Understanding disaster patterns in Brazil: Frequency, typology, and regional disparities

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Abstract

Brazil is directly affected by the social and economic impacts of disasters, which are driven by accelerated urbanization and structural vulnerability in a climate change context. Considering this scenario, this paper aims to identify the patterns of frequency, typology, and regional distribution of disasters that occurred in Brazil between 2000 and 2025. A quantitative analysis of past events is conducted in order to understand their temporal and spatial dynamics. The methodology adopted uses secondary data from the Emergency Events Database (EM-DAT), considering selection and exclusion criteria, and classifying by typology and region. The results indicate a significant increase in the number of occurrences from 2018 onward, with a peak in 2023. Hydrological disasters, especially floods, are predominant and account for the majority of recorded events. The spatial distribution reveals a concentration in the Southeast, Northeast, and South regions, with a recent intensification in the South of Brazil. Limitations were also identified, including incomplete economic loss data and the potential underreporting of lower-magnitude events.

Keywords: *disasters, climate change, Brazil, floods, droughts.*

1. Introduction

Climate change represents a threat to humanity, as the increasing frequency and intensity of extreme events, combined with the susceptibility of populations residing in risk-prone areas, amplifies the potential damage associated with disasters, especially in emerging countries, whose economic activities are characterized by institutional fragility and limited adaptive capacity (Daher, 2026; Amarasinghe et al., 2026; Alves et al., 2022; Teixeira et al., 2025). Beyond the direct impacts, these events significantly affect the economies of developing countries by reducing agricultural production, exacerbating fiscal deterioration, and contributing to increases in violence and the intensification of conflicts (Daher, 2026; Amarasinghe et al., 2026). According to the World Meteorological Organization, disasters associated with meteorological, climatic, and hydrological phenomena have occurred daily over the last 50 years, causing, on average, 115 deaths and estimated losses of approximately US$ 202 million per day (Biardeau; Sahli, 2024).

Recent events such as the 2021 earthquake in Haiti, the floods in Central Europe in 2020, the most severe flooding in Brazil's history in 2024, and the wildfires in Australia in 2020 highlight the impact of disasters. Also, evidence shows that recent disasters in India are strongly shaped by social factors, including population growth, land use and occupation, settlement patterns, and poverty distribution (Mantovani et al., 2025; Rathore et al., 2025; Jones et al., 2022; Reis et al., 2026). Therefore,. According to de Oliveira et al. (2020), risk is not limited to high-intensity hydrometeorological events alone. Hence, there is an urgency to expand research, planning, preparedness, and mitigation strategies related to natural hazards.

In Brazil, extreme events generate severe impacts due to the occupation of risk areas, the precariousness of public infrastructure, and unplanned urban growth. These factors increase cities' vulnerability, especially to floods and landslides, which are the most recurrent events in the country (Alves et al., 2025). According to data provided by the Brazilian Atlas of Natural Disasters, 3,448 disaster-related deaths were recorded from 1991 to 2012 (Santos et al., 2020). Moreover, the National Confederation of Municipalities (2024) registered a total of R$ 639.4 billion in losses throughout Brazil between 2013 and 2023, estimating that 94% of Brazilian municipalities were affected by at least one type of disaster.

Given the social and economic impacts of disasters and their increasing frequency, identifying these events is essential for understanding their effects. Such understanding is enables decision-makers to develop a more effective emergency plan (Goerlandt et al., 2022; Souza Almeida et al., 2019; Teixeira et al., 2025). Therefore, this study presents a quantitative analysis of the occurrence and distribution of disasters in Brazil from 2000 to 2025, which aims to understand what patterns can be identified regarding the frequency, typology, and regional distribution of these events.

2. Literature review

The literature review is organized as follows. Subsection 2.1 presents a synthesis of Brazil's geographic and climatic characteristics. Subsection 2.2 addresses the history of recent disasters in Brazil, and Subsection 2.3 discusses the use of the Emergency Events Database (EM-DAT) in academic research.

2.1 Geographic and climatic characteristics and disaster susceptibility in Brazil

Brazil is the fifth-largest country with an area of approximately 8,514,876 km² and a population exceeding 200 million inhabitants. The country is politically organized into five regions, with a high degree of urbanization (Pereira; Miranda, 2023). In 2025, approximately 84% of the population lived in urban areas, and according to the Brazilian Institute of Geography and Statistics (IBGE), 21.9% of the population was located in 17 municipalities with more than 1 million residents (Pereira; Miranda, 2023).

Brazil is predominantly characterized by a tropical climate, with semi-arid conditions in parts of its territory that favor recurrent drought episodes. These droughts are strongly influenced by the El Niño–Southern Oscillation (ENSO), a climate phenomenon with three phases: El Niño, marked by anomalous warming of sea surface temperatures in the central and eastern Equatorial Pacific; La Niña, characterized by the cooling of these waters; and a neutral phase, when no significant temperature anomalies are observed (De Oliveira et al., 2020; Coelho et al., 2024). Variations in ocean temperatures associated with ENSO alter atmospheric circulation, moisture transport, temperature, and precipitation patterns worldwide. In Brazil, these changes are directly related to severe droughts in the North and Northeast regions and increased rainfall in the South (Coelho et al., 2024).

Anthropogenic activities, rising temperatures, and climate change contribute to the intensification of droughts, especially in the Midwest, Northeast, Southeastern Amazon, and Southeast regions, as well as to the expansion of areas affected by wildfires across the country (Coelho et al., 2024). Among disasters associated with extreme events, droughts are characterized by greater spatial extent and high population exposure but present lower destructive potential than floods, mass movements, and severe storms (Ribeiro et al., 2021).

Landslides and floods are the leading causes of deaths associated with extreme events in Brazil, while storms and coastal flooding account for the greatest economic losses. In mountainous areas, precipitation-related disasters are driven by geomorphological and soil characteristics combined with land-use changes and high rainfall intensity. Approximately 37% of all landslides in South America occur in Brazil, with the South and Southeast regions accounting for 74% of disaster-related deaths between 1991 and 2010 (Alves et al., 2022; Barbosa et al., 2025).

In Brazil, 9 out of every 100 people live in areas classified as disaster-prone, representing approximately 2,471,349 exposed households. Of these, 17.8% include children and older adults. At the global level, the mortality rate from floods, droughts, and storms between 2010 and 2020 was 15 times higher in highly vulnerable regions than in regions with very low vulnerability (Da Fonseca; Da Silva, 2025; Coelho et al., 2024).

2.2 Historical overview of disasters in Brazil

Between 1991 and 2021, extreme events caused losses of US$ 3.8 trillion in the global agricultural sector (Coelho et al., 2024). In Brazil, the Amazon region experienced severe droughts in 1998, 2005, 2010, and 2015–2016. In São Paulo, water restrictions affected the entire metropolitan region between 2014 and 2015. More recently, from 2019 to 2022, the South region faced an intense drought that impacted urban water supply in major cities and significantly reduced agricultural production, resulting in losses of approximately R$ 13.4 billion between 2019 and 2020. During the same period, the Midwest also experienced a major drought that directly affected crop yields. As a result, losses in the agricultural sector of the South and Midwest regions were estimated at around US$ 15.3 billion for the 2022–2023 harvest (Coelho et al., 2024).

Another example of a historical event occurred in 2023, when extreme droughts deeply affected the Amazon basin, leaving people isolated and without access to food and drinking water, in addition to causing the death of fish and turtles due to rising water temperatures and reduced oxygen concentration in areas where fishing is a source of food for the population (Barbosa et al., 2025; Coelho et al., 2024).

The 13% increase in flood records between 2004 and 2009 affected more than 1 million people in 1,433 municipalities, generating an economic cost of approximately R$ 44 billion (Alves et al., 2025). From October 2021 and February 2023, several regions were hit by floods associated with intense rainfall, with various occurrences in Bahia and Minas

Gerais, as well as in Recife and in São Sebastião (SP). These events resulted in more than 500 deaths (Coelho et al., 2024). In addition, the states of Pernambuco and Alagoas suffered from successive rainfall events that triggered severe flooding in coastal basins, leading the government of the state of Pernambuco to declare a state of public calamity in 67 cities, while intense rains left about 30,000 people homeless, caused economic losses equivalent to US$ 1 billion, and resulted in 20 deaths (Coelho et al., 2024).

In 2011, in the Mountain Region of Rio de Janeiro, the largest landslide-related disaster ever recorded in Brazil's history occurred, resulting in approximately 947 deaths and affecting the municipalities of Nova Friburgo, Teresópolis, and Petrópolis (Barbosa et al., 2025). After, new landslides associated with intense rainfall were recorded, with notable occurrences in Petrópolis (RJ) in February and March 2022 (Coelho et al., 2024).

2.3 EM-DAT in disaster analysis

Kyne and Kyei (2022) used EM-DAT to assess the economic impacts of natural disasters, noting that earthquakes and floods cause greater damage. Other studies compare EM-DAT records with databases such as DesInventar, employing descriptive statistics to analyze recorded events and identify discrepancies in damage estimates, concluding that DesInventar records more occurrences but reports lower average damages per disaster than EM-DAT (Panwar et al., 2020).

In the Brazilian context, Nina et al. (2021) conducted a comparative analysis using S2ID, a database created by the National Planning for Risk Management Project (PNGR), examining discrepancies in the absolute growth rate between the two databases. The authors observed that the Brazilian government database includes low-intensity disasters, thereby increasing the total number of records. However, inconsistencies and gaps were identified, including carelessness in data entry, duplicate records, a lack of differentiation between municipalities and events, and the absence of identification of the territorial dimension and incorrect dates (Kuhn et al., 2022).

EM-DAT is a database that records nationally significant events globally and, consequently, adopts stricter criteria for the minimum intensity required for a natural disaster to be recorded (Nina et al., 2021). This methodological selectivity reduces the inclusion of low-magnitude events and minimizes issues such as duplication and record inconsistencies, which provides standardization and international comparability of data. Hence, the choice of

EM-DAT is justified by its methodological consistency, global coverage, and greater reliability in measuring events with higher economic and social impact.

3. Methodology

The methodology is as follows. Subsection 3.1 presents the EM-DAT database, Subsection 3.2 describes the selection criteria used to define the data analyzed, Subsection 3.3 details the classification criteria regarding the regional distribution of disasters, Subsection 3.4 presents the classification terminology, and Subsection 3.5 discusses the study’s limitations.

3.1 EM-DAT

The EM-DAT monitors and records natural and technological disasters, with disasters defined as events that overwhelm local capacity and meet at least one of the following inclusion criteria: (i) ten or more deaths; (ii) one hundred or more people affected; (iii) official declaration of a state of emergency; or (iv) request for international assistance (Cvetkovic et al., 2024; Delforge et al., 2025; Amarasinghe et al., 2026). EM-DAT data can be downloaded through the public portal (https://public.emdat.be), with weekly updates (Delforge et al., 2025). Coverage varies across countries, with higher reliability in regions with disaster loss monitoring systems and international media coverage (Delforge et al., 2025).

3.2 Data Collection

The data were extracted from the EM-DAT database in January 2026. The period from 2000 to 2025 was selected because of improved consistency and standardization of international records. Initially, the sample had 10,640 records. Exclusion criteria were applied to biological disasters and records without geographic reference, resulting in 9,719 occurrences. The initial distribution of data by continent is presented in Table 1.

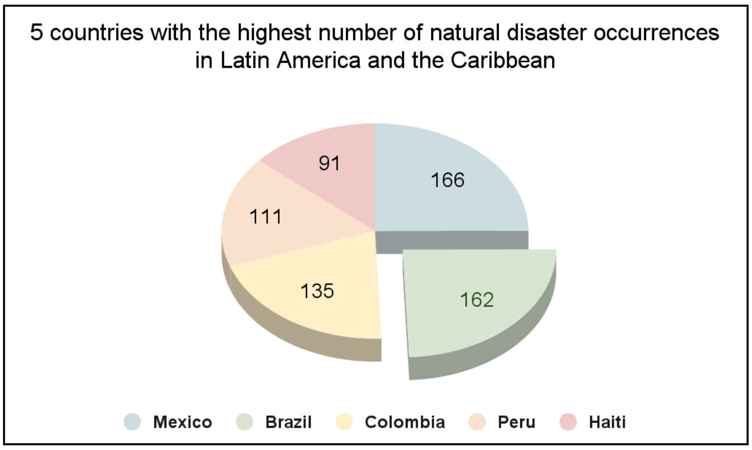
Table 1 – The total number of disasters by continent (2000-2025)

Continent	Number of disasters
Ásia	4001
África	1596
Américas	2384
Europe	1373
Oceania	365
Total	**9719**

Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

The records of disasters in Latin America and the Caribbean were filtered, yielding quantitative values shown in Figure 1. Brazil is the second country with the most records, accounting for 162 events.

Figure 1 – Top 5 countries with the highest number of natural disaster occurrences in Latin America and the Caribbean



Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

3.3 Classification Criteria

The identification of areas with higher recurrence and the exploration of factors associated with regional vulnerability were based on the specific location of each recorded event. States were classified by the location of the disaster, recognizing that a single event may affect more than one federal unit. For regional analysis, events impacting multiple states were disaggregated, with one occurrence counted for each affected state.

3.4 Terminology

To ensure accuracy in interpreting data extracted from EM-DAT, the conceptual definitions established by the Centre for Research on the Epidemiology of Disasters (CRED) were adopted. Event typology was standardized following EM-DAT terminology, grouping events into four main categories based on the origin of the phenomenon: (i) geophysical, (ii) climatological, (iii) hydrological, and (iv) meteorological. Following database standardization, the categories were subdivided into specific phenomena, including slow-onset events such as droughts and heat waves, as well as sudden events such as flash floods, cyclones, and mass movements. The complete relationship between macro categories and subcategories is detailed in Table 3.

Table 3 – Classification of natural disasters by categories and subcategories

Main category	**Type**	**Subtype**
Climatological	Fire	Wildfire

Climatological	Drought	Drought
Geophysical	Earthquake	Ground movement
Hydrological	Flood	General flood
Hydrological	Flood	Flash flood
Hydrological	Flood	Riverine flood
Hydrological	Mass movement	Mudslide
Hydrological	Mass movement	Landslide
Meteorological	Extreme temperatures	Heat wave
Meteorological	Extreme temperatures	Cold wave
Meteorological	Storm	Tropical cyclone
Meteorological	Storm	Extreme weather conditions
Meteorological	Storm	Storm
Meteorological	Storm	Thunderstorm
Meteorological	Storm	Tropical storm
Meteorological	Storm	Cyclone

Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

Human impact indicators were considered as follows: total deaths correspond to the number of confirmed fatalities or missing persons presumed dead as a direct result of the disaster. Injured refers to individuals who suffered injuries or required immediate medical assistance. The affected population comprises individuals who require basic emergency assistance, including food, water, shelter, and sanitation. Homeless refers to those whose homes were destroyed or severely damaged, requiring temporary shelter or resettlement. Finally, the total affected is the sum of injured, affected, and homeless individuals and is used to measure the non-lethal human impact of the disaster.

The definition used to assess economic damage corresponds to the value of total damages adjusted for inflation, for comparative analyses over time. This variable represents the estimated direct economic losses from the disaster, including damage to infrastructure, buildings, agriculture, and other assets, expressed in updated monetary values.

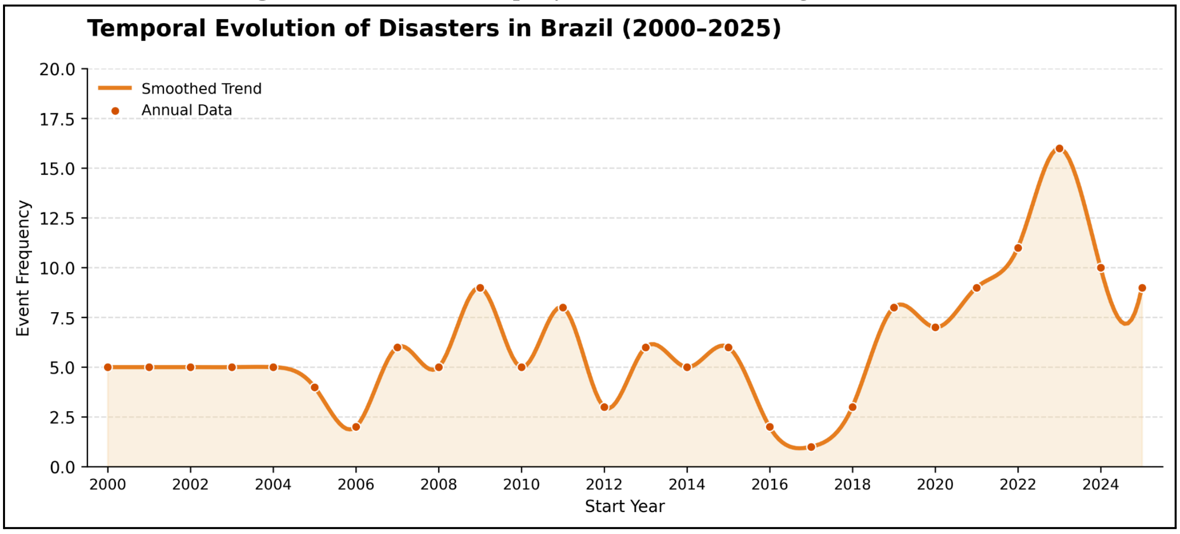
3.5. Limitations

Low-intensity events may not be recorded in EM-DAT due to the database's inclusion criteria (Nina et al., 2021). In small municipalities, events that do not generate national-level impacts, even when they cause local economic losses, are often excluded, leading to an underestimation of occurrences both regionally and nationally. Furthermore, the assessment of financial impacts is constrained by inconsistencies in economic reporting, as many records lack monetary values provided by local authorities. Finally, the reliability of the spatial analysis depends on the quality of the original georeferencing data; therefore, records without defined locations were excluded to ensure the consistency of the identified patterns.

4. Results and discussion

To identify patterns of recurrence and periods of greater criticality, it is essential to observe the quantitative behavior of these occurrences over time. The distribution of total disasters per year, presented in Figure 3, shows a fluctuating trend with pronounced peaks in the most recent period of the series (2000–2025).

Figure 3 – Total disasters per year in Brazil according to EM-DAT



Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

The frequency of events remained stable from 2000 to 2004. However, in 2005 and 2006, records declined, and starting in 2007, fluctuations began, especially between 2008 and 2015. The lowest level of the entire historical series is observed in 2016-2018. Notice that from 2018 onward, a consistent and significant increase in the number of occurrences began. This growth intensified in subsequent years, reaching a peak in 2023, with approximately sixteen recorded events. In 2024 and 2025, values were lower than the peak, but remained above the average observed at the beginning of the series.

The distribution of disasters in Brazil by subgroup, detailed in Table 4, reveals a predominance of hydrological events. Statistical analysis shows that 78.12% of disasters recorded in Brazil are hydrological, with emphasis on the period from 2021 to 2024, marked by a high proportion of hydrological events relative to the total number of disasters recorded. During this period, 2023 stands out as the most critical year, totaling 16 disasters, of which

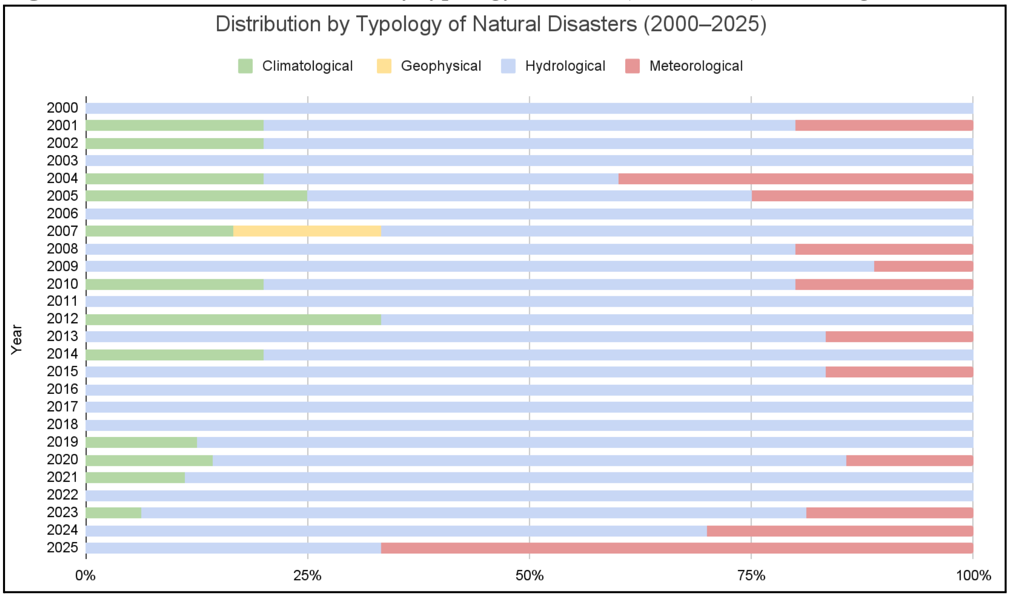
75% were hydrological in nature. In 2022, 11 occurrences were recorded, all of which belonged to the hydrological subgroup. The years 2021 and 2024 maintained the upward trend, with 8 and 7 hydrological events, respectively, consolidating the persistence of these phenomena in the national context. Complementarily, Figure 4 presents the annual evolution of these occurrences, allowing visualization of their historical distribution from 2000 to 2025.

Table 4 – Total disasters by subgroup according to EM-DAT

Subgroup	Quantity	Proportion (%)
Hydrological	125	78,12
Meteorological	22	13,75
Climatological	12	7,50
Geophysical	1	0,63
Total	160	100

Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

Figure 4 – Distribution of disasters by typology in Brazil (2000–2025) according to EM-DAT



Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

Events were classified according to their main typologies. Table 5 presents the distribution of the three most frequent disaster types, highlighting the predominance of water-related events over other categories recorded in the country. Floods emerge as the most critical issue, accounting for 73.13% of the total events cataloged in the EM-DAT database. These are further subdivided into 52 general floods, 52 riverine floods, and 13 flash floods.

Table 5 – Frequency ranking by typology

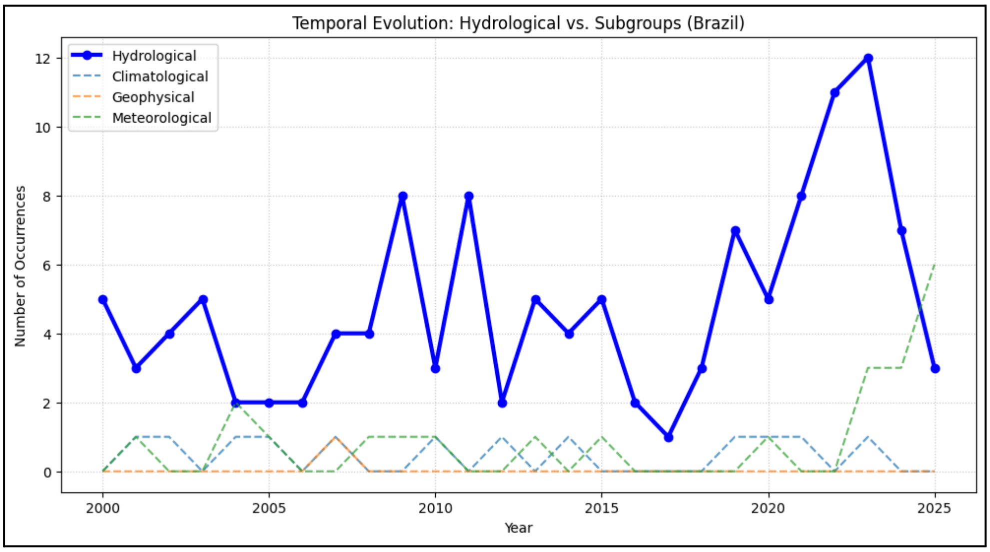
Type	Quantity	Proportion (%)
Flood	117	73,13%

Drought	20	12,5%
Storm	11	6,68%

Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

When analyzing the distribution of disasters by subgroup over the years, a reduction in the number of hydrological occurrences is observed, along with an increase in records of meteorological events, as shown in Figure 5.

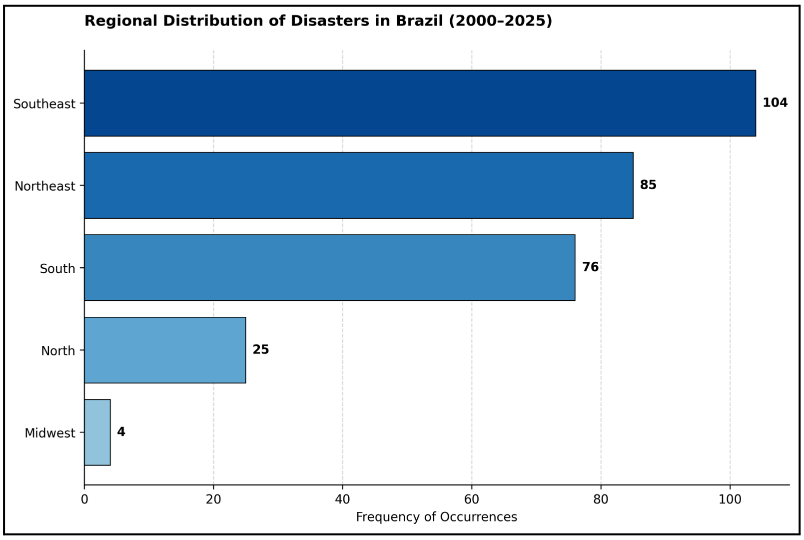
Figure 5 – Comparative temporal evolution between hydrological disasters and other subgroups in Brazil (2000–2025)



Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

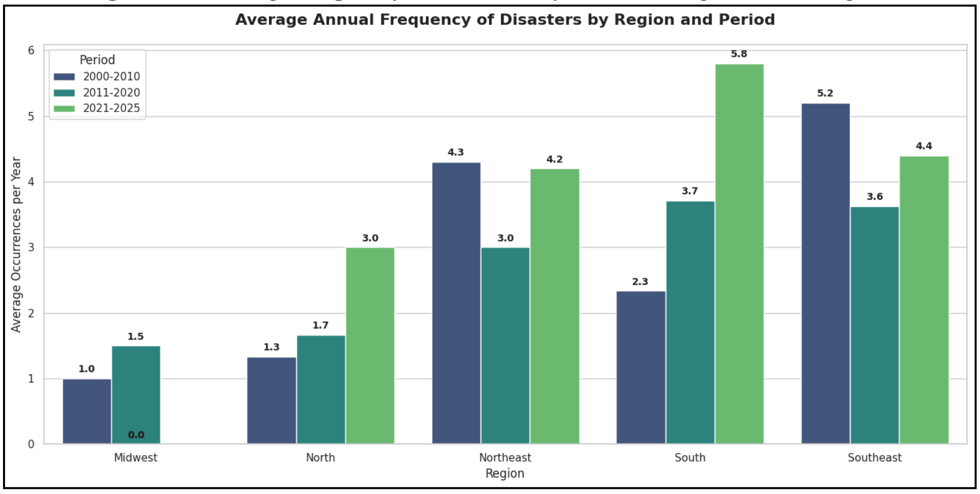
The spatial distribution of events reveals disparities among Brazil's five major regions. Figure 6 shows the cumulative number of records between 2000 and 2025. The Southeast concentrates the highest number of occurrences (104), followed by the Northeast (85) and the South (76). These three regions account for the majority of disasters recorded in the analysis. The North region registers 25 occurrences, a lower frequency than most regions, whereas the Midwest records only 4 events, the smallest share of total disasters. This pattern indicates a strong concentration of events in the Southeast, Northeast, and South, possibly associated with factors such as population density, urbanization levels, climatic conditions, and differences in monitoring and reporting capacity.

Figure 6 – Regional distribution of disasters in Brazil (2000–2025) according to EM-DAT



Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

Figure 7 – Average frequency of disasters by Brazilian region according to EM-DAT

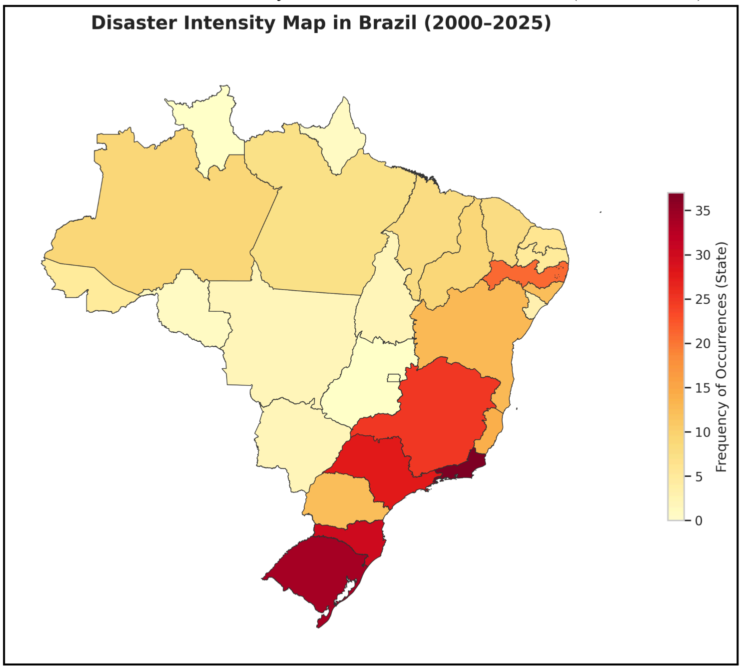


Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

Figure 7 further illustrates the annual distribution of occurrences across the regions. The Southeast presented the highest averages in the first decade, followed by a decline between 2011 and 2020 and a subsequent increase in the most recent period, although without reaching the initial levels. A similar pattern is observed in the Northeast, which experienced a reduction in the second period and a recovery between 2021 and 2025, approaching the values recorded in the first decade. In contrast, the North shows a continuous upward trend throughout the three periods. The most critical scenario, however, is observed in the South, where growth has been both consistent and pronounced. Between 2021 and 2025, the region reached the highest annual average among all regions, consolidating its position as the current epicenter of disaster frequency in the country. It is important to note that the most recent period (2021–2025) covers a considerably shorter time span than the previous intervals. The fact that both the South and the North achieved their highest averages within only five years indicates a possible acceleration in disaster occurrence dynamics.

Disaggregating the data by Federative Unit (state) allows the identification of critical centers of occurrence. Figure 8 quantifies the relative intensity of records in each state, revealing a non-uniform distribution concentrated in areas characterized by specific hydrological and climatic dynamics. Rio Grande do Sul stands out with the highest number of records between 2000 and 2025, while Rio de Janeiro leads within the Southeast region. States such as Santa Catarina, São Paulo, and Minas Gerais present moderate to high intensity levels, forming a corridor of recurrence across the Center-South of the country. In the Northeast, Pernambuco displays a moderate intensity compared to other states in the region.

Figure 8 – Distribution of disasters by Federative Unit in Brazil (2000–2025) according to EM-DAT

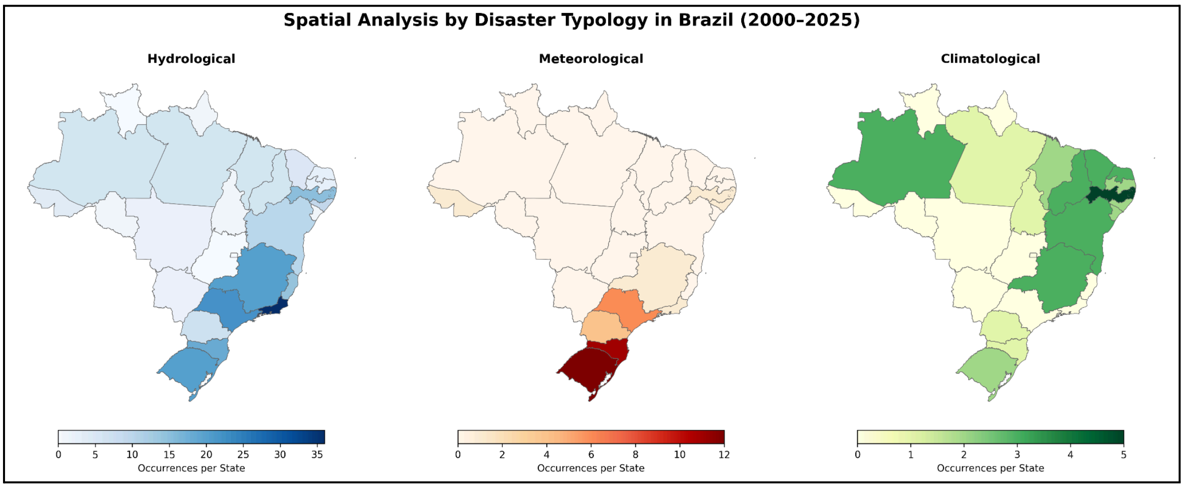


Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

Finally, Figure 9 provides a detailed view of the predominant disaster subgroups, which are useful for understanding the nature of risks affecting each locality. This chart shows how the predominance of hydrological events varies across the country. These events are strongly concentrated in the South and part of the Southeast, with Rio de Janeiro showing the highest number of records, followed by Rio Grande do Sul, Santa Catarina, Minas Gerais, and Paraná. This configuration reinforces the predominance of flood-related occurrences in the Center-South of Brazil.

Meteorological disasters are concentrated in the South, particularly in Rio Grande do Sul and Santa Catarina, while other states show comparatively low recurrence. This pattern suggests a higher incidence of severe storms and wind-related events in this region. Climatological events present a more dispersed distribution, with greater intensity in the North and Northeast and additional presence in the Midwest and Southeast, indicating a broader territorial spread.

Figure 9 – Distribution of disasters by subgroup and Federative Unit in Brazil (2000–2025) according to EM-DAT



Source: Prepared by the authors based on EM-DAT – The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED)

5. Conclusion

This study analyzed the occurrence and spatial distribution of disasters in Brazil from 2000 to 2025. The findings indicate a recent intensification of records, particularly after 2018, with a peak in 2023, and a strong predominance of hydrological disasters, especially floods. Spatial distribution shows greater concentration in the Southeast, Northeast, and South regions, with recent emphasis on the South. States in the Cent

er-South form a high-recurrence corridor due to population density, urbanization, and environmental characteristics. Database limitations, especially incomplete economic data and potential underreporting, suggest that observed declines in certain periods may reflect data gaps rather than actual reductions in disasters. Future research should incorporate social and institutional conditions to assess whether disasters are being properly identified and recorded.

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