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MILITARY LOGISTICS DEPLOYMENT IN DISASTER SCENARIOS

O EMPREGO DA LOGÍSTICA MILITAR NO CONTEXTO DE DESASTRES

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Abstract

The climate disaster that struck Rio Grande do Sul in 2024 stands as the most devastating ever recorded in Brazil, unprecedented in both magnitude and scope. The complexity of the crisis demanded an unprecedented relief operation from public authorities, underscoring the strategic role of logistics in mitigating the consequences of natural disasters. This article outlines and analyses the logistical capabilities mobilised and employed during this event in southern Brazil by examining a case study using the DOTMLPF P framework, a methodological tool to assess military logistics capabilities. The findings revealed that the disaster response efforts were coordinated among various government agencies, involved multiple actors and resources and integrated multidisciplinary operations, highlighting the importance of interagency cooperation and coordinated action under emergency conditions.

Keywords: Military logistics; natural disasters; state capabilities; DOTMLPF-P.

Resumo

O desastre climático ocorrido no Rio Grande do Sul, em 2024, configurou-se como o mais impactante já registrado no Brasil, sem precedentes quanto à sua magnitude e abrangência. A complexidade da crise exigiu uma operação de socorro ao Estado atingido de dimensões inéditas por parte dos órgãos públicos, ressaltando o papel estratégico da logística na mitigação dos efeitos de desastres naturais. Este artigo tem como objetivo analisar as capacidades logísticas mobilizadas e empregadas no desastre climático ocorrido no sul do país, por meio de estudo de caso estruturado com base na ferramenta DOTMLPF-P, direcionado à análise dos meios logísticos militares. A análise revelou uma resposta articulada por parte do Estado, envolvendo múltiplos atores e recursos, caracterizada por ações coordenadas e multidisciplinares, evidenciando integração interagências e estruturação de operações em cenários de emergência.

Palavras-Chave: *Logística militar; desastres naturais; capacidades estatais; DOTMLPF-P.*

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1. Introduction

Logistics is an essential component of productive systems. As globalisation has accelerated, it has become indispensable in the management of the flow of goods and services (Cuppini et al., 2013). The role of logistics spans all social and economic sectors and supports the functioning of public and private organisations. Without efficient logistics operations and activities, organisations would not be able to sustain their processes or complete their tasks, which would consequently destabilise the normal functioning of the state (Boratyn et al., 2024).

Under certain conditions, unforeseen events can overwhelm state capacities, reveal weaknesses and aggravate social and structural vulnerabilities, heightening public demand for an effective response (Bermúdez-Tápia, 2018). Disasters present serious threats that can lead to widespread socioeconomic disruptions, and their repercussions are intensified by extreme conditions, infrastructure gaps, lack of preventive measures and social inequality. Responding to these events requires robust logistics strategies aimed at minimising damages and restoring essential services (Barino et al., 2024).

Efficient disaster response logistics requires the strategic use of resources at all levels, supported by well established processes (Bogdanowa, 2024). Logistics support should be guided by response plans to ensure efforts are coordinated and resources are allocated efficiently during emergencies (Łapeta, 2013). In Brazil, disaster response operations are coordinated by the states through the National System of Civil Protection and Defence (SINPDEC), under the National Secretariat for Civil Protection and Defence (SEDEC), which is part of the Ministry of Integration and Regional Development. Local authorities are responsible for planning and executing operations, providing resources and defining operational procedures (Brazil, 2023).

The academic sources distinguish between military operations that support civil authorities within national borders and those carried out as part of international humanitarian missions. Domestically, the military is usually engaged in disaster response and public security operations, which are governed by national legislation and operational guidelines, rather than by the humanitarian principles that apply in international armed conflicts. In international humanitarian operations, the military is deployed on a temporary basis, as a last resort, and interventions must obey international protocols and respect the principles of neutrality, impartiality and independence (Alves, 2018; Mardini, 2022).

Disaster logistics is a subfield of logistics that encompasses plans, preparedness, regulations and measures for disaster scenarios. It employs a systematic approach to manage processes and respond effectively to extreme events. This requires a logistics support system that integrates intangible flows, which include aid delivery, health services, displacement, accommodation, protection and information, as well as the materiel resources that support those flows (Sventeková & Dvǒrák, 2012).

Logistics plays eight critical roles in climate-related disasters: i) as a cause, by generating pollutant emissions; ii) as a decarboniser, through the implementation of mitigation strategies;

iii) as a victim, given its vulnerability to extreme events; iv) as an adaptor, because it requires adapting infrastructure and systems; v) as a facilitator, by supporting mitigation efforts in other sectors; vi) as a rescuer, by supporting communities during crises through humanitarian logistics; vii) as a remover, by participating in carbon sequestration initiatives, and; viii) as a geo engineer, if drastic measures are needed to influence the climate (Mckinnon, 2024).

The current climate landscape has reshaped disaster dynamics, creating crises in previously unaffected regions and exacerbating impacts in areas already prone to such events (Paim, 2022). In Brazil, the term "disaster" encompasses a broad spectrum of phenomena, often associated with climatic extremes, from excess water events, such as floods, landslides, flash floods and river overflows, to water scarcity, including droughts and wildfires, all of which present considerable challenges for relief efforts (Alves et al., 2024).

The 2024 climate disaster in the state of Rio Grande do Sul is an example of this new dynamic. Intense and prolonged rainfall led to devastating floods, resulting in estimated losses of R$ 13.3 billion: R$ 2.6 billion in the public sector, R$ 6 billion in the private sector and R$ 4.7 billion in the housing sector (National Confederation of Municipalities – CNM, 2024). The crisis was the most severe in Brazil's recent history, comparable in scale and impact to Hurricane Katrina, which struck New Orleans in 2005. While Katrina affected approximately 1.2 million people, displaced 400,000, covered an area of 2,400 km² and resulted in 1,392 deaths, the Rio Grande do Sul disaster affected 1.3 million people, displaced 580,000, covered 3,800 km² and led to 183 deaths (Southern Military Command – CMS, 2025).

In crisis and disaster scenarios, robust, responsive logistics processes are essential to swiftly mobilise resources, sustain the flow of goods and services and support rescue operations (DHS, 2021; DOD, 2022). Well organised logistics systems help identify gaps, enable the delivery of strategic resources, improve coordination between civilian and military agencies and increase the efficiency of operations (NGB, 2023; FEMA, 2021). Resilient logistics make it possible to minimise disruptions by restoring critical services such as healthcare, energy, transportation and communications (NIMS, 2017).

This article examines the logistical capabilities deployed by the Brazilian State during the climate disaster in Rio Grande do Sul between April and July 2024. The study seeks to answer the following question: How did military logistics support the response to the 2024 climate disaster in Rio Grande do Sul? The question was explored through a case study, which was analysed using the DOTMLPF-P model (*Doctrine, Organisation, Training, Materiel, Leadership, Personnel, Facilities, and Policy*), as proposed by Tabacow & Cardoso (2024)[1]. The justification for this applied research study is the need to better understand military logistics in disaster scenarios outside combat environments. By systematically analysing data

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1 Drawing on the findings of a systematic literature review, this proposal introduces the DOTMLPF-P model as a methodological tool for analysing military capabilities, in which capability is defined as a system composed of interdependent components: Doctrine, Organisation, Training, Materiel, Leadership, Personnel, Infrastructure and Policy. Examining how these components interact helps identify gaps, redundancies and operational requirements. Applying this framework to monitor and improve military capabilities enables more strategically aligned decisions and optimises resource allocation to meet operational needs.

and mapping logistics activities, the study identifies patterns, best practices and capabilities that contribute to state action. The DOTMLPF-P model provides a structured tool to assess how each logistics component was operationalised. This article is relevant because it documents the actions executed during the crisis. This information can be used to assess and improve logistics and operational protocols.

The study is organized into five chapters. The first chapter introduces the context, the research problem and the study's objectives, classification, justification and relevance. The second chapter establishes the theoretical and conceptual foundations, focusing on Logistics Theory. The third chapter describes the methodological approach and research procedures. The fourth chapter presents the case study and how the DOTMLPF-P model was applied. The fifth and final chapter contains the study's findings.

2. Logistics - theoretical and conceptual framework

Throughout history, scientific progress has been closely tied to logistical principles. Notable examples include the invention of the wheel, Archimedes' use of the lever and the Roman Empire's road and aqueduct infrastructure. Ancient civilizations like the Phoenicians employed logistical practices by strategically positioning forces to protect trade routes, which required route planning and prior knowledge of existing routes. These practices represent the earliest documented professional applications of logistical techniques. Although logistics originated in military contexts, it has since evolved to incorporate new elements and expand its relevance beyond warfare (Almeida & Schlüter, 2009).

While logistics, as both an academic discipline and a practical field, has different definitions in military and business settings, the emphasis is always on the efficient delivery of goods through structured, system based processes. (Barino & Cardoso, 2023). Likewise, how the term "logistics" is interpreted depends on the context and area of application (Zwoliński, 2018). Broadly speaking, logistics involves the coordination of storage, transportation, order processing, handling and packaging to meet customer demands by ensuring a continuous, integrated flow of operations (Ballou, 2006).

The literature distinguishes between two types of logistics, military logistics and business logistics, which differ in several aspects. The aim of military logistics is to ensure the operational readiness of military forces by delivering combat support and sustaining operations in hostile environments. Its tasks include maintaining weapon systems and evacuating casualties. In contrast, business logistics prioritises profitability, emphasises strategic partnerships, physical distribution and customer service while managing challenges such as demand fluctuations and intercompany collaboration. While military logistics aims to sustain military operations, business logistics is driven by service levels and cost efficiency (Moura & Cardoso, 2024).

Within business logistics, humanitarian logistics presents the most complex challenges, as it involves mobilising people, resources and expertise to help victims of disasters and emergencies. This complexity stems from multiple factors: chaotic environments, urgency, diverse stakeholders, human suffering, unreliable data, unpredictable demand, high operational risk and lack of trained personnel (Van Wassenhove, 2006; Heaslip & Barber, 2016). This type of logistics requires the rapid deployment of resources, infrastructure and expertise to ensure swift disaster responses and operational continuity (Van Der Vegt, 2015). Those resources include transportation, food, water, medicine, and emergency equipment (Adiguzel, 2019).

Combining elements of civilian and military logistics, humanitarian logistics (a type of logistics that focuses on managing civilian crises) integrates the efforts of multiple organisations into a coordinated response (Nowak & Nowak, 2008). In non conflict scenarios, such activities aim to deliver humanitarian assistance to communities affected by disasters. Unlike military operations, which are characterised by the use of force, humanitarian logistics operations protect human rights by delivering aid impartially and ensuring that all individuals receive the support they need (Sierra Zamora & Rueda Serbousek, 2024).

Although the National Civil Defence Policy (PNDC) does not explicitly define logistics, it addresses its role in supporting Civil Defence operations. Its activities consist of planning and executing public procurement contracts to supply goods and services for emergency response, managing the materiel and human resources needed to support affected communities and the overseeing the transportation, storage and distribution of emergency supplies. It also supports the operational infrastructure of Civil Defence agencies during emergencies or public disasters. In essence, logistics refers to the coordination of actions and resources needed to support disaster prevention, emergency response and reconstruction operations (Brazil, 2007).

Supporting documents issued by the National Civil Defence Secretariat, such as the *Glossário de Defesa Civil Estudos de Riscos e Medicina de Desastres* [Glossary of Civil Defence, Risk Studies and Disaster Medicine], describe logistics from three perspectives: institutional, operational and technical. At institutional level, logistics is interpreted from a national and military perspective that encompasses planning, procuring and managing the resources required to sustain security and defence operations, integrating different agencies and structures to support operations during emergencies. At the operational and technical levels, its activities include supply, maintenance, procurement and transportation, as well as the organisation of logistics bases, triage stations, and distribution, supply and relief infrastructure to support disaster operations (Ministry of National Integration, 2019).

In Civil Defence operations, logistics is managed through the Operations Command System (SCO), with a logistics director responsible for coordinating the provision of support, resources and services. The system is divided into two main units: support and services (Oliveira, 2009). The structure is visually represented in Figure 1.

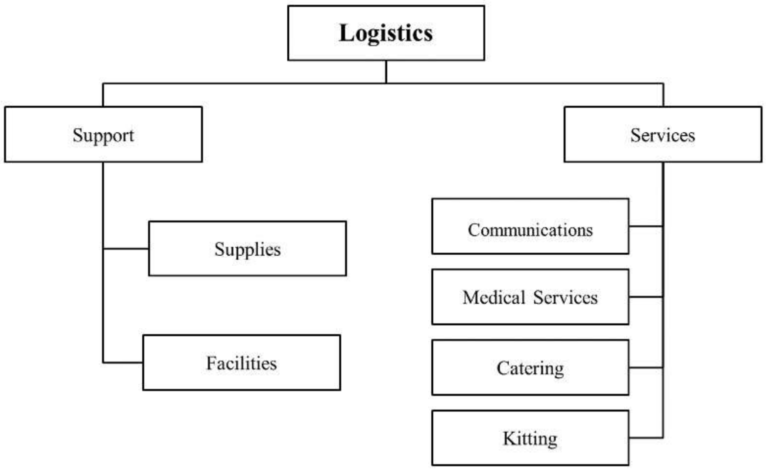

Figure 1 – Civil Defence Logistics Organisation
Source: Oliveira (2009).

The logistics area manages the materiel, services and facilities needed for operations. It is subdivided into two units: support and services. The support unit manages the requisition, reception and distribution of materiel, as well as the operation of bases, camps and command posts. The services unit oversees communications, food and medical services, ensures that contact networks are operational, manages the delivery of meals and drinking water, and provides triage, emergency care and psychological support. It also coordinates the assembly and distribution of first aid, hygiene, meal and shelter kits based on operational needs (Oliveira, 2009).

In the face of increasingly complex operational environments, particularly in terms of logistics, the importance of dual use military capabilities (capabilities that serve both military and civilian purposes) is undeniable (Wolfenstein, 2025). Civilian infrastructure, systems and logistics resources are fundamental in supporting the mobility, resilience and readiness of allied forces during peacetime and crises. They help optimise investments, increase interoperability and enhance responses to humanitarian emergencies, natural disasters and hybrid threats, making the Armed Forces more adaptable to multidimensional challenges (North Atlantic Treaty Organisation - NATO, 2023; Czerniakiewicz, 2025). When deployed to respond to natural disasters, the Brazilian Armed Forces are integrated into an interagency effort that coordinates civilian and military agencies to meet operational demands. This framework includes the Brazilian Navy, Army and Air Force, Civil Defence agencies at various levels and various ministries, government bodies, public security forces, private sector partners and NGOs. In this context, logistics is a collaborative process that aligns resources from military branches and civilian entities to ensure cohesive and agile disaster response operations (Brazilian Ministry of Defence, 2016).

Measuring logistics activities and evaluating their impact remains a challenge, largely due to persistent research gaps. The lack of reliable data makes it difficult to measure the volume of logistics activities to assess their economic impact and link those activities to the theoretical advancement of logistics as a discipline. In the corporate sector, logistics activities are usually measured through data on the physical operations involved in logistics flows, including transported volumes, types of goods, geographical coverage, labour requirements and financial costs (Klaus, 2009).

In military contexts, measuring logistics consists of assessing operational capacity as the outcome of interactions between equipment, trained personnel and the logistical support required to execute tasks. This evaluation considers factors such as doctrine, organisational structure, technical expertise, materiel, leadership, human resources, facilities, information flows, interoperability and operational support. Building these capabilities requires understanding the operational environment to ensure available resources align with mission requirements (Brick, Sanches & Gomes, 2017).

The DOTMLPF-P model is one of several methodological tools that offer a framework for organising and assessing military capabilities. By analysing interdependent components in a systematic manner, the model identifies gaps and proposes solutions that are not limited to the acquisition of equipment, but also address existing dimensions. Used in both military and civilian contexts, especially in complex logistics operations, the DOTMLPF-P framework helps define operational and structural requirements. This integrated approach enables joint planning, drives system modernisation and addresses identified gaps by ensuring decisions are aligned with real-world operational demands (Tabacow & Cardoso, 2024).

3. Methodology

This study employs a qualitative and applied approach guided by an exploratory objective and grounded in inductive reasoning, using a case study methodology supported by quantitative data from the event under analysis. By combining the interpretative depth of qualitative insights with the objectivity of quantitative metrics, this mixed approach explores different dimensions of the phenomenon, providing a more comprehensive understanding than either qualitative or quantitative approaches could achieve in isolation (Creswell & Clark, 2013).

Qualitative research is particularly well suited to studies that explore complex systems such as logistics and supply chains, as it accounts for the contextual contingencies, variations and dynamic interactions that characterise these environments. This method is widely applied in business, social sciences and organisational studies because it allows for multidimensional analyses (Karlin, 2004).

This investigation was informed by established theories and methods. In terms of purpose, the research is: i) exploratory, given the scarcity of studies on logistical capabilities in climate-related disasters; ii) descriptive, as it seeks to identify key features of unpredictable events that commonly result from such disasters; and iii) methodological, by proposing models and procedures that draw on the case study to map and analyse operational logistics capacities (Vergara, 2016).

A case study is an empirical research method designed to investigate contemporary phenomena in real world contexts. It is particularly well suited for addressing research questions that begin with "how" and "why." This study adopts a single case design, which allows for an in depth exploration of complex phenomena, especially when they involve rare, critical or revelatory events. Such cases are especially useful for developing hypotheses in emerging areas of knowledge (Cauchick et al., 2011; Yin, 2017).

The case study method follows a set sequence of stages that supports continuous review during the research (Yin, 2017). A diagram of these stages is provided in Figure 2.

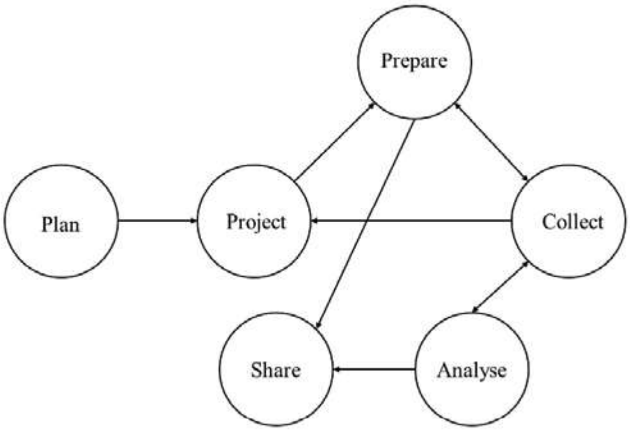

Figure 2 – Visual diagram of the case study method
Source: Yin (2017).

The methodology adopted in this article follows six sequential stages as proposed by Yin (2017): i) plan; ii) design; iii) prepare; iv) collect; v) analyse; and vi) share.

The first stage, "plan", consists of adapting the case study method to the research objective and providing a rationale for its selection. This approach was considered appropriate for analysing the logistical capabilities mobilised by the Brazilian State during the climate disaster in Rio Grande do Sul between April and July 2024.

In the second stage, "project", the study is organised around five components: i) the research questions; ii) the proposition (where applicable); iii) the unit(s) of analysis; iv) the logic linking the data to the propositions; and v) the criteria for interpreting the findings. In this study, the research question focuses on how to assess military logistics in non combat scenarios. The unit of analysis comprises the military organisations that operated under the Joint Command of Operation Taquari II, which was activated in response to the disaster. The logic of adequacy to standard was applied to link the collected data to the study's proposition. Real-world data were used as interpretive criteria to develop insights that support, complement or challenge existing literature.

The third stage, "prepare", consists of developing a research protocol to define the theoretical framework, the methodological procedures and testing mechanisms to guide the researcher during the data collection and analysis phases and in the overall execution of the study.

The fourth stage, "collect", involves gathering data from multiple sources. Two categories of sources were consulted: i) non-academic literature, including institutional publications, bulletins and official reports; and ii) documents issued by the Brazilian government, the Armed Forces, other state institutions and scientific studies. The data were collected between January and May 2025. All sources used in this research are publicly accessible.

The fifth stage, "analyse", consists of verifying, categorising, classifying or recombining the collected data. A standardisation technique was applied, using the benchmarks identified in the theoretical and conceptual framework and the DOTMLPF-P model as a forecasting tool.

The sixth and final stage, "share", focuses on presenting relevant insights obtained from the study, which are detailed in the findings chapter.

The DOTMLPF-P framework (Doctrine, Organisation, Training, Materiel, Leadership, Personnel, Facilities, and Policy) was used to analyse a single case study, as suggested by Tabacow & Cardoso (2024). The analysis focuses on Capability-Based Planning (CBP), which involves the strategic allocation of resources and efforts to meet the specific demands of each operational scenario. The acronym represents the following domains:

Table 1 – DOTMLPF-P components

Acronym	Component	Description
D	Doctrine	How forces operate, including principles, tactics, and strategies.
O	Organisation	How forces are organised to operate.
T	Training	How military personnel are trained to operate.
M	Materiel	Equipment and supplies required for operations, without necessitating new development.
L	Leadership and Education	Development of military leaders at all levels, from basic to strategic command.
P	Personnel	Availability and management of qualified personnel.
F	Facilities	Physical and industrial infrastructure that supports operational activities.
P	Policy	Institutional, interagency or international policies that influence the other domains.

Source: Chairman of the Joint Chiefs of Staff (2021).

The DOTMLPF-P model is similar to NATO's DOTMLPF-I model, as both are structured around eight functional components for building military capabilities. Doctrine, Organisation, Training, Materiel, Leadership, Personnel and Facilities are common to both models. The difference lies in the eighth component: where the DOTMLPF-P has "Policy", reflecting an emphasis on strategic governance and interagency collaboration, the DOTMLPF I prioritises "Interoperability", highlighting the importance of multinational integration and joint operational capacity among allied forces.

In the Brazilian context, interoperability among the Armed Forces refers to the ability to conduct joint operations through the standardisation of procedures, doctrines, systems and command structures. It encompasses multiple organisational aspects, which involve human, cultural and doctrinal factors, as well as technical aspects, which include communications, weaponry and logistics. The objective is to ensure effective coordination between the Navy, the Army and the Air Force at the strategic, operational and tactical level by integrating their respective capabilities.

The operations analysed in this case study take place an interagency environment where governmental and non governmental entities, both national and international, collaborate to achieve political and strategic objectives of national interest. This requires aligning diverse institutional cultures and efforts to respond effectively complex scenarios. NATO's "interoperability" component emphasises multinational integration, whereas Brazil's approach to disaster response focuses on coordination and joint action in responding to emergencies within the national territory, relying on unified command, institutional cooperation and the complementarity of resources. As such, this component was excluded from the analysis.

The results are analysed through the lens of Bloom's taxonomy, which allows for rich interpretations of collected data by examining the findings at different levels of cognitive complexity, offering nuanced, contextualised insights.

According to Croom (2005), a study's validity is the result of a reflective, context dependent process in which researchers assess the relevance of their findings to the context, maintaining consistency between the collected data and their interpretations, describe the analytical approach and combine theoretical and empirical knowledge, demonstrating the ability to interpret and represent constructed meanings in a rigorous and contextualised manner.

Generalisations drawn from case studies are analytical and contextual rather than statistical, as the purpose of exploratory and descriptive research is building interpretative frameworks that may be applied to similar scenarios. In this study, the insights inferred from empirical data on Operation Taquari II show that the military logistics capabilities deployed were effective in responding to a large-scale climate disaster. This inference was confirmed by the systematic application of the DOTMLPF-P framework, which enabled the identification of patterns and attributes that may be transferred to other contexts. Thus, the validity of the generalisation does not depend on statistical sampling, but on the analytical consistency and robustness of the theoretical model.

4. Presentation of data and discussion of findings

4.1. Data collected from the case study

The floods in Rio Grande do Sul between late April and early May 2024 were described by the state government as the worst climate disaster in the region's history, based on the intensity and widespread nature of the rainfall. Some municipalities recorded 500 to 700 mm of precipitation in just five days, which is equivalent to one third of the region's annual average. Other areas experienced rainfall between 300 and 400 mm of rainfall, with conditions deteriorating further between 3 and 5 May (Permanent Council of Applied Agrometeorology of the State of Rio Grande do Sul – COPAAERGS, 2024). Over 14 trillion litres of water flowed into Lake Guaíba, affecting nearly the entire state (COPAAERGS; 2024). The scale of the disaster is summarised in Table 2.

Table 2 – Number of people affected by the floods

Event	Number
Missing	25
Injured	806
Affected	2,398,255
Homeless	1,474
Displaced	69,304
Affected municipalities	478
Confirmed deaths	184

Source: Civil Defence of Rio Grande do Sul (2025).

The event began on 27 April with intense rainfall that led to flooding in Santa Cruz do Sul, landslides in the mountainous and central regions, and a tornado in São Martinho da Serra. The situation escalated between 29 April and 1 May, with further flooding, the declaration of a state of emergency in 95 municipalities and disruptions to water and electricity services, particularly in the Central and Serra regions, Vale do Rio Pardo, Vale do Taquari and Vale do Caí (CMS, 2025). On 2 May, rescue operations were hindered by roadblocks and flight restrictions caused by adverse weather. Between 3 and 5 May, Lake Guaíba surpassed its historical maximum level, inundating several neighbourhoods in Porto Alegre and adjacent cities, such as Canoas and São Leopoldo, with rescue efforts intensifying as dikes failed and access routes to the capital became severely congested (CMS, 2025). From 6 May through early June, operations focused on rescuing survivors, delivering humanitarian assistance and managing new overflows in affected basins, particularly in the Serra region and Vale do Taquari. As of 1 June, search teams remained in the field to locate missing persons (CMS, 2025).

The floods caused extensive damage to urban and rural infrastructure. More than 640,000 homes lost access to clean water and approximately 440,000 electricity consumers experienced power outages. Landslides, floods, fallen trees, dam breaches and road collapses blocked several highways, restricting access and mobility. The National Confederation of Municipalities estimated total losses at R$13.3 billion (CNM 2024), while the National Confederation of Insurers classified the event as the most significant disaster in the history of the sector in Brazil, with insurance claims surpassing R$5.6 billion (National Confederation of Insurers, 2024). A breakdown of the losses is provided in Table 3.

Table 3 – Damage caused by the 2024 floods

Sector	Amount	Details
Public	R$: 433.3 million	Public facilities.
	R$: 1.8 billion	Infrastructure works.
	R$: 154.6 million	Transport system.
	R$: 15.1 million	Emergency medical assistance.
	R$: 27.3 million	Sewage system.
	R$: 41.2 million	Urban cleaning and debris removal (collection and disposal).
	R$: 6.3 million	Electricity generation and distribution.
	R$: 85.2 million	Education system.
	R$: 15 million	Water supply.
	R$: 1.8 million	Pest and vector control system (disinfestation and disinfection).
	R$: 1.7 million	Fuel distribution.
	R$: 2.3 million	Public safety.
	R$: 1.1 million	Telecommunications.
Private	R$: 4.9 billion	Agriculture.
	R$: 514.8 million	Livestock.
	R$: 293 million	Industry.
	R$: 143.4 million	Local commerce.
	R$: 88.9 million	Other services.

Source: CMN (2024).

The disaster significantly disrupted daily life and public services across the state, including transportation, healthcare and education. A total of 577 schools were damaged by the floods, affecting approximately 225,000 students, and over 80 state schools were used as emergency shelters (National Water Agency – ANA, 2025). The road network suffered extensive damage, with more than 250 road sections and 140 bridges compromised, leaving several communities isolated. Dams used for power generation, irrigation and water supply were at high risk of collapse, further aggravating the crisis. The accumulation of solid waste in urban areas and exposure to contaminated floodwaters led to over 15,000 reported cases of leptospirosis (ANA, 2025). More than 200,000 vehicles were destroyed and hospitals were evacuated, temporarily halting medical services (ANA, 2025).

The destruction caused by the rainfall and the floods rendered roads impassable, caused supply shortages and affected hospital operations. As a result, three humanitarian corridors were built to deliver emergency aid. The corridors were completed in less than 24 hours and required the demolition of a bus terminal overpass to allow the transit of tall vehicles. Emergency vehicles and vehicles transporting donations had priority in these corridors (Portal de Notícias G1, 2024).

As security risks escalated in the hardest hit areas, several municipalities suspended school activities (including daycare centres) following rweports of arrests linked to vandalism, property invasions, property damage, looting of commercial and residential buildings, arson attacks on railway stations and theft of boats and rescue equipment. The situation was exacerbated by reports of sexual violence in shelters (Portal de Notícias Bandeirantes – BAND, 2024). In response to threats of looting, the federal police was tasked with guarding the Porto Alegre International Airport, which had suspended operations (Cable News Network, 2024).

During the floods, a variety of health problems were documented. There were 7,129 reported cases of leptospirosis, 788 confirmed cases and 26 deaths. Ten outbreaks of acute diarrhoeal disease were recorded, affecting 151 people, as well as 10 reported cases of accidental tetanus, four of which were confirmed. Rabies treatment was administered in 7,722 instances, including 7,177 incidents involving dogs and cats and 545 involving other animals (CMS, 2025). Additionally, 31 cases of hepatitis A were reported (with 28 confirmed cases), as well as 1,370 accidents involving venomous animals (903 were caused by spider bites and 467 by other species) (CMS, 2025).

Given the severity and scale of the damage, the Government of the State of Rio Grande do Sul declared a state of public calamity on 1 May 2024 through Decree No. 57,596 (Government of the State of Rio Grande do Sul, 2024). The event was classified according to the Brazilian Classification and Codification of Disasters (COBRADE)[2] as heavy rains (1.3.2.1.4), a subtype of meteorological disasters under the storms subgroup, categorised as local/convective storms. This classification includes episodes of intense rainfall that lead to widespread impacts such as floods, flash floods and landslides (COBRADE, 2016).

On 3 May 2024, the Ministry of Defence issued Ordinance No. 2,309, authorising the deployment of the Armed Forces, which were tasked with providing logistics support for Civil Protection and Defence operations in affected municipalities across the southern region. This directive led to the activation of the Taquari II Joint Operational Command, which coordinated Navy, Army and Air Force personnel (Brazil, 2024). Operation Taquari II included rescue operations, air transport, medical assistance, supply delivery, the installation of field hospitals and temporary shelters, and infrastructure repairs (Secretariat of Social Communication of the Federal Republic of Brazil, 2024). A summary of these actions is provided in Table 4.

[2] The Brazilian Classification and Codification of Disasters (COBRADE), established by Regulatory Decree No. 01/2012 from the Brazilian Ministry of National Integration, provides a structured system for classifying disasters in Brazil using a five digit code. Disasters are categorised based on their origin as natural, technological, or biological. This system seeks to align the national disaster classification with international standards, particularly those of the EM-DAT database, ensuring compatibility with international guidelines. Standardisation helps coordinate different administrative levels, streamlines the process of requesting technical and financial assistance during emergencies and supports evidence based planning using historical evidence and objective criteria.

Table 4 – Personnel employed in the Rio Grande do Sul disaster

Armed Forces	Quantity
Joint Command Operation Taquari II	170
Brazilian Navy	2,317
Brazilian Army	12,129
Brazilian Air Force	4,305
Police Forces	
Military Brigade	6,685
Civil Police	5,746
Federal Police	404
Federal Highway Police	394
National Security Force	209
Police forces from other states	
Military Police	238
Civil Police	50
General Institute of Forensics	758
Firefighters and Civil Defence	
Rio Grande do Sul Fire Brigade	1,319
Firefighters (other states)	384
Civil Defence	214
Agencies	
Ministry of Health	11
Health Secretariat	252
National Health Force of the Unified Health System	110
Federal Public Defender's Office	720
Brazilian Institute of Environment and Renewable Natural Resources	36
National Foundation for Indigenous Peoples	09

Source: CMS (2025).

In addition to deploying personnel, a significant amount of logistical resources was mobilised to address urgent needs. These resources are listed in Table 5.

Table 5 – Mobilised logistical resources

Entity	Resource	Quantity
Southern Military Command	Aluminium walkway	15
	Heavy gate	03
	M6T6 Supported Military Bridge	04
	M4T6 floating bridge	01
	Lightweight bridge	02

[Cont.]

	LSB (Logistic Support Bridge)	16
	COMPACT 200 logistics bridge	01
	Bailey bridge	01
	Field hospitals	05
	Veterinary field hospital	01
	Motor pumps	18
	Buses	12
	Trucks	26
	Machinery	206
	Vehicles	56
	Mobile workshop truck	01
	Water tank trailers	02
	Van	01
	Flatbed truck	01
	Tanker truck	06
	Fuel truck	06
Brazilian Navy	Ships	15
	Vessels	81
	Boats	167
	Heavy vehicles	33
	Light vehicles	25
	Field hospitals	02
	Water treatment stations	02
Brazilian Air Force	Aircraft	21
	Field hospitals	02
Unified Health System	Field hospitals	02
Military Brigade of Rio Grande do Sul	Vehicles	1,560
	Vessels	23
	Aircraft	02
Civil Defence	Aircraft	25
	Vehicles	31
	Trucks	111
	Vessels	05
	Mini excavator	01
	Dredge pumps	08
	Generators	03

Source: CMS (2025).

The Civil Defence response integrated efforts in rescue, humanitarian support and emergency reconstruction operations, in coordination with agencies from other states. Interinstitutional teams conducted land, air and river operations, rescuing over 3,300 people and approximately 500 animals, and specialised teams were deployed to identify victims and transport the deceased. Helicopters were used in isolated areas to transport patients, medical teams, supplies and government officials. Simultaneously, more than 220 donation distribution operations were carried out using mixed logistics routes, coordinated from regional operations centres. Public companies worked to restore electricity and water services by installing drainage pumps and dispatching water trucks (CMS, 2025).

The Taquari II Joint Operational Command, led by the Brazilian Army, Navy, and Air Force, rescued people and animals, installed 29 improvised bridges to restore access to isolated areas, enabling the delivery of water, food, clothing and medical supplies. The operation involved the delivery of supplies to affected communities, the distribution of 32,000 operational rations to response teams, the removal of 123,381 m^3 of debris, road clearing to restore traffic flow, the delivery of over 3.2 million litres of fuel and the sanitation of schools and healthcare facilities. Military chaplains provided religious services in shelters and hospitals, offering spiritual support to those affected by the disaster (CMS, 2025).

The Brazilian Air Force played a critical role in search, rescue and humanitarian support operations, coordinating military and civilian aircraft (both domestic and international) to transport donations, conduct aeromedical evacuations and transport people, volunteers, officials and animals. It also installed two field hospitals in Canoas, which provided approximately 700 medical consultations per day. The Canoas Air Base accommodated about 1,500 people daily, offering meals and lodging, and supported commercial flight operations during the closure of Salgado Filho Airport. In total, the Air Force logged 2,814 flight hours, rescued 2,177 people and 369 animals, transported 2,386 tonnes of materiel and delivered 1,039 tonnes of donations (Brazilian Air Force, 2024).

The Rio Grande do Sul Military Brigade contributed to the response efforts by patrolling flooded areas and shelters, conducting urban and road operations, and using drones and aircraft to conduct surveillance and deliver supplies. It also provided escorts, checkpoints, triage support and assistance to volunteers, and intensified patrols to prevent looting and riots. An incident command system was set up in strategic locations such as Porto Alegre, Canoas, Eldorado, Guaíba, Vale do Rio dos Sinos and Vale do Taquari (CMS, 2025) to coordinate these operations, which helped maintain public order and provide logistical support to affected areas.

The Health Secretariat of Rio Grande do Sul implemented emergency measures to ensure the distribution of medicines, supplies and immunobiological products during the floods. It delivered a total of 4,987,971 units of pharmaceutics to hospitals and 51 million to municipalities across 216 locations. The Ministry of Health provided 130 emergency kits (sufficient to assist 300,000 people for 15 days) and vaccinated 26,000 individuals in shelters. During the operation, it conducted eight air shipments to isolated regions, set up three alternative land routes per day, delivered 1,336,137 doses of vaccines, serums and immunoglobulins and 1,116,700 syringes and needles, refilled oxygen cylinders, relocated and replaced equipment and set up new infrastructures to support these services (CMS, 2025).

The Ministry of Integration and Regional Development issued a directive entrusting the Brazilian Postal Service with managing the logistics of donation operations, from request processing to final delivery. Five Integrated Logistics Centres were set up in Porto Alegre, Caxias do Sul, Rio Grande, Cachoeirinha and Santa Maria. Initially, the Army assisted with warehouse operations until outsourced teams arrived. The Rio Grande centre processed 204 national and international containers, totalling 5,000 tonnes of goods. Throughout the operation, the Postal Service handled 107,459 shipments, distributed 19,000 tonnes of donations, responded to over 1,500 requests, completed around 4,000 trips using a fleet of more than 100 vehicles and covered a distance of over 1.2 million kilometres. Additionally, the Postal Service was formally tasked by the State Civil Defence with overseeing deliveries. It operated from a 10,000 m^2 facility with a dedicated team of 87 professionals responsible for provisioning and inventory management, handling supplies, monitoring expiration dates, assembling kits and organising warehouse operations (CMS, 2025).

The International Organisation for Migration, an agency affiliated with the United Nations, collaborated with federal and local authorities by deploying technical teams to assist in the management of reception centres and conduct social protection assessments. These operations aimed to support and protect displaced populations by delivering immediate relief. Managing the humanitarian centres involved distributing meals and essential goods, providing psychosocial support and carrying out socioeconomic integration activities. Other operations aimed to protect human rights, improve access to services and enhance preparedness for future emergencies, working in close coordination with government authorities at various levels (CMS, 2025).

4.2. Discussion of findings and analysis of logistics capabilities using the DOTMLPF-P framework

Using the data collected, organised and presented in the case study, the following section applies the DOTMLPF-P framework to identify how each component was operationalised in the logistics response to the 2024 climate disaster in Rio Grande do Sul. Table 6 summarises the findings for each component.

Table 6 – Analysis of logistical capabilities using the DOTMLPF-P framework

DOTMLPF-P component	Analysis
D Doctrine	The response was guided by the doctrines of the National Civil Protection and Defence System (SINPDEC) and the Operations Command System (SCO), supported by military doctrine for joint operations and emergency operations. The current operational guidelines are clear, but require updating to better address events of this magnitude.
O Organisation	A joint logistical structure was established, integrating the Civil Defence, the Armed Forces and law enforcement agencies, as well as municipal, state and federal institutions, the Postal Service, the health sector and international organisations. The operations were coordinated through the SCO and the Taquari II Joint Operational Command.
T Training	Teams received technical training for specific tasks (rescue operations, deployment of mobile bridges and field hospitals). However, it is not clear whether personnel had prior training or participated in joint exercises. Gaps were identified in preparing for large-scale, multi impact scenarios. The lack of interagency exercises, simulations and post-action reviews hindered logistical readiness and joint responses in complex scenarios, highlighting the need for personnel trained in critical functions, supported by military doctrines that emphasise continuous training, to improve operational integration and optimise performance under crisis conditions.
M Materiel	The logistical resources mobilised included: bridges, vessels, vehicles, field hospitals, aircraft, motor pumps, food, donations, operational rations, vaccines, medicines and fuel. Challenges included transportation and distribution bottlenecks in the early stages of the response.
L Leadership and Education	The response was led by both civilian and military authorities: the Ministry of Defence, the SEDEC and regional commands. Operations were coordinated using a centralised command and control model. Despite this, challenges in interagency communication persisted.
P Personnel	There was a massive deployment of qualified personnel, but overloads were reported in critical areas such as health and safety.
F Facilities	The infrastructure used in the response included field hospitals, adapted logistics centres, air bases, schools repurposed as support centres and improvised triage points. However, capacity and infrastructure limitations posed challenges.
P Policy	Policy measures included the activation of disaster decrees, ministerial ordinances, federal cooperation policies and national and international humanitarian aid protocols.

Doctrine (D) – a unified command structure was established by integrating the National Civil Protection and Defence System (SINPDEC) and the Operations Command System (SCO) through legal instruments such as Decree No. 57.596/2024 and Ordinance No. 2.309/2024 from the Ministry of Defence, which demonstrates the application of the principles of joint operations. The successful execution of complex logistical tasks (such as resource mobilisation, installation of temporary infrastructure, distribution of supplies and deployment of specialised transport) confirms that the doctrine was operationalised. Despite this coordinated response, the scale of the disaster exposed limitations in the current doctrine, underscoring the need to develop dynamic procedures, manuals on integrated civil-military planning and simulated exercises that help translate lessons learned guidelines adaptable to future crises.

Organisation (O) – the activation of the Taquari II Joint Operational Command, which unified efforts across Civil Defence, the Armed Forces, law enforcement agencies, state agencies at all levels, the Postal Service, the Unified Health System and international organizations such as the International Organisation for Migration shows that the principles of unified command and control were applied to centralise decision making and prevent redundancy, making it possible to conduct simultaneous operations, which included rescue, humanitarian aid, supply distribution and healthcare delivery. However, the ad hoc nature of this arrangement, although effective at the tactical and operational levels, highlights the need to create a permanent joint command for disaster response, supported by predefined protocols tested regularly during non crises periods, to ensure a swift, cohesive and resilient response in future high volatility scenarios.

Training (T) – the teams applied their technical expertise by conducting rescue operations, building crossings, operating specialised equipment and assembling emergency infrastructure. These activities produced measurable outcomes: thousands of disaster victims were assisted, tonnes of supplies distributed and hundreds of rescue flights conducted. These results show that the teams mastered technical procedures and applied them effectively under challenging conditions. However, while effective at the tactical level, the current model does not does fully prepare all stakeholders to operate in an integrated, real-time manner in complex scenarios, that is, it does not ensure strategic readiness. This gap highlights the need to develop continuous training programmes with standardised protocols to make interagency cooperation and coordination a routine practice in future disaster responses.

Materiel (M) – the response mobilised an extensive array of civil and military resources ready for immediate activation. The speed at which these assets were deployed demonstrates knowledge of adaptive logistics and shows that alert protocols were effective and that capabilities could be activated at short notice. Tangible results included reopening roads, executing rescue missions, transporting supplies via air and river networks and delivering care in hospitals and shelters. However, road collapse and flooding blocked access routes and created distribution bottlenecks that limited land based logistics operations, which meant that alternative routes had to be improvised, increasing reliance on air and river transport. Adaptations were made on the ground to ensure materiel was available to address the disaster's evolution. Developing a dedicated logistics doctrine for degraded environments would improve operational readiness, and integrating specialised airlift, amphibious and emergency engineering capabilities would ensure that material resources are converted into sustained, reliable support, enhancing responses to large scale disasters.

Leadership (L) – a centralised command and control model, formalised by Ordinance No. 2.309/2024 and Decree No. 57.596/2024, brought together the Ministry of Defence, the National Secretariat for Civil Protection and Defence (SEDEC) and regional military commands under the Taquari II Joint Operational Command. This framework ensured unity of effort in a highly chaotic operational environment, preventing resource dispersion and enabling the coordination of rescue operations, supply chains, humanitarian aid and shelter management. This joint leadership structure was able to rapidly mobilise civilian and military efforts to mount an organised response despite the scale of the disaster. This centralised approach proved highly effective for large scale integration and coordination but also highlighted the need for greater operational adaptability. Incorporating greater tactical autonomy for commanders would allow for faster and more consistent decision making at the local level. This would make the leadership model more flexible and better equipped to handle complex crises.

Personnel (P) – there was a massive mobilisation of personnel from multiple institutions and specialities, who carried out simultaneous rescue, healthcare, logistics, and security operations. This demonstrated the ability to operate in an interagency context and apply technical expertise under extreme conditions. Moreover, the ability to swiftly deploy skilled personnel in critical sectors prevented interruptions in operations and made it possible to coordinate the relief efforts. While personnel were highly qualified, the operation revealed areas for improvement in the way human resources are managed to sustain performance during prolonged operations.

Facilities (F) – logistics centres were improvised, military bases were repurposed as evacuation and reception points for teams and victims, and schools and other structures were converted into shelters and triage centres. This strategic reorganisation demonstrated adaptability and practical expertise and ensured that emergency aid reached affected communities. An integrated network of facilities was used to process and distribute donations, deliver medical care in field hospitals and provide shelter to people affected by the disaster. Despite infrastructure and service limitations in isolated areas, interagency collaboration made it possible to develop resilient and flexible solutions and maintain operational continuity. The experience gained from the operation provides an opportunity to prepare strategic infrastructure such as fully equipped logistics hubs, high occupancy shelters and support bases.

Policy (P) – various legal instruments were used to enable the rapid mobilisation of resource and coordinated actions across government levels and institutions. Decree No. 57.596/2024 and Ordinance No. 2.309/2024 brought together the Ministries of Health, Defence, Citizenship and Integration, empowering federal authorities and accelerating joint operations. These policies included the formal designation of the Brazilian Postal Service as the official logistics operator, which streamlined the management of donations, evacuations, medical care and reconstruction. These policies translated strategic decisions into coordinated actions by aligning federal, state and municipal authorities, and provided a legal framework for the relief operation, confirming that well structured, adaptable public policies streamline institutional mobilisation in large scale disaster scenarios.

The response to the 2024 climate disaster in Rio Grande do Sul unified government entities, the Armed Forces, federal agencies, the private sector and international organisations under the Taquari II Joint Operational Command, making it possible to synchronise operations across multiple fronts. This multidisciplinary approach enabled the mobilisation of human and material resources for simultaneous operations, including rescue missions, logistical support, medical assistance and shelter management. The deployment of aircraft, vessels, mobile bridges and field hospitals showed a high level of technical expertise and operational readiness. By adapting military capabilities to non combat roles and integrating cross-institutional teams, it was possible to overcome organisational and cultural barriers and sustain operations under extreme conditions.

5. Conclusions

This article examined the logistical capabilities mobilised and deployed during the 2024 climate disaster in the state of Rio Grande do Sul, using the DOTMLPF-P model to highlight the strategic role of logistics in natural disaster response operations.

The article begins by defining and characterising logistics, focusing on military logistics operations in disaster response scenarios, and identifying the key actors involved. A case study was conducted using a predefined protocol and publicly available academic and documentary sources. The DOTMLPF-P model was used to analyse the collected data and assess the logistical capabilities deployed by the Brazilian state during the disaster. One limitation identified during the study was the quality of the data, which were dispersed across multiple sources.

By exploring the research question "How did military logistics support the response to the 2024 climate disaster in Rio Grande do Sul?" the study revealed that military logistics capabilities were deployed in a coordinated multidimensional operation led by the Taquari II Joint Operational Command. The logistics operation mobilised the Armed Forces' human and material resources, in collaboration with other participating agencies, in an operational environment whose complexity and scale underscored the fundamental role of military logistics in scenarios of civil disruption. This interinstitutional framework brought together civil and military resources to conduct rescue operations, manage transport logistics, and provide assistance to affected communities. By applying the DOTMLPF-P model, the study systematically analysed the logistical capabilities employed in the response, demonstrating how military logistics facilitated operational cohesion and readiness, confirming its importance in supporting communities during climate disasters in non combat contexts.

This investigation offers contributions in three interconnected dimensions: i) theoretically, the study confirms the importance of transdisciplinary approaches, demonstrating how military logistics concepts can be applied in extreme events in civilian contexts, proposing a framework that can be adapted to the disaster management cycle and broadening the scope of public safety by recognising environmental events as structural threats; ii) methodologically, the study's use of a case study based on the DOTMLPF-P model lends it analytical rigour and provides a replicable structure; and iii) operationally, by describing logistical practices that can inform future planning, the study assesses the readiness of current capabilities and suggests doctrinal updates to improve coordination among Defence, Health and civilian institutions in large scale emergencies.

This study proposes that interagency coordination and interoperability are critical success factors in logistics operations involving multiple agencies. The collaboration between the Armed Forces, civil agencies, federal entities and international organisations demonstrated that integrating logistical capabilities produces tangible results, especially when resources are complementary and efforts are aligned. Although this case study analyses a domestic event and does not address multinational cooperation, it confirms that logistical interoperability (supported by doctrinal, procedural, technical and human dimensions) enhances operational resilience and institutional readiness in emergencies. As such, interoperability is an essential factor in mitigating the impacts of extreme events and enabling cohesive responses to future crises.

Future studies should further explore the role of military logistics in coordination with non state actors in complex civil emergencies, focusing on non governmental organisations and other non commercial entities. The aim of these studies would be to enhance disaster response plans that involve the Armed Forces.

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