

# HYDROGRAPHIC REGIONS AS A UNIT FOR ANALYZING DISASTER THREATS IN PARÁ

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## ABSTRACT

Every year, the Amazon region experiences frequent and intense natural phenomena, called extreme or adverse events, with the capacity to cause unpredictable and incalculable damage and losses to the affected populations, natural ecosystems and basic infrastructures in urban and rural areas. In this context, the Fire Department of the State of Pará and the State Coordination of Civil Defense (CEDEC/CBMPA) promoted the identification of threats in the State of Pará, considering its Hydrographic Regions (RHs). The data used were from the historical series of federal recognition of emergency situations and states of public calamities from the Brazilian Atlas of Natural Disasters (ABDN), until 2012, and from this until 2020 from the Integrated Disaster Information System (S<sup>2</sup>ID). CEDEC/CBMPA launched the Map of Multiple Threats of the State of Pará (M<sup>2</sup>A-Pará) type document, considering the scale of the seven RHs of Pará, to assist in the identification of extreme events, and, consequently, those that require priorities for prevention and risk management actions. The multiple threats by HRs in M<sup>2</sup>A-Pará, identified over more than a decade, bring to light the discussion about planning and managing disaster risks in the Pará Amazon proactively, in order to establish mitigating actions based on their past extreme events, which represents a type of warning with the purpose of reducing human and/or material, economic or environmental losses.

**Keywords:** Natural disasters, Civil Defense, Risk management.

## 1. Introduction

The Hydrographic Regions (RHs) are the scene of extreme events that can cause harm to populations living in environmentally vulnerable and high-risk occupations. Human damage, such as deaths, injuries, illnesses, homelessness, displacement and disappearances, are a consequence of extreme events in the RHs of Pará, which occur due to extreme events, resulting from the rainfall regime in Pará or drought, which, in certain periods, cause serious harm to the population.

Losses, in turn, refer to changes in economic flows resulting from the disaster, which usually continue until full economic recovery and reconstruction, and may last for several years. They can be classified as private, when they impact sectors of the economy, such as commerce and agricultural production, and public, when measured through the reduction in tax collection, for example. They are necessarily estimated in monetary values.

The State Civil Defense and Protection Policy (PEPDEC), Law No. 9207 of January 13, 2021, establishes the use of the State's hydrographic basins or Hydrographic Regions (RH) as a unit of analysis for disaster prevention actions. In this scenario, PEPDEC - 2024 understands that Hydrographic Basins (BH's) or Hydrographic Regions (RH's) are analysis scales composed of

groups of adjacent hydrographic basins, with similar natural, social and economic characteristics, which should guide the planning and management of natural disaster risks.

Material damage is represented by the quantity and value of elements damaged or destroyed in whole or in part by the disaster. Its cost is estimated in replacement or physical repair, considering market values prior to the disaster.

Thus, PEPDEC/21 recommends that BH's be used to monitor disasters, but, in much of the literature, there is no exact judgment of this system. However, Law No. 9,207 establishes that disaster management must follow Law No. 9,433, of January 8, 1997, which defines the National Water Resources Policy (PNRH), since extreme events require the shared management of bodies or institutions that are involved in disasters.

The main objective of this research is to identify and quantify the natural disasters that occurred in the State of Pará between 2003 and 2018, with the following objectives: to identify and classify recognized and recurring extreme events; to classify the Hydrographic Regions (RH) with recognized and recurring extreme events; and, finally, to prepare a Multiple Threat Map of the State of Pará (M<sup>2</sup>A – Pará) to assist in the management of disaster threats in the Amazon region of Pará.

## 2. MATERIALS AND METHODS

The data used were from the historical series of federal recognition of emergency situations and states of public calamity Brazilian Atlas of Natural Disasters (ABDN), up to 2012, and from this point until 2020 of the Integrated Disaster Information System (S<sup>2</sup>ID).

The ABDN from 2003 to 2012 and the Recognized Emergency Situations (RES) decreed by the Ministry of Integration (MI) between 2013 and 2018 are available on the MI page, and the extreme and constant events in the disaster processes of the Disaster Information Forms of the MI and the State Coordination of Protection and Civil Defense of Pará (CEDEC) were analyzed.

It is worth noting, however, that the records are made directly by the municipalities and states, without a subsequent qualitative analysis, as is carried out in the other databases mentioned here, being susceptible to different interpretations, depending on the understanding of the person responsible for the record. This, added to the inherent difficulty of, in many cases, identifying a prevalent cause for a disaster with several elements present (flooding, floods, windstorms, landslides, etc.), can lead to variations in the classification of the disaster typology.

ABDN and S<sup>2</sup>ID allowed us to record, with period options, detailed regions of interest, summaries of relevant occurrences of emergency situations and states of calamity for 30 years in each municipality, compiled in xls format. Thus, information/data from the records of emergency situations and states of public

calamity are from the monthly and annual historical series of the State of Pará.

After meetings with technicians from CEDEC in Pará, specifically with professionals from the Community Support Division (DAC) and Operations Division (DivOp), a Geographic Database (BDG) was created through the Geographic Information System (GIS) QGIS and a Map of Multiple Threats of Pará (M2A – Pará) was prepared by HR, considering that disasters that occurred in the past have a greater probability of repeating themselves in the future.

To define the limits of the RH of Pará (Figure 2), the geographic limits of the watersheds of each region were considered, according to the geographic, economic and historical characteristics.

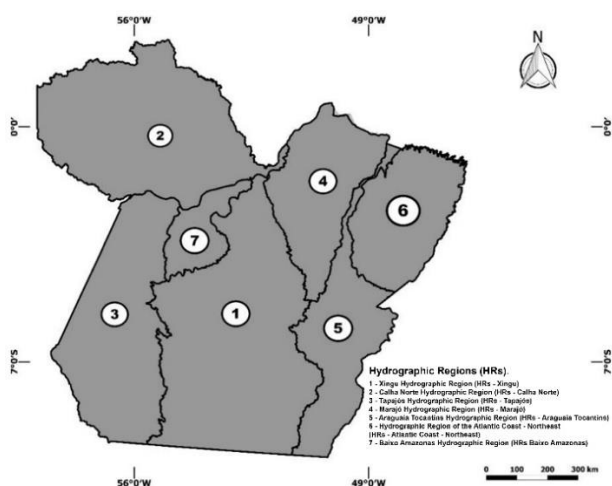


Figure 1. Hydrographic regions of the state of Pará

The issue of the scale of disaster studies in municipalities is considered by PEPDC - 2024 as systemic, as it involves several natural, social, economic, cultural and political elements, which form the different environmental systems, bases for Disaster Risk Reduction (DRR).

### 3. RESULTS

The concept of threat refers to the danger or possibility of danger that an extreme situation can generate, and in certain circumstances can affect the lives of people nearby (CASTIEL et al., 2010). The threats presented in this work are considered a hidden danger, described by COBRADE, divided into four hydrographic regions that have affected this territory more than four times, which significantly reduces the response capacity of local public managers to return to normality. In other words, the threat can be understood as a warning to life (FRANCA, 2015; PEREIRA; SZLAFSZTEIN; ARAÚJO, 2016).

From the tabulation, classification and analysis of the frequencies of extreme events, disaster and emergency processes recognized by the National, State and Municipal Civil Defense of the State of Pará between 2003 and 2018, recurring extreme events were identified in all Hydrographic Regions (RH) of Pará, characterizing the Regions and their Multiple Characterizations (Figure 2).

In the 1st RMAs (RH – Xingu), with an area of 335,316.04 km<sup>2</sup>, there were 31 cases of emergency declared and approved by the MI in the period analyzed. The occurrences of heavy rains, floods and flash floods are the most frequent in this Human Resources area, mainly due to the "Amazonian winter", which represents 23% of the Recurrent Emergency Situations (SER) in the State of Pará (Figure 2).

The second RMA (2nd RMA) (RH - Calha Norte) has an area of 21.8% of the state, consisting of the basins of the Nhamundá, Trombetas, Cuminapanema, Maecurú, Pará and Jarí rivers, which together accounted for 36 SER in 15 years, representing 18.8% of the extreme events in Pará. In this RH, maritime transport disasters (shipwrecks) stand out, which produce a large number of victims due to gales during heavy rainfall in the rivers of the Amazon, such as the shipwreck of the ship Haidar, which sank with five thousand live cattle in the port of Vila do Conde, in Barcarena, northeast of Pará (Figure 2).

The third RMA is the Tapajós river basin with the Tapajós, Teles Pires, Jamaxim, São Benedito and Arapiuns rivers, where 15.42% of the SER were caused by rainfall and water accumulation, resulting in flooding, downpours and continental erosion.

The 4th RMAs (RH – Portel – Marajó), composed of the municipalities of Santarém, Placas, Uruará, Rurópolis, Prainha, Medicilândia and Porto de Moz, had 8 SER over the Tocantins River basin up to its mouth in the Atlantic Ocean. In this RH, shipwrecks are also cyclical, in addition to coastal erosion events (Figure 2).

The 5th RMAs (RH – Araguaia – Tocantins) concentrated the damage caused by floods and downpours, in addition to bridges, which are other structures that were greatly affected in this RH, such as the rupture of irrigation dams in the municipality of Paragominas, which generated a Working Group for Studies and Safety of Dams in the State of Pará, which reinforced the need for constant and efficient monitoring, as well as control and inspection of these structures (Figure 2).

The 6th Multiple Threat Region (RH – Atlantic Coast – North) comprises 24.2% of the SER in Pará, with 60 disaster cases recognized in this territory by the DCN and CEDEC in the period analyzed. According to COBRADE, the RH Atlantic Coast – North presents a greater variety of SER, with emphasis on urban fires and hazardous products registered by the COMPEDEC most active in this region, such as Belém and Marituba, which account for 1.8% and 1.5% of this type of event, respectively.

The occurrence of recurring outbreaks of infestations that alter the ecological balance of a region, river basin or biome affected by their predatory actions is also considered in the 6th RMAs, such as the new Coronavirus. The other threats presented in the 6th RMAs of M2A-Pará are from the Technological Group of types: hazardous products, urban fires, dam rupture, maritime and waterway transport and, finally, the collapse of civil structures. The bridge over the Moju River, which connects the capital to the northeast, south and southeast regions of Pará, caused a loss of R\$ 100 million for the region, since dozens of cargo vehicles had difficulty circulating.

Finally, the 7th RMA (RH – Lower Amazon), composed of the basins of the Anapu and Pacajá rivers, the basins of the western region of Marajó and eastern Marajó, with 8 SE approved and recurring for the same period, representing only 4% of the SER, mainly due to heavy rains with the potential to generate social, economic and environmental impacts (Figure 2).

In general, each RMA was characterized with SER, however, the fact that a certain event has not yet occurred in some RMA does not mean that it will not occur, such as, for example, disasters caused by viral infectious diseases and other infections legitimized with SE in the 6th RMA, resulting from contamination of the environment, water, soil and vegetation, lack of waste management in the landfill, and today due to COVID-19.

## 5. CONCLUSION

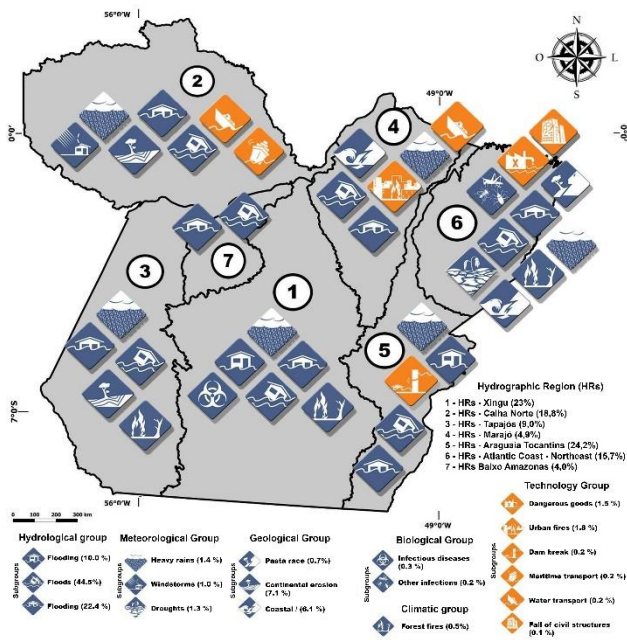
Mapping the various threats should be done with the aim of preventing them from becoming a crisis, which could harm the functioning of society and cause major material, human or environmental damage. In this case, it is recommended that public managers use M2A – Pará as a resource to save lives and prevent tragic losses, as recommended by Law No. 12,608/2012, art. 4. In addition, it is an important instrument in the development of government policies that consider risk management a priority.

Global climate change must be considered when analyzing and predicting extreme weather events in the Amazon. The River Basin Regions are the main targets of natural disasters. It is the responsibility of civil defense agencies to develop state contingency plans based on previous extreme events, allowing public managers to understand the occurrence of these events in the present day, representing a type of warning for communities, with the aim of minimizing human, material, economic or environmental losses.

In this specific case, in-depth analyses of various threats are necessary, based on the historical statistics of each hydrographic region, so that the historical series of extreme events represent a warning to communities or society in the Amazon region. Thus, M2A-Pará can be part of the planning of the civil protection and defense body focused on prevention, mitigation and preparedness actions, with initial emphasis on the analysis of variables of extreme events in Pará, which allows establishing relationships cause and effect of the risk element.

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**Figure 2.** Multiple Threat Map of the State of Pará (M2A-Pará).

According to Vaz (2015) and Pamplona (2016), Law No. 12,608, 2012, art. 4 provides for the “adoption of Regions or hydrographic basins” as the unit of analysis, in this sense the Multiple Threats Map of Pará (M2A-Pará) (Figure 2) by Hydrographic Regions with cyclical threats in Pará, should be considered as a summary instrument of guidance for the state and municipal coordinators of protection and civil defense, in order to define strategies to reduce the risks of their hydrographic region in the PEPDC - 2024.

## 4. DISCUSSION

The distribution of recurring disasters (threats) through M2A-Pará can guide the 118 Municipal Civil Defense and Protection Coordinators (COMPDEC), 29 of which are in the RH Costa do Atlântico – Norte (6th RMAs), followed by the 5th RMAs (RH Tocantins-Araguaia), with 25 COMPDECs, which were the ones that managed to recognize the most SE (24%) of the disasters that occurred in the state of Pará. H Portel-Marajó (4th RMAs) and Xingu (1st RMAs) have 11 COMPDECs each, while RH Calha Norte (2nd RMAs) has 9, RH (3rd RMAs) has 8 and RH do Baixo Amazonas (7th RMAs) has only three COMPDECs.

Natural disasters in the Amazon attract the attention of the national and international scientific community, but these events are generally seen as a media spectacle. Given this scenario, the various threats in the Amazon are a cause for great concern, since they can cause harm and damage to vulnerable populations in emergency or public calamity situations that can turn into true catastrophes.

The comprehensive approach to cyclical disasters in Pará allows for a change in the culture of risk management in municipalities, which represents an additional risk for the Amazonian population and for municipal and state public managers, which represents an advance in the way municipalities deal with the issues of cyclical disasters.

The various threats identified over more than a decade by hydrographic region bring to the fore the discussion about monitoring disasters in the Pará Amazon, with the aim of adopting preventive measures based on previous extreme events, which represents a form of protection to minimize human, material, economic or environmental losses.

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