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BRAZILIAN SEMI-ARID REGION. A TERRITORY OF THREE BIOMES

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Mariana de Melo Silva[1], Daniel Duarte Pereira[2], Bianca Marina Costa Nascimento[3], Adailson Tulio dos Santos Silva[4], Pollyanna da Silva Soares[5], Evilásio Vieira Silva[6], Luan Correia de Oliveira[7], João Paulo Rocha de Araújo[8] and Estephany Vitoria Batista Cardoso[9]

[1] Graduated in Biological Sciences
Federal University of Paraíba
E-mail: mariana.melo@academico.ufpb.br
ORCID: https://orcid.org/0000-0002-0204-2533
LATTES: http://lattes.cnpq.br/6274208988343804
[2] Doctor in Natural Resources
Professor at the Federal University of Paraíba
E-mail: danielduartepereira66@gmail.com
ORCID: https://orcid.org/0000-0002-0859-9463
LATTES: http://lattes.cnpq.br/9991335219423354
[3] Graduated in Biological Sciences
Federal University of Paraíba
E-mail: biancamarina.bio@gmail.com
ORCID: https://orcid.org/0000-0003-0354-6132
LATTES: http://lattes.cnpq.br/9991335219423354
[4] Graduated in Granomy
Federal University of Paraíba
E-mail: adailsontulio6@gmail.com
ORCID: https://orcid.org/0000-0002-6647-3885
LATTES: http://lattes.cnpq.br/3258606744886335
[5] Graduated in Biological Sciences
Federal University of Paraíba
E-mail: pss@academico.ufpb.br
ORCID: https://orcid.org/0009-0004-3286-7183
LATTES: http://lattes.cnpq.br/3882101153871008
[6] Undergraduate student in Biological Sciences
Federal University of Paraíba
E-mail: evs@academico.ufpb.br
ORCID: https://orcid.org/0009-0008-5790-8913
LATTES: http://lattes.cnpq.br/9068666960741581
[7] Graduating in Agranômy
Federal University of Paraíba
E-mail: luancorreia1807@gmail.com
ORCID: https://orcid.org/0009-0003-8740-121X
LATTES: https://lattes.cnpq.br/6607516150049572
[8] Graduating in Agranômy
Federal University of Paraíba
E-mail: joaopaullora@gmail.com
ORCID: https://orcid.org/0009-0007-3648-1466
LATTES: https://lattes.cnpq.br/5629503865540307
[9] Undergraduate student in Agronomy
Federal University of Paraíba
E-mail: Estephany.vbc@gmail.com
ORCID: https://orcid.org/0000-0002-0392-292X
LATTES: http://lattes.cnpq.br/4247264002001176

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ABSTRACT
The Brazilian Semi-arid is a complex region, not only in terms of climate but also in terms of geography, history, vegetation, and socioeconomic aspects. Initially delimited in 1936 as the "Polygon of Droughts", the region was predominantly associated with the Brazilian Northeast, but over time, its understanding and delimitation have been expanded and refined. This study aimed to analyze the contribution of the three main Brazilian biomes - Caatinga, Cerrado, and Atlantic Forest - in the composition of the Brazilian Semiarid. Using data from the Brazilian Institute of Geography and Statistics (IBGE), the research mapped the presence of these biomes and their transitions in the semi-arid region. The results revealed that the Caatinga is the predominant biome in the region, present in about 78% of the municipalities and covering more than 75% of the total area of the Semi-arid region. However, there was a significant increase in the presence of the Cerrado Complex and the Atlantic Forest Biome, indicating environmental diversification in the region. These findings have important implications for public policy planning, suggesting the need for more localized approaches adapted to the specific characteristics of each area to promote the sustainable development and resilience of semi-arid communities.

Keywords: Semiaridity. Caatinga. Atlantic Forest. Scrubland. Planning.

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INTRODUCTION

The term Semi-arid can have several interpretations. In Brazil, it is usually associated, first, with a region and then with a climate. Although it is predominantly a climate. As a region, the first attempts at delimitation arose when the publication of Federal Law No. 175, of January 7, 1936 (BRASIL, 1936), which established the territorial bases for what would later be called the Brazilian Semi-Arid - SAB or Semi-Arid Region - RSA, from the delimitation of the Polygon of Droughts, at the time, formed by part of the states of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia. The term Polygon of Droughts referred to the Region from 1936 to 1988 when, for constitutional purposes (BRASIL, 1988), it came to be called "... Northeast Region, preferably in the Semi-arid Region" (Article 42, Item II) and "... to the semi-arid Northeast..." (Article 159, Subsection I, letter c). It should be noted that there was still no understanding that the Semi-arid was not only in the Northeast, since Federal Decree-Law No. 8,486, of December 28, 1945 (BRASIL, 1945) inserted municipalities in Minas Gerais, and consensus as to the spelling to be used.

After undergoing several modifications in terms of area and number of municipalities without scientific criteria, it was from 1989 onwards that the insertion of the average rainfall of the last 30 years equivalent to ≤ 800.0 mm was established as a criterion for the insertion of municipalities in the Region (SUDENE, 2021). Subsequently, in 2005, the criteria of Average Precipitation ≤ 800.0 mm, Aridity Index ≤ 0.50, and Daily Percentage of Water Deficit ≥ 60% considering all days of the year or Drought Risk ≥ 60% were inserted (SUDENE, 2021). Some authors, such as Letras Ambientais (2022), have correctly inserted territorial continuity.

The 2017 (SUDENE, 2017) and 2021/2022 (SUDENE, 2021; IBGE 2022a) however, did not carry out these mappings, which makes the level of participation of each Biome, and its transitions, in the region confusing. Thus, some planning and public policies are not endorsed, nor implemented correctly, because there is no deeper delimitation in terms of biomes, interfering in scenarios and actions to be taken.

The 2021/2022 update was judicialized, and it was only accepted in January 2024. Thus, there is a gap between the 2005 and 2021/2022 updates in terms of the contribution of the Cerrado, Atlantic Forest, and Cerrado Biomes in the SAB/RSA and, consequently, which interventions can be strengthened for each space. For example, agroforestry systems (AFS) can be better used in an Atlantic Forest and Cerrado environment, due to

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higher rainfall and the nature of soils. Cisterns, underground dams, and xerophytic crops are more classified for the semi-arid environment of the Caatinga, characterized by a more irregular water regime and young soils.

Thus, this research proposed to update the delimitation of the Semi-arid region, considering the expressiveness of the biomes and their transitions, to provide subsidies for more effective planning and public policies aimed at the sustainable development of the region.

METHODOLOGY

To carry out the research, the Brazilian Semi-arid Region (IBGE, 2022a) was accessed to obtain the updated list of municipalities belonging to the Semi-arid region from the 2021 delimitation. In Territorial Areas (IBGE, 2022b) the updated areas were obtained, in km², of each municipality. And, finally, in Biomes (IBGE, 2019) the biomes, or their transitions, to which they belonged were obtained from each municipality. The results resulted in three Microsoft Excel spreadsheets, where only the municipalities belonging to the Semi-arid region were separated, since the spreadsheets of Territorial Areas and Biomes refer to all Brazilian municipalities. From a matrix spreadsheet, the states belonging to the Semi-arid (MA, PI, CE, RN. PB, PE, AL, SE, BA, MG, and ES) and, for each one, the biomes and their respective transitions were listed. For the values obtained for the Caatinga, Caatinga/Cerrado Transition, Caatinga/Atlantic Forest Transition, and Caatinga/Cerrado/Atlantic Forest Transition, the Caatinga Complex was called Caatinga Complex due to the predominance of this Biome. The values obtained for the Cerrado and Cerrado/Atlantic Forest Transition were called the Cerrado Complex. The tabulated data resulted in tables and percentages of the contribution of each biome and its complexes in the semiarid space.

RESULTS

The current Brazilian Semi-arid Region - SAB, or Semi-arid Region - RSA, has an area of 1,318,750.00 km² and 1,477 municipalities IBGE (2022a) being formed by parts of the states of MA, PI, CE, RN, PB, PE, AL, SE, BA, MG and ES. Of these 1,477 municipalities, 925 (62.62%) are inserted in the Caatinga Biome and 226 (15.30%) in their transitions (Chart 1). Therefore, the participation of the Caatinga Complex in the SAB/RSA is 1,151 municipalities, or 77.92% of the total.

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Table 01 - Caatinga Biome in the Brazilian Semi-arid Region

State	Mun No.	Mun SAB No.	Mun SAB %	Area State km²	Area SAB km²	Biome/ State Transition %
Caatinga Biome						
Total	2.429	925	37,92	1.809.037,91	694.073,47	38,37
Caatinga/Cerrado Transition						
Total	1.711	128	7,48	1.732.681,38	261.486,458	15,09
Caatinga/Atlantic Forest Transition						
Total	1.168	95	0,34	821.874,00	50.923,78	6,20
Caatinga/Cerrado/Atlantic Forest Transition						
Total	1.270	03	0,24	1.151.274,41	4.447,65	0,39
Grand Total	**2.554***	**1.151**	**45,06**	**2.138.689,40****	**1.010.931,358**	**47,26**

Source: IBGE (2019). IBGE (2022a). IBGE (2022b). **Sum of the municipalities of each state surveyed. *Sum of the areas of each state surveyed. Mun = Municipalities.

In Table 02 it can be seen that the Cerrado Biome is present in 139 municipalities of the 1,477 that make up the SAB/RSA, or in 9.41%. In terms of area, the representativeness was 198,279.34 km², which represents 14.86% of the total area of 1,333,528.910 km². The Cerrado Complex, on the other hand, resulted in 157 municipalities (10.62% of the total) and an area of 214,784.173 km² (16.10% of the total).

Table 02 - Cerrado Biome in the Brazilian Semi-arid Region

State	Mun No	Mun SAB No	Mun SAB %	Area State km²	Area SAB km²	Biome/ State Transition %
Cerrado Biome						
Total	1.711	139	8,12	1.732.681,38	198.279,34	11,44
Cerrado/Atlantic Forest Transition						
Total	853	18	2,11	586.513,983	16.504,833	2,81
Total	**2564***	**157**	**6,12**	**2.319.195,363****	**214.784,173**	**9,26**

Source: IBGE (2019). IBGE (2022a). IBGE (2022b). *Sum of the municipalities of each state surveyed. **Sum of the areas of each state surveyed. Mun = Municipalities.

Table 03 shows that the Atlantic Forest Biome occurs in 170 municipalities (11.50%) of the SAB/RSA and that the territorial area is 107,813.37 km² (8.08%). The territorial values and the number of municipalities are well above those found by Marinho (2015) who found that the Atlantic Forest Biome, for the delimitation of the Semi-arid region of 2005, occupied an area of 54,783.36 km² and covered 72 municipalities.

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Table 03 - Atlantic Forest Biome in the Brazilian Semi-arid Region

State	Mun. No	Mun. SAB No.	Mun. SAT %	Area State km²	Area SAB km²	Biome/ State Transition %
Atlantic Forest Biome						
Total	1.709*	170	9,95	1.345.185,59**	107.813,37	8,01

Source: IBGE (2019). IBGE (2022a). IBGE (2022b). *Sum of the municipalities of each state surveyed.**Sum of the areas of each state surveyed. Mun = Municipalities.

DISCUSSION

For the IBGE (2022), the SAB/RSA has an area of 1,318,750.00 km². This is due to the non-addition of the 50 municipalities that were still litigating regarding the update carried out in 2021 and endorsed in 2024. For the research, the data were updated, resulting in an area of 1,333,528.910 km², equivalent to what can be called the Semi-arid of PET AgroBio. Considering this area value, the Caatinga Biome contributes 694,073.470 km² to the semi-arid area or 52.04% of the area. The Caatinga Complex contributes 1,010,931.358 km² or 75.80%.

Marinho (2015), when researching the contribution of each Biome in the 2005 Semi-arid update (980,857.00 km² and 1,135 municipalities), found that the contribution of the Caatinga Biome was 660,053.49 km² and 858 municipalities. The Caatinga Complex participated with 851,864.17 km² and 1,016 municipalities. The research data allow us to infer that from the 2005 update to the 2002/2024 update, there was a significant increase in the participation of the Caatinga Complex in the territory and the number of municipalities. It is important to note that the Caatinga Complex is present in 45.06% of the municipalities of the states that form the SAB/RSA and in 47.26% of the sum of their territorial area. In 2005, the contribution of the Cerrado Biome (table 2) to the then SAB/RSA was 56,508.89 km² or 30 municipalities. The Cerrado Complex resulted in an area of 72,116.280 km² and 47 municipalities. (MARINHO, 2015). These data allow us to observe that between 2005 and 2021/2024 there was a significant increase in the participation of the Cerrado Complex in the SAB/RSA.

The Cerrado Complex is present in 6.12% of the municipalities of the states that make up the SAB/RSA and in 9.26% of the sum of their territorial area.

Considering the participation of each Biome in the Semi-arid region, it is possible to infer that the Caatinga Complex participates in 75.81% of the area (1,010,931.36 km²), the Cerrado Complex with 214,784.17 km² (16.11%) and the Atlantic Forest Biome with 107,813.37 km² (8.08%). Comparing with the participation of these Biomes and Complexes

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in the 2005 delimitation, it can be observed that the territorial area of the Caatinga Complex increased from 851,864.170 km² to 1,010,931.358 km² (18.67%). The Cerrado Complex increased from 72,116.280 km² to 214,784.173 km² (197.83%) and the Atlantic Forest Biome went from 54,783.36 km² to 107,813.37 km² (96.79%).

For the 2021 delimitation, SUDENE (2021) noted that the insertion values of more municipalities in the Caatinga Complex (858 to 1,151 or 34.14%), Cerrado Complex (47 to 157, or 234.04%) and Atlantic Forest (72 to 170, or 136.11%) bring concerns and that these should be included in the planning scopes aimed at the portions of these Biomes inserted in the Semi-arid Region.

CONCLUSION

As of 2005, it was established that the delimitation of the semi-arid region would be updated every ten years. The new delimitations that occurred in 2017 and 2021, judicialized and accepted in 2024, always bring information on the expansions and retractions of areas involved by the indicators of precipitation, aridity, and risk of drought. However, little is observed about the expansion of the areas of the Biomes that are part of the region.

The research showed that although the Caatinga Complex remains with the largest amplitude in area and municipalities, Complexes such as those of the Cerrado and the Atlantic Forest Biome resulted in expressive values in terms of insertion of area and municipalities. This indicates that many public policies should be rethought in a more local way and not as a general norm for the entire semi-arid region.

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