in the Southwest Bahia Identity Territory: Implications for Water Resources Management

Análise do Regime Pluviométrico no Território de Identidade do Sudoeste Baiano: Implicações para a Gestão dos Recursos Hídricos

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Abstract: The present study analyzed the pluviometric regime in the Southwest Bahia Identity Territory, using data from 20 selected rainfall stations from an initial set of 228. The aim was to investigate possible changes in precipitation rates due to climatic factors or changes in the landscape. We identified 19 stations with a significant reduction at the 5% significance level in the stationarity test of the historical data series, with an average period between 1943 and 2020. This study highlights the importance of understanding these changes for the sustainable management of water resources and ecosystem conservation in the region.

Keywords: Pluviometric regime; Southwest Bahia; Climate change.

Resumo: O estudo em questão analisou o regime pluviométrico na região do Território de Identidade do Sudoeste Baiano, empregando dados de 20 estações pluviométricas selecionadas a partir de um conjunto inicial de 228. O objetivo foi investigar possíveis mudanças nos índices de precipitação devido a fatores climáticos ou alterações na paisagem. Foram identificadas 19 estações com redução significativa no nível de significância de 5% no teste de estacionariedade da série de dados histórica, com período médio entre 1943 a 2020. Esse estudo destaca a importância de compreender tais mudanças para a gestão sustentável dos recursos hídricos e conservação do ecossistema na região.

Palavras-chave: Regime pluviométrico; Sudoeste Baiano; Mudanças climáticas.

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1. Introduction

A river basin, defined as a geographical area in which all surface and groundwater drain to a single outlet point, is a fundamental unit for the study and management of water resources. A detailed understanding of the characteristics and processes that occur in a river basin is essential for sustainable development and the preservation of aquatic and terrestrial ecosystems (FINKLER, 2023, p. 22).

In this context, the collection and analysis of accurate data plays a crucial role in the proper management of river basins. Rainfall data provides essencial information on weather patterns and water availability, allowing a deeper understanding of seasonal variations and long-term trends (AMÉRICO-PINHEIRO; RIBEIRO, 2018, p. 118). The relationship between rainfall and the processes of runoff and infiltration is a key aspect of hydrological modeling, allowing the assessment of climatic influences on basin dynamics (SANTOS, 2017, p. 9).

In summary, this study aims to present and make available geospatial information and climate data to provide an understanding of the watersheds of the Rio Pardo, Rio Gavião and Rio de Contas, located in the Southwest Bahia Identity Territory. The analyses carried out not only enrich current knowledge about the region, but also open doors for future research that can contribute significantly to the sustainable management of the environment and natural resources.

2. Methodology

2.1. Study area

The Southwest Bahia Identity Territory (Figure 1), formerly known as the Vitória da Conquista Identity Territory, is located in the northeast of Brazil, in the state of Bahia. Located in the South Central region of the state, it comprises 24 cities: Anagé, Aracatu, Barra do Choça, Belo Campo, Bom Jesus da Serra, Caetanos, Cândido Sales, Caraíbas, Condeúba, Cordeiros, Encruzilhada, Guajerú, Jacaraci, Licínio de Almeida, Maetinga, Mirante, Mortugaba, Piripá, Planalto, Poções, Presidente Jânio Quadros, Ribeirão do Largo, Tremedal and Vitória da Conquista (Flores, 2014).

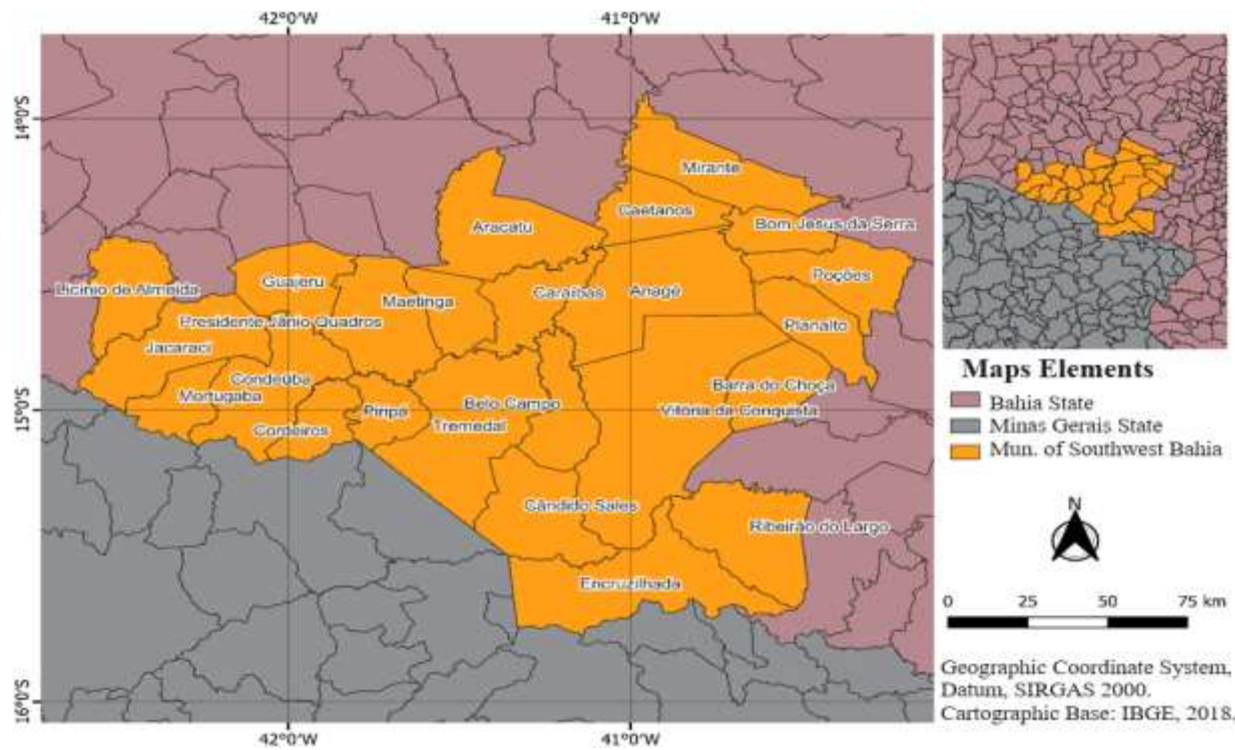

Figure 1 – Southwest Bahia Identity Territory
Source: The authors (2023).

According to Ferraz et al. (2015), the territory covers 26,809.99 km², distributed heterogeneously among its municipalities. According to the IBGE Demographic Census (2010), its total population is 695,302 inhabitants, making it the fourth most populous territory in Bahia. Of this population, 35% live in rural areas, while 65% live in urban areas. The demographic density is around 25.9 inhabitants per square kilometer, as can be seen in Table 1.

Table 1 – Total population and population percentage, in descending order, of the municipalities in the Southwest Bahia Identity Territory, Bahia, 2010.

City	Total	%
Vitória da Conquista	306.9	44,1
Poções	44.7	6,4
Barra do Choça	34.79	5,0
Cândido Sales	27.92	4,0
Anagé	25.52	3,7
Planalto	24.48	3,5
Encruzilhada	23.77	3,4
Tremedal	17.03	2,4
Condeúba	16.9	2,4
Belo Campo	16.02	2,3
Aracatu	13.74	2,0
Presidente Jânio Quadros	13.65	2,0
Jacaraci	13.65	2,0
Caetanos	13.64	2,0
Piripá	12.78	1,8
Mortugaba	12.48	1,8
Licínio de Almeida	12.31	1,8
Mirante	10.51	1,5
Guajeru	10.41	1,5
Caraíbas	10.22	1,5
Bom Jesus da Serra	10.11	1,5
Ribeirão do Largo	8.602	1,2
Cordeiros	8.168	1,2
Maetinga	7.038	1,0
Grand Total	695.302	100,00

Source: SIDRA/IBGE, 2010 Demographic Census.

The region's leading city is Vitória da Conquista, with 44.1% of the total population, equivalent to 306,866 people in 2010. The second largest city in terms of population is Poções, with 44,701 inhabitants, followed by Barra do Choça, with 34,788 residents. There are four municipalities with populations between 23,766 and 27,918, fourteen between 10,113 and 17,029, and three between 7,038 and 8,602. This population distribution reflects the historical process of formation of the territory and the polarizing role of the city of Vitória da Conquista in the region. The centralization is a result of the services offered in the city, especially in the areas of health, education, commerce and the public sector at federal, state and municipal levels.

The southwestern region of Bahia is characterized by a topography ranging from flat to strongly undulating, with a hot and semi-arid climate, and altitudes between 350 m and 1,090 m (EMBRAPA, 2007, p. 26). The area also has a rich ecological diversity, encompassing a wide range of flora and fauna. Among the forest formations, we highlight the

Mesophytic Forest or Coastal Forest, located on the eastern side, the exclusive Cipó Forest, found only in Bahia, and the Caatinga biome, which has the largest extension in the region. However, inadequate human environmental management practices, combined with anthropism, have caused significant transformations in the region's soil and climate conditions. This has resulted not only in the progressive loss of these valuable ecosystems, but has also made it difficult to grow traditional agricultural crops in the area (EMBRAPA, 2007, p. 27).

The southwestern region of Bahia is home to three river basins (Figure 2): the Contas River, the Gavião River and the Pardo River.

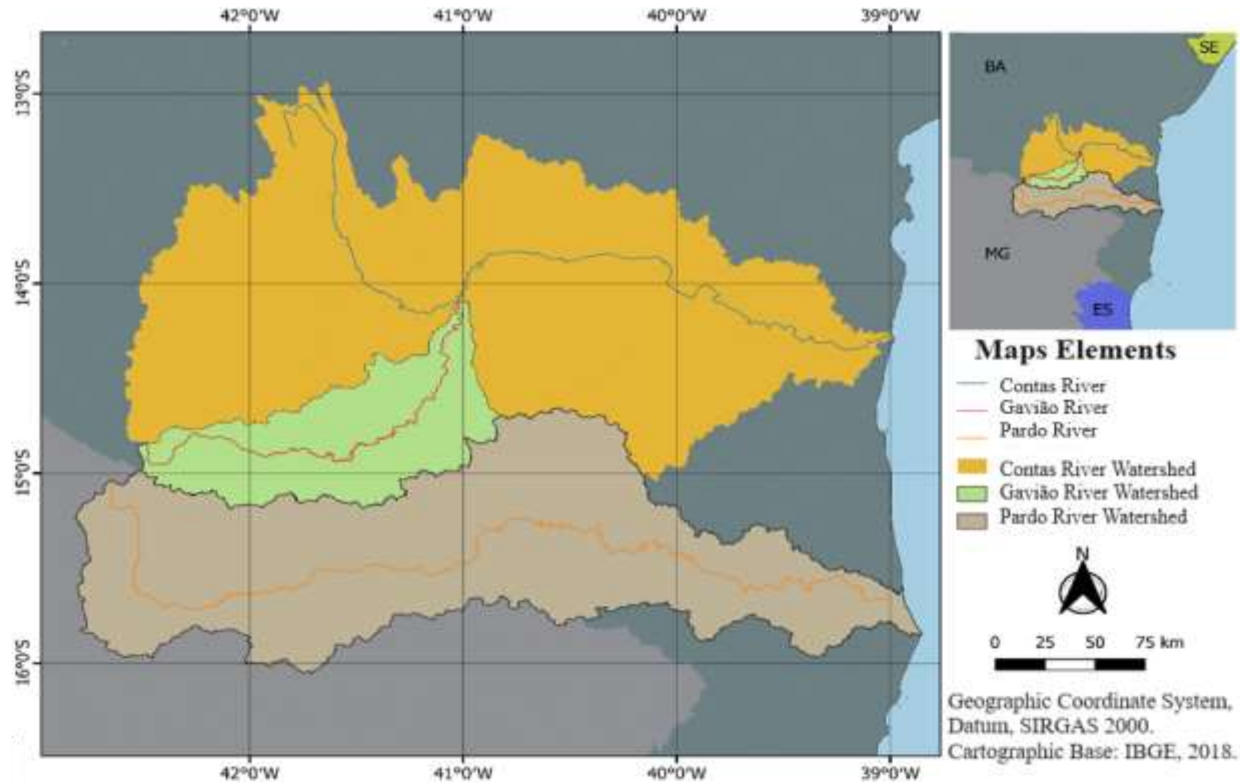

Figure 2 – Hydrographic basins located within the Southwest Bahia Identity Territory
Source: The authors (2023).

The Contas River hydrographic basin covers an area of 55,483 km² and falls within the boundaries of Water Planning and Management Region VIII (RPGA VIII) (INEMA, 2005). Located in the south-central region of the state, its geographical coordinates are 12º 55' to 15º 10' South latitude and 39º 00' to 42º 35' West longitude. This basin is geographically delimited in a specific way: to the north, it borders the Paraguaçu River and Recôncavo Sul River hydrographic basins; to the west, it borders the São Francisco River hydrographic basin; to the east, it is bordered by the Atlantic Ocean; and to the south, it borders the Pardo hydrographic basin, as well as the state of Minas Gerais.

The hydrographic area belonging to the Gavião River is positioned within the following geographical coordinates: longitude O 42° 31' 35''; latitude 15° 12' 10'' S to longitude O 40° 48' 46'' S. The sub-basin, in turn, covers an area of 10,262.37 km², with around 75% of its surface falling within the Caatinga biome and the remaining 25% within the Atlantic Forest biome. This is in line with the regional context of the semi-arid region of Bahia, according to data recorded by IBAMA (2004), ANA (2010) and INSA (2014).

In addition, it displays a spatial distribution pattern of a pinnate dendritic nature. Until the last three decades, the Gavião River was in line with the prototype of rivers typical of the semi-arid northeastern region (CLEMENTE; SANTOS, 2017). The authors also point out that these bodies of water were marked by high-magnitude floods during the period from October to March, while remaining dry for most of the year. The Gavião River hydrographic basin region is totally inserted in the context of the semi-arid area and, consequently, in the territory of the Polígono das Secas. This location places it in a category characterized by lower socio-economic levels in the State.

Finally, the hydrographic basin corresponding to the Pardo River covers a territorial extension of 32,627 km², permeating parts of the states of Bahia and Minas Gerais, as illustrated in Figure 2. This territorial coverage involves a total of 35 municipalities, distributed between 22 located in the state of Bahia and 13 located in the state of Minas Gerais (SANTOS, 2017).

Under federal jurisdiction, the Pardo River is administered by the Federal Government, with the National Water Agency (ANA) responsible for regulating it. As for its geographical position, the basin is geographically delimited by the coordinates 16º0'0" and 15º0'0" south latitude and 43º0'0" and 39º0'0" west longitude (Sampaio, 2013).

The basin's drainage area is defined by the region between the mouth of the Contas River to the north and the mouth of the Jequitinhonha River to the south, as documented by GASSER (2012).

2.2. Acquisition and processing of climate data

The study was based on data from the National Water and Sanitation Agency's (ANA) network of meteorological stations, made available through the "Portal HidroWeb". This portal is part of the National Water Resources Information System (SNIRH) and offers access to the database containing all the information collected by the National Hydrometeorological Network (RHN). This information includes data on river levels, flows, rainfall, climatology, water quality and sediment.

We analyzed 228 data points from rainfall stations throughout the southwest of Bahia and surrounding areas. Distributed in 3 States of the Federation: Bahia, Espírito Santo and Minas Gerais.

Rainfall stations with a data series of more than 20 years and data records up to at least 2010 were selected to form an annual series of rainfall totals. The statistical analysis used was the Student's t-test, specifically the t-test for two paired samples, in which the "hypothesis of difference in means" was assigned as "0" for groups of similar samples. Samples with one-tailed P-values ($T < t$) below 5% ($p < 0.05$) were considered relevant or significant.

2.3. Acquisition of Digital Elevation Models (DEMs)

Initially, the elevation data was identified and obtained from reliable sources. In this study, the DEM was obtained using images from the interferometric radar topographic mission known as the Shuttle Radar Topography Mission (SRTM). This mission was developed in collaboration between NASA (National Aeronautics and Space Administration) and the NGA (National Geospatial-Intelligence Agency) of the United States.

The DEMs were downloaded in raster format, compatible with QGIS. They were then imported into QGIS, where they were manipulated and processed to meet the needs of the research. During the process, pre-processing techniques were applied to correct possible imperfections and guarantee the quality of the data. This included filling in gaps, correcting errors and adjusting measurement units.

After pre-processing, the DEMs were integrated with the respective river basins, namely: Rio Pardo, Rio Gavião and Rio de Contas, using spatial overlay tools available in QGIS. This allowed the drainage areas of the basins to be precisely delimited.

Finally, the processed Digital Elevation Models were exported in formats compatible with further analysis, ensuring that the data is ready to be used as inputs in hydrological mathematical models and other analyses relevant to the research.

3. Results and discussion

Initially, a set of 228 rainfall stations was analyzed. However, only 20 of these stations were chosen for inclusion in the study, due to the presence of data with a historical series of more than 20 years and covering information records up to at least 2010, as shown in Table 2.

Table 2 – Rainfall stations selected for the study with more than 20 years of data and with records up to at least 2010 in the Southwest Bahia Identity Territory.

City	St	Station name	Code	From	To	Series length (years)
BELMONTE	BA	BELMONTE	01538001	1946	2022	76
PLANALTO	BA	LUCAIA (CAMPOS SALES)	01440009	1963	2022	59
CAMACAN	BA	CAMACAN (VARGITO)	01539022	1973	2022	49
CAMACAN	BA	FAZENDA NANCY	01539014	1963	2022	59
CÂNDIDO SALES	BA	CÂNDIDO SALES	01541001	1973	2022	49
MASCOTE	BA	MASCOTE	01539010	1945	2022	77
ITAMBÉ	BA	ITAMBÉ	01540004	1946	2022	76
GONGOGI	BA	PEDRINHAS	01439006	1949	2022	73
JEQUIÉ	BA	JEQUIÉ	01340003	1945	2022	77
MUCUGÊ	BA	GUINÉ	01241032	1985	2022	37
ITUAÇU	BA	ITUAÇU	01341029	1985	2022	37
TANHAÇU	BA	SANTO ANTÔNIO	01441000	1941	2022	81
MUCUGÊ	BA	USINA MUCUGÊ	01241033	1987	2022	35
VITÓRIA DA CONQUISTA	BA	INHOBIM	01540003	1967	2022	55
MIRANTE	BA	AREIÃO	01440032	1985	2022	37
IPIAÚ	BA	IPIAÚ	01439014	1944	2010	66
CAETITÉ	BA	CAETITÉ	01442015	1962	2017	55
ÁGUAS VERMELHAS	MG	ITAMARATI	01541010	1977	2022	45
SÃO JOÃO DO PARAÍSO	MG	SÃO JOÃO DO PARAÍSO	01542014	1977	2022	45
SÃO JOÃO DO PARAÍSO	MG	VEREDA DO PARAÍSO	01541013	1985	2022	37

Source: The authors (2023).

It is important to note that some of the stations selected are located outside the Southwest Bahia Identity Territory. The choice of rainfall stations located outside this territory was due to the fact that the rainfall data collected within the territory itself did not meet the pre-established criteria, or because there were no available records of rainfall stations in the area under discussion. This approach was adopted to provide a more comprehensive understanding of the climatic conditions in this specific region, taking into account information from nearby stations.

The rainfall stations selected, from adjacent areas, included the following identifications: 01541010 (Águas Vermelhas - MG); 01542014 (São João do Paraíso - MG); 01541013 (São João do Paraíso - MG); 01442015 (Caetité - BA); 01241033 (Mucugê - BA); 01441000 (Tanhaçu - BA); 01341029 (Ituaçu - BA); 01241032 (Mucugê - BA); 01439014 (Ipiaú - BA) 01340003 (Jequié - BA); 01439006 (Gongogi - BA); 01540004 (Itambé - BA); 01539010 (Mascote - BA); 01539014 (Camacan - BA); 01539022 (Camacan - BA); 01538001 (Belmonte - BA). In all, 15 adjacent rainfall stations were considered.

The analysis of the meteorological data presented (Table 3) reveals that there are trends in precipitation conditions at the stations analyzed, which are located in Bahia and Minas Gerais. In Belmonte, for example, there has been a significant reduction of 821.75 mm/year in recent average rainfall compared to older years, indicating a possible change in the local climate pattern. This trend is repeated at several stations, such as Lucaia (Campos Sales) and Camacan (Vargito), where decreases of 558.62 mm/year and 977.76 mm/year, respectively, raise concerns about the availability of water resources in these areas. Furthermore, the association of the data with the p-values highlights the statistical significance of these changes.

The p-values play a crucial role in the statistical interpretation of the precipitation data analyzed. It can be seen that most of the stations have significantly low values, indicating strong statistical evidence against the null hypothesis that there are no changes in rainfall over the course of time. This observation is most evident in stations such as Fazenda Nancy, in Camacan, with a p-value of 0.00086, and in Gongogi, with an impressively low p-value of 0.00000.

Table 3 – Stationarity analysis of the selected stations comparing the oldest and most recent average precipitation (P)/(mm/year), within a historical series (years).

City	**St**	**Station name**	**Code**	**Series length (years)**	**Old Average P (mm/year)**	**Recent Average P (mm/year)**	**Difference between P (Recent-Old)**	**p-value**
BELMONTE	BA	BELMONTE	1538001	76	3281.98	2460.23	-821.75	0.01703*
PLANALTO	BA	LUCAIA (CAMPOS SALES)	01440009	59	1856.57	1297.95	-558.62	0.00102**
CAMACAN	BA	CAMACAN (VARGITO)	1539022	49	2940.61	1962.86	-977.76	0.00002***
CAMACAN	BA	FAZENDA NANCY	1539014	59	2239.61	1531.97	-707.64	0.00086***
CÂNDIDO SALES	BA	CÂNDIDO SALES	01541001	49	1498.60	923.05	-575.55	0.00129**
MASCOTE	BA	MASCOTE	1539010	77	3113.67	2224.57	-889.10	0.00001***
ITAMBÉ	BA	ITAMBÉ	1540004	76	1303.40	750.94	-552.47	0.00003***
GONGOGI	BA	PEDRINHAS	1439006	73	2347.96	1501.11	-846.85	0.00000***
JEQUIÉ	BA	JEQUIÉ	1340003	77	1321.88	875.49	-446.39	0.00006***
IPIAÚ	BA	IPIAÚ	01439014	66	2133.68	1998.7	-134.98	0.20418
MUCUGÊ	BA	GUINÉ	1241032	37	1514.51	978.67	-535.84	0.00123**
ITUAÇU	BA	ITUAÇU	1341029	37	1249.28	792.45	-456.83	0.00450**

TANHAÇU	BA	SANTO ANTÔNIO	1441000	81	1183.84	883.74	-300.10	0.00129**
MUCUGÊ	BA	USINA MUCUGÊ	1241033	35	1984.35	1150.03	-834.32	0.00106**
VITÓRIA DA CONQUISTA	BA	INHOBIM	01540003	55	1493.51	957.81	-535.70	0.00001***
MIRANTE	BA	AREIÃO	01440032	37	923.13	632.19	-290.94	0.00703**
CAETITÉ	BA	CAETITÉ	1442015	55	861.80	753.54	-108.26	0.03055*
ÁGUAS VERMELHAS	MG	ITAMARATI	1541010	45	1520.09	924.63	-595.45	0.00011***
SÃO JOÃO DO PARAÍSO	MG	SÃO JOÃO DO PARAÍSO	01542014	45	1505.07	973.91	-531.17	0.00066***
SÃO JOÃO DO PARAÍSO	MG	VEREDA DO PARAÍSO	1541013	37	1426.56	869.53	-557.03	0.00100***

Source: The authors (2023).

Where: * significant differences at the "p"<0.05 level; ** significant differences at the "p"<0.01 level; *** significant differences at the "p"<0.001 level.

Below is a representation of the spatial distribution of the 20 rainfall stations (Figure 3), which were chosen according to the criteria mentioned above and which conduct the selection for this study (as detailed in Table 2). The stations that meet the selection criteria are identified on the map, with the blue colored dots corresponding to the stations that showed statistically significant differences, considering a significance level of 5%. On the other hand, the point colored in red is where no statistically significant differences were observed.

Figure 3 – Spatial distribution of the rainfall stations analyzed during the study, with a representation of the stations that showed and did not show a significant difference at the 5% significance level in the stationarity test of the data series.
Source: The authors (2023).

It was decided to use a percentage representation as a means of demonstrating the decrease in the annual volume of precipitation at the stations that showed statistically significant variations. To carry out this analysis, a comparison was made between the average for the most recent period and the average for the most recent period. The result of this calculation is shown in detail in Table 4.

Table 4 – Reduction in the average annual precipitation volume of the rainfall stations with a significance level of 5%.

City	**Code**	**Station Name**	**St**	**Reduction (%)***
BELMONTE	01538001	BELMONTE	BA	25.04
PLANALTO	01440009	LUCAIA (CAMPOS SALES)	BA	30.09
CAMACAN	01539022	CAMACAN (VARGITO)	BA	33.25
CAMACAN	01539014	FAZENDA NANCY	BA	31.60
CÂNDIDO SALES	01541001	CÂNDIDO SALES	BA	38.41
MASCOTE	01539010	MASCOTE	BA	28.55
ITAMBÉ	01540004	ITAMBÉ	BA	42.39
GONGOGI	01439006	PEDRINHAS	BA	36.07
JEQUIÉ	01340003	JEQUIÉ	BA	33.77

MUCUGÊ	01241032	GUINÉ	BA	35.38
ITUAÇU	01341029	ITUAÇU	BA	36.57
TANHAÇU	01441000	SANTO ANTÔNIO	BA	25.35
MUCUGÊ	01241033	USINA MUCUGÊ	BA	42.04
VITÓRIA DA CONQUISTA	01540003	INHOBIM	BA	35.87
MIRANTE	01440032	AREIÃO	BA	31.52
CAETITÉ	01442015	CAETITÉ	BA	12.56
ÁGUAS VERMELHAS	01541010	ITAMARATI	MG	39.17
SÃO JOÃO DO PARAÍSO	01542014	SÃO JOÃO DO PARAÍSO	MG	35.29
SÃO JOÃO DO PARAÍSO	01541013	VEREDA DO PARAÍSO	MG	39.05

Source: The authors (2023).

* The percentage reduction in rainfall was calculated in relation to the two averages, from the oldest period to the most recent data period.

Data analysis reveals a consistent downward trend in the volume of precipitation at all the rainfall stations considered, which prompts a deep reflection on the climatic conditions under discussion. The results point to a significant decrease in the amount of rainfall recorded in several municipalities, with the percentages of reduction varying according to the values presented. This trend highlights significant concerns regarding the availability of water resources, as well as the environmental and agricultural impact in these regions.

Taking the example of the city of Belmonte, the "BELMONTE" rainfall station showed a 25.04% reduction in the volume of precipitation, which points to a substantial climate change. In Planalto, the "LUCAIA (CAMPOS SALES)" station also showed a notable decrease, registering a reduction of 30.09%. Camacan, through the "CAMACAN (VARGITO)" and "(FAZENDA NANCY)" stations, faces reductions of 33.25% and 31.60%, respectively, which highlights the broad scope of this trend. Meanwhile, Cândido Sales is experiencing an even more severe reality, with the "CÂNDIDO SALES" station showing a 38.41% reduction in rainfall, which points to significant challenges in terms of water and agricultural management.

Other locations, such as Mascote and Itambé, are also in a state of decline, with the "MASCOTE" and "ITAMBÉ" stations recording drops of 28.55% and 42.39% respectively. These figures highlight the complexity of the situation and the need for targeted actions to deal with this reality. In cites such as Gongogi, Jequié and Mucugê, the reductions are also sharp, reaching percentages of 36.07%, 33.77% and 35.38% at the "PEDRINHAS", "JEQUIÉ" and "GUINÉ" stations, respectively.

It is important to mention that this pattern of reduction is not only restricted to the state of Bahia, but also extends to rainfall stations in Minas Gerais. In Águas Vermelhas, the "ITAMARATI" station recorded a reduction of 39.17%, while "SÃO JOÃO DO PARAÍSO" showed a decrease of 35.29%, and "VEREDA DO PARAÍSO" exhibited a notable reduction of 39.05%.

Besides, climate models project that Brazil will be subject to the impacts of climate change, with temperatures expected to rise by 2°C to 3°C by the year 2070. This thermal variation is especially significant for the Midwest, North and Northeast regions of the country, as pointed out by studies conducted by SALAZAR et al. (2007) and the Brazilian Panel on Climate Change (PBMC, 2014).

Over the last decade, Brazil has already witnessed some events characterized by a shortage of water resources in urban areas located in the Atlantic Forest. States such as São Paulo and Bahia, recognized for their rich biodiversity, have had episodes of water restriction, as documented by ESCOBAR (2015) and corroborated by MARENGO et al. (2018). It is worth noting that such occurrences may recur and intensify in prospective scenarios, given the complex interaction between ongoing climate change and patterns of water use and management.

This scenario requires a comprehensive approach that considers both environmental and socio-economic implications. The projections reinforce the importance of adaptive and mitigation measures to face the climate challenges ahead, especially in the search for strategies that guarantee a sustainable water supply and the resilience of communities in the face of future water restrictions.

Schiavetti & Camargo (2002) propose a hypothesis that emphasizes the impact of anthropogenic activities on the hydrological cycle of river basins, when conducted in an exploitative manner and without conservation considerations.

The authors point out that actions such as monoculture, grazing and mining, when not accompanied by mitigation measures for the resulting environmental impacts, can trigger a significant imbalance.

Schiavetti & Camargo's analysis points out that land use and occupation that disregards environmental conservation tends to culminate, in the medium and long term, in the degradation of the affected areas. This process is intensified by the reduced fertility of the soil and its compaction as a result of unregulated activities. Two essential components of the hydrological cycle, evapotranspiration and infiltration, are adversely impacted. This correlation is simplified by the authors: smaller vegetation areas correspond to lower volumes transpired by plants, and soil compaction reduces the capacity for water infiltration.

In addition, the exposure of soil without vegetation cover provides conditions for erosion, which can manifest itself in various ways. This can occur due to the impact of raindrops, resulting in the detachment of soil particles, or due to the dragging effect of the wind. These erosive processes can evolve into the formation of gullies and, in extreme situations, even trigger the desertification of previously productive areas.

Thus, Schiavetti & Camargo's research points to the urgent need to consider a balanced and conservationist approach to anthropogenic activities in order to mitigate the negative effects on the hydrological cycle of river basins and safeguard the long-term environmental health of these areas.

Given these results, an in-depth analysis is essential to understand the factors behind these reductions and their large implications for water resources, agriculture and the sustainability of these regions. Concrete adaptation and mitigation measures need to be considered urgently to ensure the resilience of these areas in the face of the climate challenges ahead.

4. Final considerations

The conclusion is that there is a consistent downward trend in the volume of precipitation at all the rainfall stations examined. This observation alone calls for deep reflection on the complex climate dynamics underway. The results highlight a significant decrease in the amount of rainfall recorded in several cites, with varying percentages of reduction, but all of them pointing to a notable climate transformation.

This trend has far-reaching implications, especially with regard to the availability of water resources and the environmental and agricultural effects on the areas in question.

Given this scenario, the complexity of the observed reductions in precipitation requires deeper analysis and strategic interventions. It is mandatory to implement adaptive and mitigation measures to face the emerging climate challenges. The sustainable future of the affected areas depends on a balanced and multidisciplinary approach, ensuring resilience in the face of climate uncertainties and guaranteeing the continued availability of water resources and long-term environmental preservation.

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References

AGÊNCIA NACIONAL DAS ÁGUAS – ANA. *Limites das bacias hidrográficas brasileira*, 2010. Disponível em:<> Acesso em: 06/02/2023.

AGÊNCIA NACIONAL DE ÁGUAS – ANA. Hidroweb: Sistemas de informações hidrológicas. Disponível em: <http://hidroweb.ana.gov.br/> Acesso em: 02/02/2023.

AMÉRICO-PINHEIRO, J. H. P.; BENINI, S. M. Monitoramento de recursos hídricos e parâmetros de qualidade de água em bacias hidrográficas. Bacias hidrográficas: fundamentos e aplicações, v. 2, p. 204, 2018.

CLEMENTE, Carlos Magno Santos; SANTOS, Pablo Santana. *Geotecnologias como suporte para análise da vegetação natural na sub-bacia hidrográfica do rio Gavião* (1988 A 2015). Revista Cerrados (Unimontes), vol. 15, núm. 1, pp. 98-113, 2017.

EMBRAPA. *Simpósio sobre Reflorestamento na Região Sudoeste da Bahia* (2. : 2005 : Vitória da Conquista, BA). Memórias ... [recurso eletrônico] / Álvaro Figueredo dos Santos ... [et al.], editores. - Dados eletrônicos. - Colombo : Embrapa Florestas, 2007.

ESCOBAR, H. *Drought triggers alarms in Brazil's biggest metropolis*. Science, v. 347, n. 6224, p. 812–812, 2015.

FERRAZ, A. E. Q.; GUSMÃO, A. D. F.; ROCHA, A. A.; ALCÂNTARA, F. V.; OLIVEIRA, V. F. *Belo Campo: pensar a cidade, desafios e possibilidades*. Vitória da Conquista: Conhecer, 2015. 52p.

FINKLER, Raquel. *Planejamento, manejo e gestão de bacias*, 2023. Disponível em: < https://planejamento.mppr.mp.br/arquivos/File/bacias_hidrograficas/planejamento_manejo_e_gestao_unidade_1.pdf >. Acesso em 04/02/2023.

FLORES, Cintya Dantas. *Territórios de identidade na Bahia: saúde, educação, cultura e meio ambiente frente à dinâmica territoria*l – Salvador, 2015.

GASSER, R. S. *Caracterização Geológica, Petrográfica, Geoquímica e Potencialidades Metalogenéticas da Formação Água Preta, Bacia do Rio Pardo, BA*. Salvador-BA: UFBA, 2012, 88 p. Trabalho de Conclusão de Curso (Graduação em Geologia) – Universidade Federal da Bahia.

IBGE. *Instituto Brasileiro de Geografia e Estatística*. SIDRA. Disponível em: IBGE. Instituto Brasileiro de Geografia e Estatística. SIDRA. Disponível em:< http://www.ibge.gov.br/>. Acesso em: 05/02/2023.

INEMA, Instituto do Meio Ambiente e Recursos Hídricos da Bahia. *O Plano Estadual de Recursos Hídricos*. De 22 de março de 2005. Disponível em:< http://www.inema.ba.gov.br/gestao-2/rpgas>. Acesso em: 06/02/2023.

INSTITUTO NACIONAL DO SEMIÁRIDO. *Delimitação do Semiárido Brasileiro*. 2014. Disponível em: < http://www.insa.gov.br/ >. Acesso em: 06/02/2023.

MARENGO, J.A.; ALVES, L.M.; ALVALA, R.C.S.; CUNHA, A.P.; BRITO, S.; MORAES, O.L.L. *Climatic characteristics of the 2010-2016 drought in the semiarid Northeast Brazil region*, An. Acad. Bras. Ciênc., v. 90, n. 2, 2018.

MINISTÉRIO DO MEIO AMBIENTE – MMA. *Projeto monitoramento do desmatamento nos biomas brasileiros por satélite*. Acordo de cooperação técnica MMA/IBAMA, BRASÍLIA/DF. Disponível em: <>. Acesso em: 06/02/2023.

PBMC – PAINEL BRASILEIRO DE MUDANÇAS CLIMÁTICAS. *Base científica das mudanças climáticas - Grupo de Trabalho 1*. In: AMBRIZZI, T.; ARAUJO, M. (Eds.) Primeiro Relatório da Avaliação Nacional sobre Mudanças Climáticas. Rio de Janeiro: COPPE, 2014, 464 pp.

SALAZAR, L.F.; NOBRE, C.A.; OYAMA, M.D. *Climate change consequences on the biome distribution in tropical South America. Geophysical Research Letters*, v. 34, n. 9, NEVES et al. Drivers of vulnerability to climate change 15 Soc. Nat. | Uberlândia, MG | v.34 | e62222 | 2022 | ISSN 1982-4513 p.1–8, 2007.

SAMPAIO, N. *Invisibilidade das comunidades tradicionais: rio Pardo no Sudoeste da Bahia*. Anais do I Simpósio Baiano de Geografia Agrária e Semana de Geografia da UESB. Vitória da Conquista: Universidade Estadual do Sudoeste da Bahia, 2013, 21 p.

SANTOS, Juliano Böeck. *Modelagem hidrológica hec-hms da bacia hidrográfica do ribeirão lava-pés-* Botucatu-SP. 2017.

SANTOS, Lucia C. O. *Influência dos usos consuntivos da água e do uso e cobertura da terra na vazão da bacia hidrográfica do rio pardo*. Vitória Da Conquista. 2017.

SCHIAVETTI, Alexandre; CAMARGO, Antonio FM. Conceitos de bacias hidrográficas: teorias e aplicações. 2002.