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Natural disasters in the south of brazil and the normative support of state climate policy

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Abstract
The state of Rio Grande do Sul has been affected in recent years by catastrophic climatic events, causing damage to territorial structures and loss of lives. In this context, this study aimed to address two questions for analysis: a) What is the spatial profile and incidence of disasters related to climatic events, specifically intense rains, floods, and flash floods, in Rio Grande do Sul? b) What are the regulatory indicators that are evident for dealing with the repercussions of climate change? To answer these questions, data was collected from the S2iD platform, cartographic resources were obtained through IBGE, mapping was conducted using QGis software, graphs and maps were created, and the normative perspective on climate change in the state was systematized. It was concluded that there is considerable intra-regional vulnerability to the listed disasters, with intensification in certain areas and a spread of recognition across almost the entire federation unit. From a normative perspective, Rio Grande do Sul proved to be unprepared from a legislative legal standpoint for the future scenarios of climate change.

Keywords: Climate change. Environmental law. Territorial impacts. Environmental policies. Brazilian south.

Desastres naturais no rio grande do sul e o suporte normativo da política climática estadual

Resumo
O estado do Rio Grande do Sul vem sendo afetado nos últimos anos por eventos climáticos catastróficos, provocando danos às estruturas territoriais e perda de vidas. Nesse sentido, este trabalho procurou situar dois questionamentos para a análise: a) qual o perfil espacial e de incidência de desastres relacionados aos eventos climáticos, especificando as chuvas intensas, inundações e enxurradas no Rio Grande do Sul? b) Quais os indicativos normativos que se evidenciam para o tratamento dos desdobramentos advindos das mudanças climáticas? Para responder às perguntas, partiu-se do levantamento de dados na plataforma S2iD, na obtenção de recursos cartográficos através do IBGE, mapeamento pelo software QGis, elaboração de gráficos e mapas, e sistematização da perspectiva normativa

sobre as mudanças do clima no estado. Conclui-se que há uma considerável vulnerabilidade intra-regional aos desastres elencados, sendo que ocorre intensificação em determinadas áreas e, conjuntamente, um espalhamento de reconhecimentos por quase toda a unidade da federação. Para a perspectiva normativa, o Rio Grande do Sul mostrou-se ser um estado despreparado do ponto de vista jurídico legislativo para os cenários futuros das mudanças climáticas.

Palavras–chave: Mudanças climáticas. Direito ambiental. Impactos territoriais. Políticas ambientais. Região sul do Brasil.

Desastres naturales en rio grande do sul y el apoyo regulatorio de la política climática del estado

Resumen
El estado de Rio Grande do Sul se ha visto afectado en los últimos años por eventos climáticos catastróficos, provocando daños a las estructuras territoriales y pérdidas de vidas. En este sentido, este trabajo buscó abordar dos cuestiones de análisis: a) ¿cuál es el perfil espacial y de incidencia de los desastres relacionados con eventos climáticos, especificando lluvias intensas, inundaciones e inundaciones repentinas, en Rio Grande do Sul? b) ¿Qué indicadores normativos son evidentes para afrontar las consecuencias derivadas del cambio climático? Para responder a las preguntas, partimos de la recopilación de datos en la plataforma S2iD, la obtención de recursos cartográficos a través del IBGE, el mapeo mediante el software QGis, la elaboración de gráficos y mapas y la sistematización de la perspectiva normativa sobre el cambio climático en el estado. Se concluye que existe una considerable vulnerabilidad intrarregional a los desastres enumerados, con una intensificación en ciertas áreas y, en conjunto, una extensión del reconocimiento en casi toda la unidad de la federación. Desde una perspectiva normativa, Rio Grande do Sul demostró ser un estado no preparado desde el punto de vista legal y legislativo para futuros escenarios de cambio climático.

Palabras clave: Cambio climático. Derecho Ambiental. Impactos territoriales. Politicas ambientales. Région sur de Brasil.

1 Introduction

In recent years, the state of Rio Grande do Sul has been in the media spotlight as the scene of climate-related disasters, with major events that have generated significant impacts on territorial structures, as well as on the different socio-environmental frameworks. In May 2024, according to the UFRGS repository, 242,000 households were directly affected by climate-related disasters, with more than 150,000 people also directly affected in its capital, Porto Alegre, on the same date.

This platform is being developed on an emergency and voluntary basis by various sectors of the UFRGS in conjunction with volunteer external researchers. Possantti *et al* (2024) points out that the platform will provide models for predicting water level rises, mapping areas affected by flooding and other critical information for dealing with the May 2024 flood crisis in Rio Grande do Sul.

In a report published in 2023, the World Bank stated that extreme weather events could cause an annual loss of 13 billion Reais to the economy, as well as disrupting transport and energy infrastructures and harming competitiveness and

the poorest populations. As noted, "[...] Even without considering possible tipping points, climate shocks could push an additional 800,000 to 3 million Brazilians into extreme poverty from 2030 [...]" (World Bank, 2023, s/p).

In this way, this research sought to answer the following questions: a) a) what is the spatial profile and incidence of disasters related to climatic events, specifically heavy rainfall, floods and flash floods, in Rio Grande do Sul? b) What normative indications are there for dealing with the consequences of climate change?

To do this, the database of the Integrated Disaster Information System (S2iD) and the relevant state legislation were surveyed . The spatializations were made using the QGis GIS.

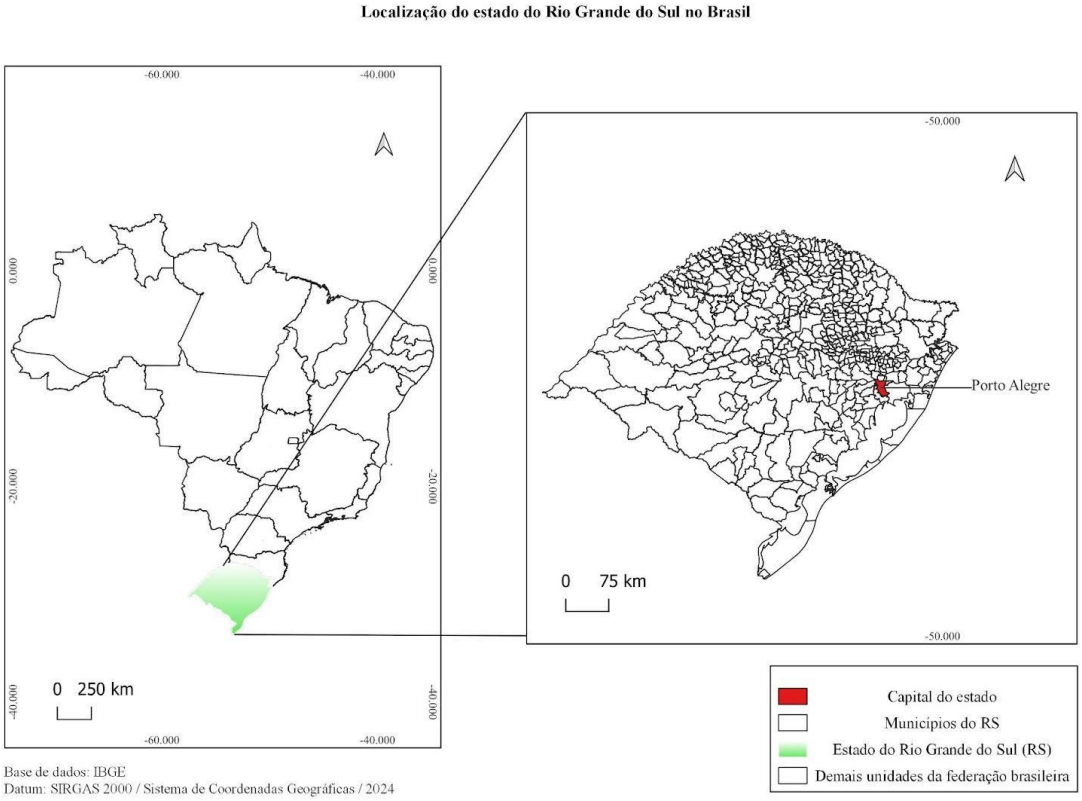
The paper therefore presents the methodological constitution of the proposal, a conceptual framework that supports the interpretations of the events measured, the results of the systematic organization and, finally, a discussion based on the normative surveys.

2 Methodology

The methodological procedure used to carry out this research was a literature review based on academic references that support the topic, data collection on the platform of the Integrated Disaster Information System (S2iD) of the Ministry of Integration and Regional Development, as well as analysis of legislative texts on climate policy in the state of Rio Grande do Sul. The information was systematized using graphs, charts and maps. The organization work was carried out using *Google* Spreadsheets, *Google* Documents and the free mapping software QGis.

The state of Rio Grande do Sul was adopted as the spatial cut-off point for this approach, as shown from a locational perspective on Map 1 below.

Map 1. Location of the state of Rio Grande do Sul in Brazil.



Source: Organized by the authors.

According to the latest Census by the Brazilian Institute of Geography and Statistics (IBGE), in 2022 the state's territorial area comprised 281,707.151 km², with 10,882,965 residents. The Socioeconomic Atlas of Rio Grande do Sul (2022) shows that the state has 497 municipalities, representing the sixth most populous unit of the federation, corresponding to 5.4% of the Brazilian population.

3 Conceptual frameworks

According to the Brazilian Classification and Codification of Disasters (Cobrade), the recognition of disasters falls into groups, subgroups, types, subtypes and definitions. The disasters recognized and listed for verification in this work are organized as follows, according to Table 1.

Table 1. Characterization of disasters according to Cobrade.

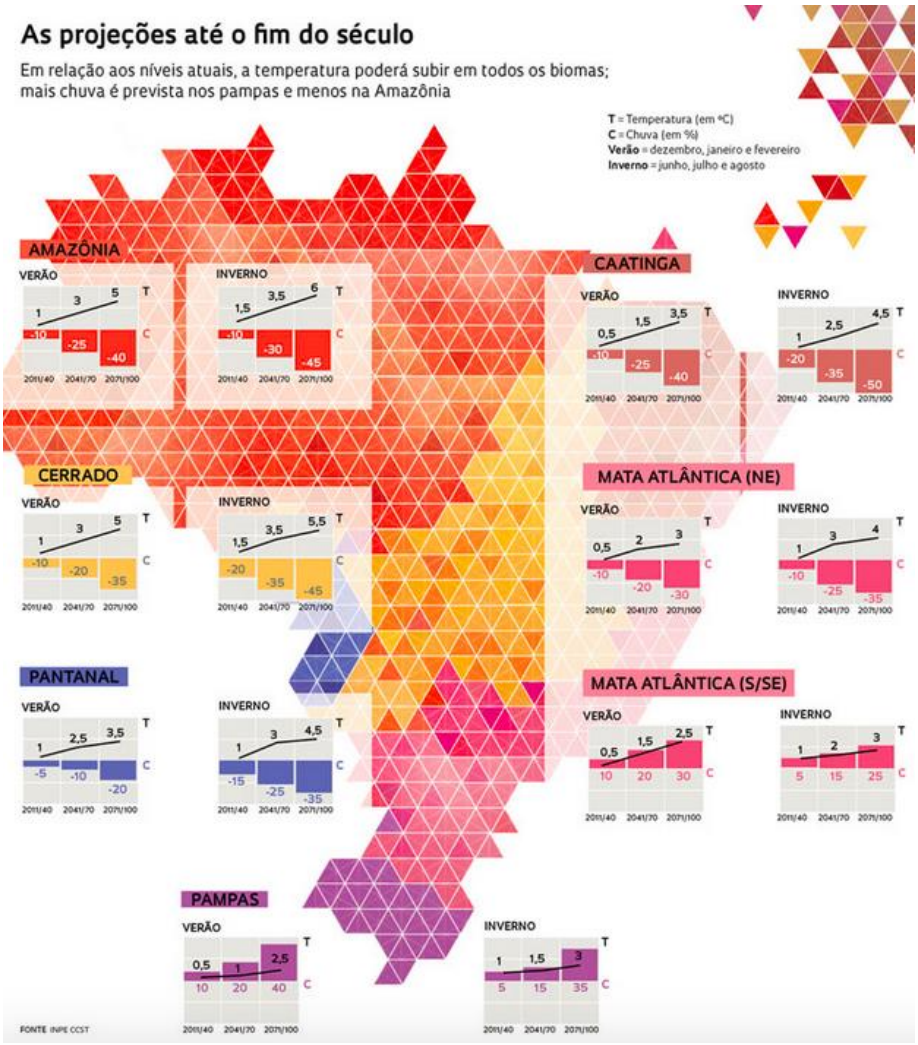
Group	Subgroup	Type	Subtype	Definition
Hydrological	Flooding	0	0	Submergence of areas outside the normal limits of a watercourse in areas that are not normally submerged. Overflow occurs gradually, usually caused by prolonged rainfall in lowland areas.
Hydrological	Floods	0	0	High-speed, high-energy surface runoff caused by intense, concentrated rainfall, usually in small basins with rugged terrain. Characterized by sudden rise in the flow of a given drainage system and sudden overflow of the river channel. It has great destructive power.
Weather	Storms	Storm local/ Convective	Rainfall intense	These are rains that occur with significant accumulations, causing multiple disasters (e.g. floods, mass movements, torrents, etc.).

Source: Brazilian Classification and Codification of Disasters (Cobrade) - Organization by the authors.

It can be seen from the aspects listed that all of them have implications related to climate scopes, especially considering rainfall in the state. In this sense, the report on climate change by Marengo (2007), in a study supported by CPTEC/INPE, shows that in the southern region of Brazil, the systematic increase in rainfall can also be observed in the hydrological records, (...), where the flows of the Jacuí River, in Espumoso, and Passo, Bela Vista, show positive trends [...] (MARENGO, 2007).

The magazine Pesquisa FAPESP, in August 2013, carried a summary map produced by INPE/CCST, in which it is possible to check the climate projections for the end of the century in the country, expressed here in Figure 1.

Figure 1. Rainfall and temperature projections until the end of the 21st century - Brazil.



Source: Revista Pesquisa Fapesp (2013).

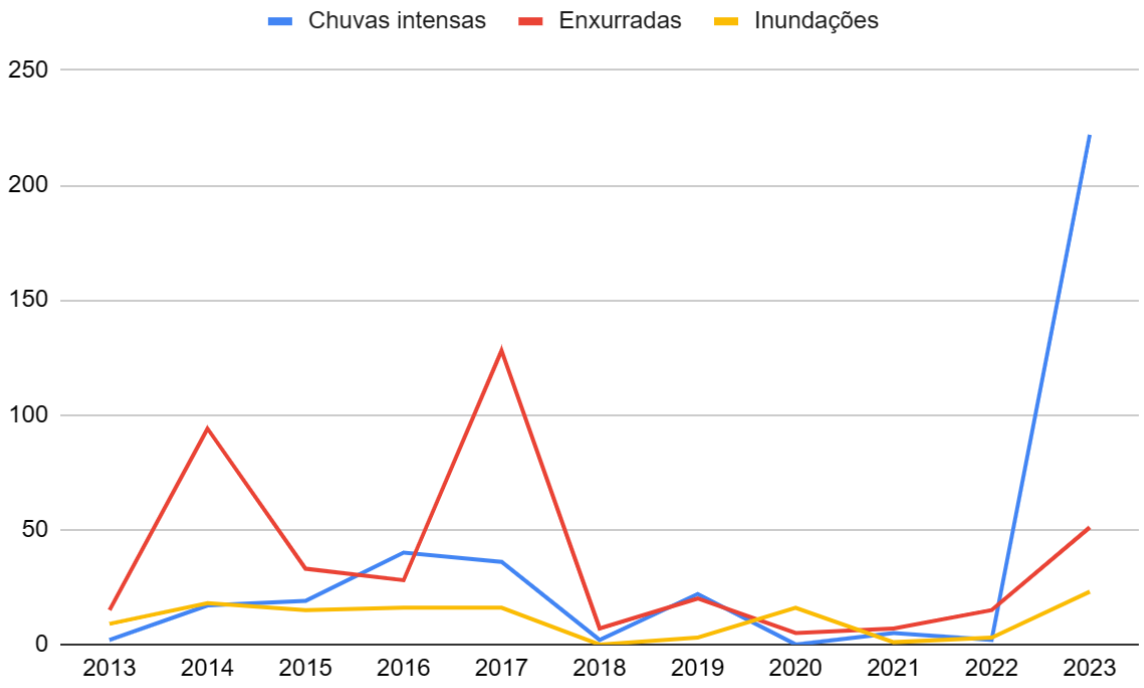
It can be seen that for the southern region of Brazil, the projected increase in temperatures and rainfall is significant, with a rise in precipitation of around 35% to 40% by 2100, considering different areas of incidence.

For these reasons, the next topic presents the results of the systematization of the listed disasters and their spatial approach in the state.

4 Results

Based on the S2iD survey of disasters recognized between 2013 and 2023 in the state of Rio Grande do Sul, the following is a graph of the incidence of heavy rainfall, floods and flash floods.

Figure 2. Intensive weather events in Rio Grande do Sul - Brasil.



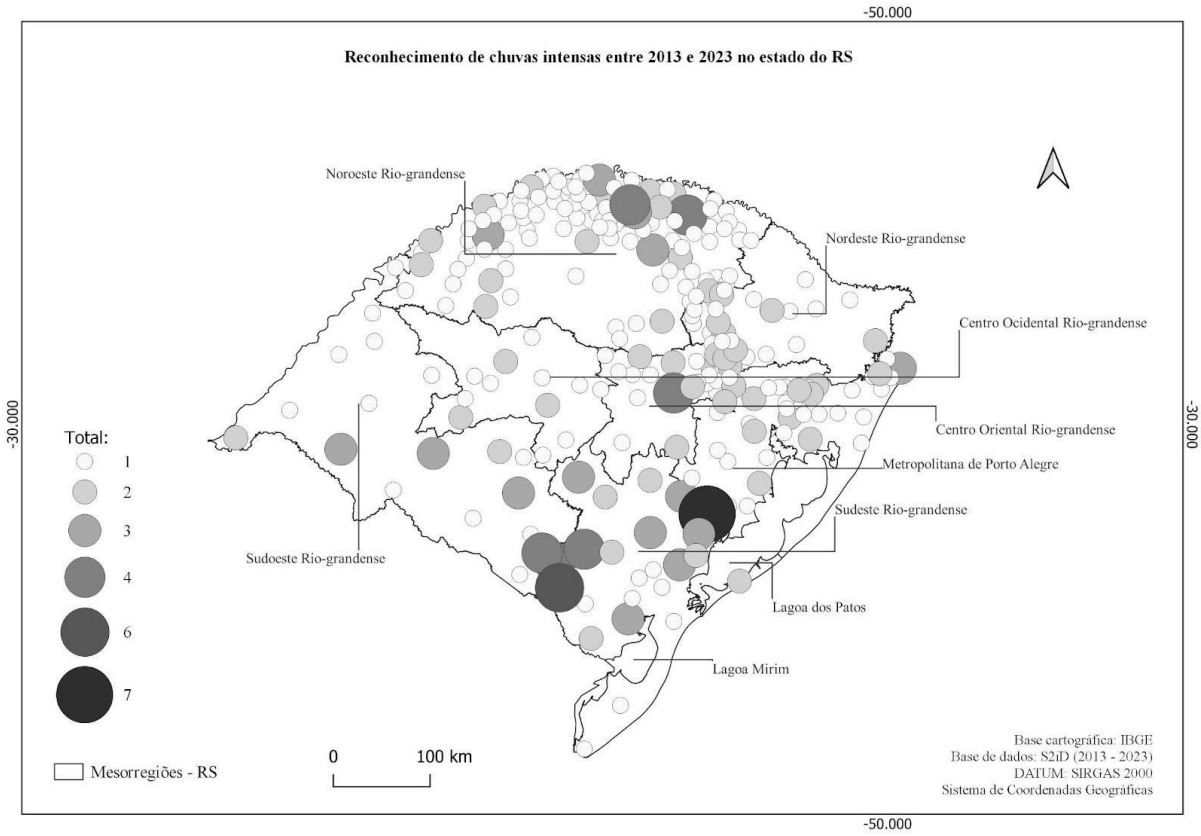
Source: S2iD.

It is worth noting that floods showed peaks in recognition in 2014 and 2017, reaching more than 100 cases in the latter year. Another relevant factor is that, from 2022 onwards, the data curve tends to rise, with intense rainfall reaching numbers greater than 200 cases of recognition as disasters.

From this systematization of data over time, based on the incidence of each recognition of the specified disasters, the spatial contexts of manifestations of the perspectives pointed out are presented, seeking to discern the field of regionalization of their events.

The southeastern part of Rio-Grandense showed a significant impact in terms of heavy rainfall, and it is important to note that the recognition of this phenomenon as a disaster is spread throughout the state, which also represents a macro-scale dimension within the federative unit, as can be seen in Map 2 below.

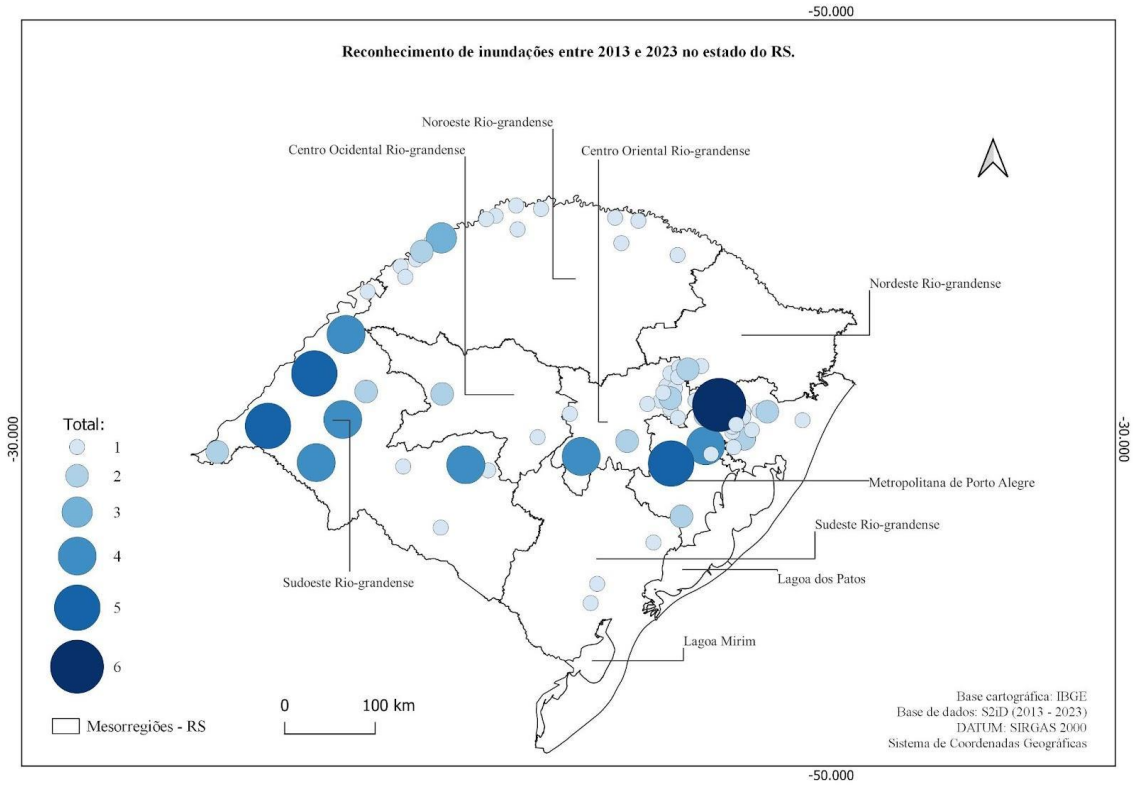
Map 2. Recognition of intense rainfall between 2013 and 2023 in the state of Rio Grande do Sul (RS).



Source: S2iD; IBGE; Authors' organization.

Floods as recognized disasters, systematized in Map 3, have specific delimitations, concentrated more intensely in the Central East of Rio Grande do Sul, the Metropolitan Area of Porto Alegre and the Southwest of Rio Grande do Sul. To a lesser extent, the northwest of Rio Grande do Sul and the southeast of Rio Grande do Sul are affected.

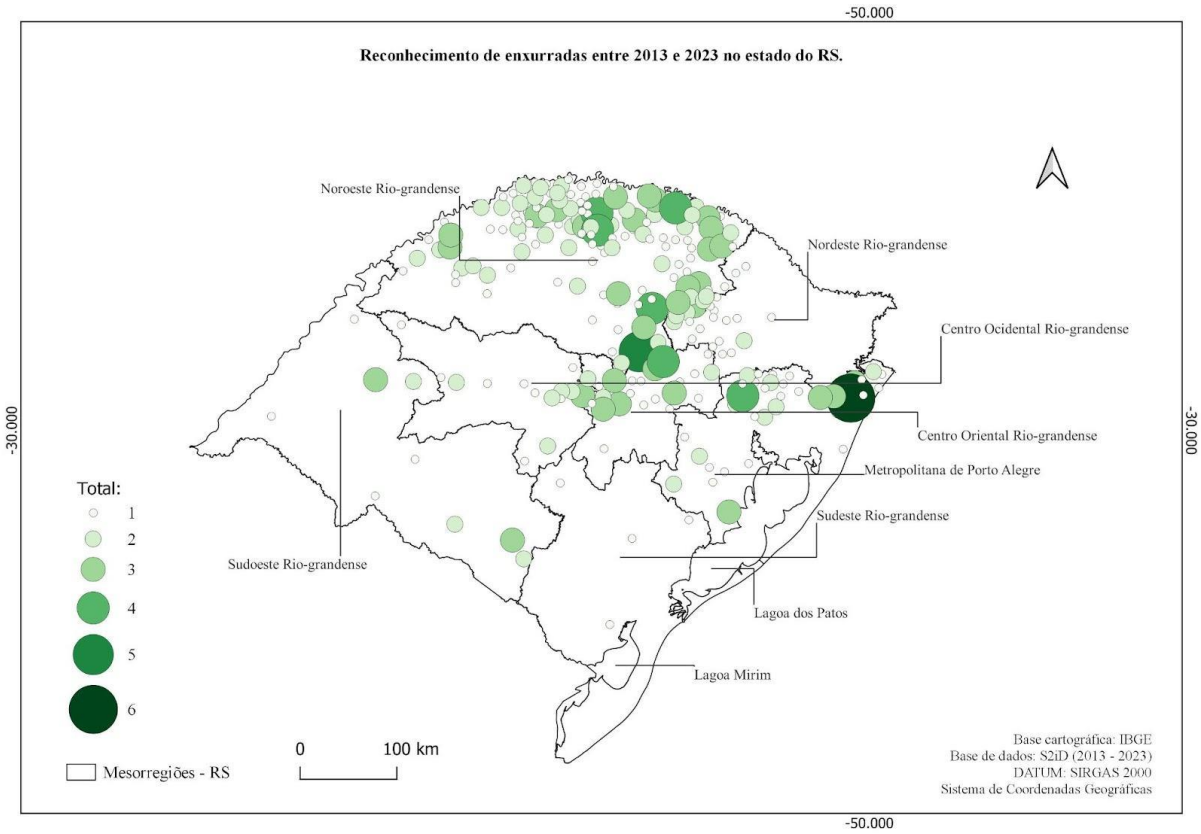
Map 3. Flood reconnaissance between 2013 and 2023 in the state of Rio Grande do Sul (RS).



Source: S2iD; IBGE; Authors' organization.

The floods were very significant in the east, center and northwest of the state. As can be seen on Map 4, the events were directed towards the center and northwest of the state.

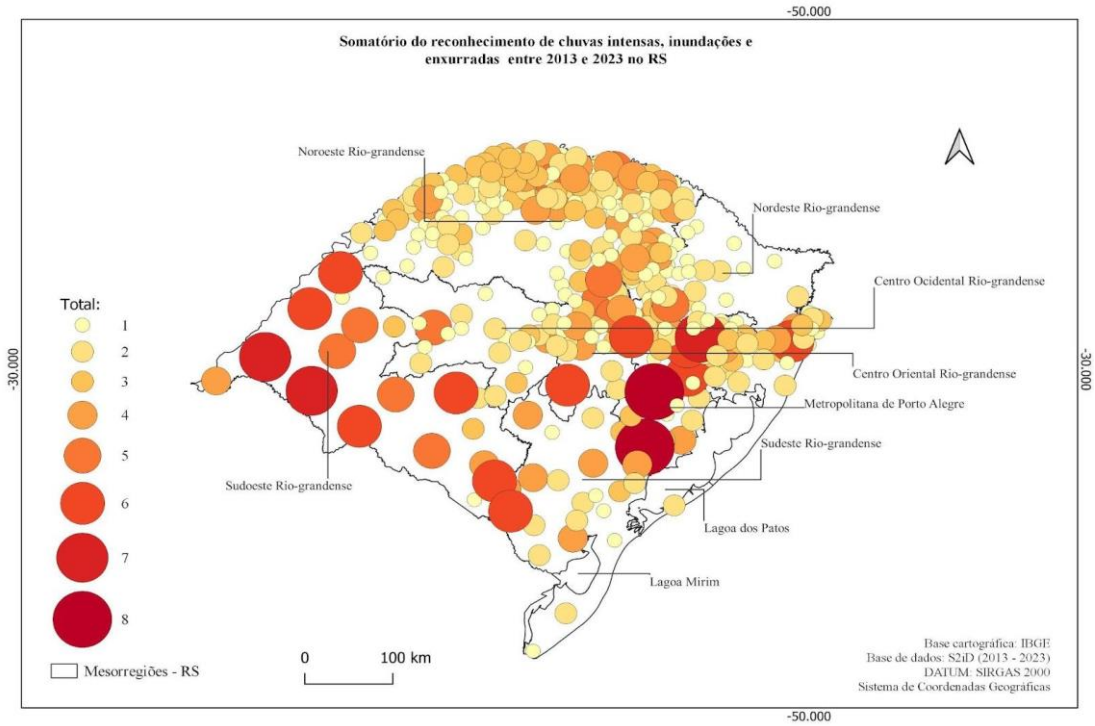
Map 4. Flood reconnaissance between 2013 and 2023 in the state of Rio Grande do Sul (RS).



Source: S2iD; IBGE; Authors' organization.

In an attempt to provide a summary of the disasters listed, we have Map 5, with the general sum of recognitions of floods, intense rainfall and flooding between 2013 and 2023 in the state. This mapping seeks to provide a general framework for the disasters listed in association, allowing for a macro-scale indication of vulnerabilities.

Map 5. Flood reconnaissance between 2013 and 2023 in the state of Rio Grande do Sul (RS).



Source: S2iD; IBGE; Authors' organization.

It can be seen that, in terms of intensity for the selected disasters, there is an accentuation of recognition in the regions: a) Metropolitan Porto Alegre; b) Southeast Rio Grande do Sul; c) Southwest Rio Grande do Sul. However, it is important to note that the spatial dimension is significant in understanding these recognitions, since in the Northwest Region of Rio Grande do Sul, for example, there is a significant volume of events demarcated as disasters by the state in different municipalities.

Specifically with regard to the consequences of heavy rainfall, floods and flash floods, it is clear that Rio Grande do Sul is highly vulnerable to these disasters, both in terms of intensity and the number of occurrences in various municipalities within the same internal region.

As shown in the results of the systematization, the state of Rio Grande do Sul is widely affected by disasters caused by heavy rainfall, torrents and floods. This means that the need to create new structures and resize existing territorial contributions is latent, especially considering the analytical scope of the selected disasters. Drainage capacity, absorption/infiltration of the volume of water, bridges, roads, homes - as well as other elements of the territories - need to be resized and/or built based on the indications of intensity and recurrence of the events addressed.

There has been a significant increase in the number of records of these disasters in the areas pointed out by the PBMC in its 2013 report, where temperatures and rainfall have risen. Because of these aspects, the presence of vulnerabilities now demarcated in the territory of Rio Grande do Sul also stems from a lack of organized construction of territorial support for the events that have

unfolded as a result of climate change over the last ten years.

As such, it is necessary to engage in a dialogue with the normative approaches in the state, seeking to highlight how the legal guidelines that support the treatment of the problem in this unit of the federation are expressed.

4 Regulations for natural disasters resulting from climate policy in the state

The aim of this topic was to answer a fundamental question for the development of this article: what is the regulation of natural disasters in the state law that instituted the climate change policy in Rio Grande do Sul?

Rio Grande do Sul has been discussing the construction of its state policy since 2009, when the first Rio Grande do Sul Climate Change Forum was established through Decree 45.098/2007.

The Rio Grande do Sul Forum was a milestone for subsequent legislation directly linked to climate change, as shown in the table below:

Table 2. Chronology of Climate Change Regulations in Rio Grande do Sul

Type of Standard	Number	Date	Menu
Decree	**45.098**	15/06/2007	Creates the Rio Grande do Sul Climate Change Forum and makes other provisions.
Ordinary law	**13.302**	01/12/2009	Provides for the broadcasting of official reports warning the population about risks caused by meteorological phenomena.
Ordinary law	**13.594**	30/12/2010	Establishes the Rio Grande do Sul policy on climate change, setting out its objectives, principles, guidelines and instruments, and makes other provisions.
Decree	**50.590**	26/08/2013	Establishes the sectoral plan for mitigation and adaptation to climate change for the consolidation of a low carbon emission economy in agriculture in rio grande do sul - abc/rs plan
Decree	**56.347**	26/01/2022	Provides for the state of rio grande sul to join the "race to zero" and "race to resilience" campaigns under the united nations framework convention on climate change.
Decree	**56.437**	29/03/2022	Provides for the Gaucho Climate Change Forum.
Decree	**57.063**	19/06/2023	Amends decree no. 56.437, of March 29, 2022, which provides for the Rio Grande do Sul climate change forum.
Ordinary law	**15.992**	31/08/2023	Ratifies the memorandum of understanding signed between the states for the creation of an interstate consortium with the aim of tackling the adverse effects of climate change in Brazil.
Decree	**57.323**	20/11/2023	Establishes the climate crisis office.

Source: Prepared by the authors

The Forum was created 15 years ago with the aim of promoting discussion and proposing government actions, including the energy, transport, industry, agriculture, irrigation, forestry and waste treatment sectors, the scientific community, and entities representing organized civil society on issues related to Global Climate Change.

The Decree of the first Forum was revoked and it was re-established by Decree 56.437/2022 with some changes in competence in that year and in 2023 with Decree 57.063.

Based on the debate opened up by the Forum, the state of Rio Grande do Sul enacted its State Policy on Climate Change (PEMC) 3 years after its creation, established by Law No. 13.594 of 30/12/2010.

The main objective of the Gaucho Climate Change Policy was to formalize the state's commitment to the challenge of global climate change. Its purpose was to create conditions for adapting to the impacts of these changes and to contribute to the reduction of greenhouse gasses in the atmosphere, with a view to ensuring sustainable development. These objectives are set out directly in Article 2.

It is important to note that Rio Grande do Sul's climate policy provides for some important governance instruments and that this would be the responsibility of the Intersectoral Commission of State Bodies and Secretariats; the Rio Grande do Sul Climate Change Forum; the Brazilian Research Network on Climate Change and Natural Disaster Prevention (Rede Clima Sul); the State Environment Council; the State Commission for Meteorology, Climatology and Hydrology Activities; and the Executive Secretariat of the Rio Grande do Sul Climate Change Policy.

Governance instruments are essential in climate policies, providing regulatory frameworks and coordination mechanisms to tackle environmental challenges. They guarantee the effective implementation of mitigation and adaptation measures, promoting transparency and the responsibility of the actors involved. They also facilitate collaboration between different sectors and levels of government, promoting an integrated and holistic approach to dealing with climate issues.

Article 8 of the policy establishes the definition of global emission reduction targets at state level, based on inventories of local emissions. It also includes efficiency and reduction targets by sector, aligned with the inventoried emissions of each.

As stipulated by law, Rio Grande do Sul made a voluntary commitment to reduce its total emissions in line with national targets by 2020 and established a timetable as direct policy targets set out in Art. 30 of the PEMC.

Of the commitments made, only the creation of the Gaucho Forum has been fulfilled, 12 years after the Policy was enacted. However, it is important to note that it already existed before the PEMC, and was recreated.

The table below consolidates the targets set in Art. 30:

Table 3. Goals established in the Gaucho State Policy on Climate Change.

Goals	Compliance
1. draw up the methodology for the Public Emissions Registry within one year;	No
2. Publish the results of the Public Emissions Registry within two years;	No
3. Define the indicators and criteria for the Strategic Environmental Assessment and Ecological-Economic Zoning within one year;	No
4. Implement the Strategic Environmental Assessment and Ecological-Economic Zoning within three years;	No
5. Organize the sustainable public bidding model within two years;	No
6. Draw up the State Plan on Climate Change, defining the state target and sectoral targets, within one year;	No
7. Set up the Gaucho Climate Change Forum within six months.	Yes

Source: Prepared by the authors

It is observed, therefore, that there has been a significant lack of support for the perspectives given by the state policy on climate change. This demonstrates a political choice not to structure the territory with effective projects based on regulatory frameworks.

The public record of emissions falls into this area, as the information shows delays and a disconnect from the broader contexts of global agreements and targets, as well as the delayed Ecological-Economic Zoning. Studies for Ecological-Economic Zoning began only in 2012, with diagnostics, workshops, and a series of activities completed in 2019.

The Secretariat for the Environment and Infrastructure (Sema) invested US$ 8.7 million in a consortium formed by the companies Codex Remote, Acquaplan, and Gitec to carry out the zoning. However, the instrument – which should have supported territorial management by considering socioeconomic, environmental, and physical factors for land-use decisions – was never implemented, according to Marcuzzo (2023).

No state regulation for organizing a "sustainable public bidding" was found in the legislative research conducted. The State Fund for Climate Change and Environmental Disasters was never executed (BROSE, 2019).

Advancing the analysis on the regulatory framework in the PEMC (State Climate Policy) specifically aimed at Natural Disasters, the policy uses the term "Disasters" four times directly in the text of its 41 articles, as well as the term "extreme weather events."

There are direct regulations aimed at natural disasters in the Gaúcha PEMC, but, as we will see, with limited or ineffective real impact. Initially, in Article 3, the State Policy states that the State System for its Implementation will include the Brazilian Network for Research on Climate Change and Natural Disaster Prevention – Rede Clima Sul, as well as the State Fund for Climate Change and Environmental

Disasters.

Rede Clima Sul, like the State Fund for Climate Change and Environmental Disasters, never continued. There was news of its creation intention in 2013 and a meeting in 2016 to establish a construction protocol with financial support from the states of the Southern Region, but without further executive action.

As mentioned earlier, the State Fund, also referenced in Article 26, was never materialized. Article 9 states that the sectoral development process should be accompanied by a strategic environmental assessment that includes assistance plans for municipalities for mitigation and adaptation actions to extreme weather events.

In Article 11, when establishing rules for the use of urban and rural land, the Climate Policy mandates that zoning should aim to reduce the effects of climate-related disasters, preventing and minimizing impacts primarily on areas of greater vulnerability. This article also indirectly or specifically addresses disasters, explicitly mentioning phenomena such as "desertification," "wildfires," "fires," "erosions," and "floods."

Land use planning should regulate agriculture, livestock, and extractive activities, adapting production to new climate patterns and water availability, diversifying production to ensure supply, preventing desertification, utilizing degraded areas without compromising natural ecosystems, controlling wildfires and fires, preventing erosion, protecting springs and forest fragments, and restoring biodiversity corridors.

The same article mandates that land use should manage the multiple uses of water, allowing for the protection of water resources, shared and rational water management, and the prevention or mitigation of flood effects. These regulations are of a principled nature, as they are based on a "ought-to-be" directive for norms that may later be developed to regulate land use.

The legislation, in Article 12, included the recognition of a "water attention status" for municipalities where climate change forecasts predict reduced precipitation that significantly impacts the quality of life, local/regional economy, and the environment.

In theory, this would aim to equip the State with management tools for preventive actions and to speed up procedures in emergency situations. Article 14 allows for the use of macro-drainage systems to ensure the protection of water resources and the prevention or mitigation of flood effects.

Based on the outlined data, the following table was created to analyze the regulatory framework present in the Gaúcha Climate Policy regarding natural disasters:

Table 4. Gaucho Climate Change Policy and direct or indirect regulations for Natural Disasters.

Legal provision	**Forecast**
Art. 3:	Composition of the State System for implementing the policy with the Brazilian Research Network on Climate Change and Natural Disaster Prevention - Rede Clima Sul (Southern Climate Network)

Art. 3:	Composition of the State System for implementing the policy with a State Fund for Climate Change and Environmental Disasters
Art.11:	Mitigating the effects of climate-related disasters by regulating land use
Art.11:	Containment of desertification in land use discipline will seek to contain
Art. 11	Control of burn-offs and fires in land use regulation will seek to contain
Art. 11	Erosion prevention in land use regulation will seek to contain
Art. 11	Prevention or mitigation of the effects of flooding on land use discipline
Art. 12	Recognition of a "water alert situation" for municipalities with reduced rainfall
Art.14	Use of macro-drains to ensure the protection of water resources and the prevention or mitigation of the effects of flooding.

Source: Prepared by the authors.

Although Rio Grande do Sul has a State Policy on Climate Change with direct regulations on natural disasters, the state does not have systematic and complex regulations on the issue.

As you can see, the targets set by the PEMC in Rio Grande do Sul have not been met and the regulations put forward for natural disasters are of a limited legal nature, i.e. they only take full effect after other regulations have been put in place. This is especially true of the rules on land use.

One of the important points to note is the lack of implementation of Ecological-Economic Zoning (ZEE) in the state, since this could, in theory, make the provisions of Article 11 of the State Climate Policy more effective.

Another legal instrument that would make the indirect norms present in the PEMC in Rio Grande do Sul fully effective would be a policy focused exclusively on Natural Disasters.

According to MARCUZZO (2023), a draft law that would generate a State Policy for Natural Disaster Risk Management was contracted out to a private business consultancy. This produced thematic tables and seminars with the participation of various institutions, but the document was never forwarded to the Legislative Assembly for a vote.

Climate legislation and natural disasters are interconnected and crucial issues for the sustainability and future of our planet.

According to Rajamani et al (2017) and Carlane and Farber (2022) climate legislation covers laws and regulations established by governments to mitigate the emissions of gases that cause climate change and promote adaptation to its consequences. Generally, these laws, including at the international level, identify the causes and effects of climate change and promote the transition to a low-carbon, climate-resilient economy.

They should include actions to protect and conserve ecosystems and the population vulnerable to disasters (RAJAMANI ET AL, 2017; CARLANE and FARBER,

2022).

By implementing these measures, state governments will be mitigating the adverse effects of climate change and natural disasters, which can intensify as climate scenarios evolve. Extreme weather events, such as heavy rainfall, can cause floods, landslides, agricultural losses, damage to infrastructure and loss of human life.

These disasters can also lead to the displacement of communities, the destruction of natural habitats, the contamination of water resources and significant economic impacts.

The National Civil Protection and Defense Policy, established by Law 12.608/201

establishes that in order to deal with natural disasters, state and federal legislation must include prevention, response and recovery measures

This can involve implementing early warning systems, establishing evacuation plans, building resilient infrastructure, strengthening emergency response capacities and allocating resources for post-disaster recovery.

In addition to the fact that Rio Grande do Sul's PEMC does not dialogue with these premises, Rio Grande do Sul has no systematized regulations for natural disasters in its climate policy, nor does it have specific legislation with prevention and recovery measures in the face of disasters.

The state legal system has only 4 decrees aimed solely at responding to post-disaster emergencies, as shown in the table below:

Chart 5. Standards for Natural Disasters in Rio Grande do Sul

Type of Standard	Number	Date	Menu
Decree	46.774	01/12/2009	Creates a task force to assist the population living in municipalities affected by natural disasters and makes other provisions.
Decree	49.637	01/10/2012	Establishes the inter-institutional commission for the state policy on integrated risk management and responses to natural disasters.
Decree	49.915	30/11/2012	Creates a working group to enable the contracting and monitoring of projects under the national plan for risk management and responses to natural disasters - 2012-2014.
Decree	57.323	20/11/2023	Establishes the climate crisis office.

Source: Prepared by the authors

Some measures that could be included in future laws are: the mapping of areas susceptible to natural disasters, such as floods, landslides, droughts and dry spells; risk assessment to identify critical areas and adopt preventive measures; the implementation of preventive actions, such as the construction of containment barriers, adequate drainage, reforestation of vulnerable areas and the promotion of sustainable agricultural practices to reduce soil erosion; the establishment of early warning systems to provide timely information on impending extreme weather events; the development of emergency response plans to ensure a rapid and

effective response to natural disasters, including coordination between government agencies and the mobilization of resources; and the promotion of adaptation measures to help communities cope with the impacts, such as adopting resilient agricultural practices, encouraging the construction of climate-resilient infrastructure and implementing awareness programs to improve communities' ability to respond (Góis; Verges, 2024).

In addition, legislation should require environmental impact assessments and the application of mitigation measures to reduce disaster risks. It is essential that climate legislation and measures related to natural disasters are integrated and comprehensively address the challenges faced. This requires collaboration between governments, international organizations, the private sector and civil society. Climate legislation and natural disaster management are essential components for promoting sustainability and resilience (Góis; Verges, 2024).

According to the analysis, Rio Grande do Sul has shown itself to be unprepared from a legal and legislative point of view for the future scenarios of climate change, its impacts and the possible intensification of extreme weather events and natural disasters.

6 Conclusion

Although there is a correlation between climate scenarios and the increase in natural disasters in the country and the region, the possibility of this unfolding and the very uncertainty shown about this relationship, as well as the complexity of the variables involved, generate the need, due to the seriousness of the data presented, to develop public policies that allow the population to adapt to climate change and that aim to mitigate greenhouse gas (GHG) emissions as much as possible. Between 2013 and 2022, there was a significant increase in the number of natural disasters in Rio Grande do Sul, which makes it necessary to delve deeper into scientific theories that enable more effective disaster risk management and that take into account future climate scenarios and their interconnection.

Despite the existence of some regulations in the state's climate policy, the institutional framework analyzed, due to its fragility, increases the vulnerability of the population of Rio Grande do Sul. Not only does the unfolding of the framework of public policies and legislation presented for the regional level make the population more vulnerable, since they are fragile and incomplete, but the consequences of future climate scenarios of climate change that are already occurring and the various natural disasters reported, according to the social perceptions gathered by the methods applied. It is also necessary, according to the reference analyzed and given the lack of risk assessment of climate change and natural disasters, to consider and invest in research that analyzes the climate trends exposed in the climate scenarios presented, their implications and the vulnerability of the population that will suffer from the increasingly severe consequences.

The regional and local deployment of climate change policies and sectoral plans at smaller scales is necessary for a region that has a deficit in the legislative and political framework for basic environmental issues. In order to reflect on the innovations that will guide future research, it is crucial to analyze the existing set of public structures and policies aimed at dealing with climate change in the state of

Rio Grande do Sul. And we need to understand whether these policies are being integrated into broader, more comprehensive policies that are linked to environmental preservation or aim to resolve issues related to climate change

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