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Mental health in the age of climate crisis: insights following major floods in Rio Grande do Sul, Brazil

Saúde mental na era da crise climática: reflexões após as grandes enchentes no Rio Grande do Sul, Brasil

Ana Sfoggia[1]
https://orcid.org/0009-0005-8168-8437

Raul Costa Fabris[1]

Aline Mastella Sartori[1]

Clara Sfoggia

Olga Garcia Falceto[2]

ABSTRACT | Climate change is increasingly contributing to the frequency and intensity of natural disasters, with floods being the most common worldwide. This article explores the intersection of climate change — framed within the Anthropocene Epoch — and mental health, focusing on the devastating floods of May 2024 in Rio Grande do Sul, Brazil. It highlights the emerging field of planetary health, which emphasizes the intrinsic connection between human well-being and environmental stability. The study examines the mental health consequences of climate-related disasters, particularly floods, which are linked to increased rates of anxiety, depression, post-traumatic stress disorder, and substance use. It draws on examples from this research group's interventions and projects. The discussion centers on the psychological and social impacts of flooding on affected communities, with particular attention to the cumulative stress experienced by vulnerable populations. The article identifies gaps in the literature regarding the long-term mental health effects of climate disasters — especially among marginalized groups such as children, women, and Indigenous communities, who are disproportionately impacted. It also underscores the need to understand both the direct and indirect consequences of climate events on mental health, including displacement and the breakdown of social structures. This study calls for urgent global action to address the mental health burden associated with climate disasters. It advocates for creative, community-based interventions that incorporate the psychosocial dimensions of these events. Furthermore, it recommends the development of policies that prioritize mental health within climate change response strategies, particularly in low-resource settings, where vulnerability is greatest. Recognizing that each climate disaster adds new layers of stress to already at-risk populations, the article emphasizes the importance of preparedness and coordinated government and community responses. It argues that effective transformations in human-led systems must include collaborative strategies for recovery and long-term resilience, with mental health placed at the core. These strategies should be grounded in a perspective long held by Indigenous peoples: that we are not separate from nature — we are nature.

Keywords | Climate change; environmental disasters; mental health; floods; vulnerable populations; planetary health; ecoanxiety.

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[1]Escola de Medicina, Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porto Alegre, RS, Brazil.
[2]Faculdade de Medicina, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil. Instituto da Família, Porto Alegre, RS, Brazil. Programa de Embaixadores de Saúde Planetária-Brasil, Instituto de Estudos Avançados, Universidade de São Paulo, São Paulo, SP, Brazil.

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Correspondence: Ana Sfoggia
E-mail: ana.sfoggia@pucrs.br

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Introduction

Humans have long been fascinated, intrigued, and simultaneously terrified by climate phenomena, particularly natural disasters. Historically, such events have been closely tied to the development of human civilization and culture, often serving as key inspirations for myths and religions. What distinguishes the present era is that climate change is driving a rise in both the frequency and intensity of environmental disasters. Scientists have linked these changes to what is now referred to as the Anthropocene Epoch. Despite growing concern, there remains limited literature exploring the hypothesis that the Anthropocene may be contributing to the emergence of mental illnesses. Conversely, could the Anthropocene itself be a manifestation of collective human mental dysfunction? This provocative question warrants further investigation and should form the foundation of new research on this topic.

Aiming to explore this premise, this article focuses on floods and their effects on mental health, using as a case study the experience of this research group before, during, and after the floods of May 2024. These floods devastated large areas of Rio Grande do Sul (RS), the southernmost state of Brazil, where the group lives and conducts its work.

What is the Anthropocene Epoch, and how is it associated with climate change and environmental disasters?

The Anthropocene Epoch is an informal geologic term referring to the current period in Earth's history, characterized by the unprecedented impact of human activity on the planet's surface, climate, and ecosystems. It marks the first time a single species has so rapidly and extensively altered the conditions that sustain life on Earth. The intensive use of fossil fuels to power industry, along with the widespread application of pesticides in agriculture, has triggered a cascade of environmental changes that pose serious threats to global ecosystems. Among these changes is a global temperature increase of approximately 1.5 °C compared to pre-industrial levels.

Based on findings from scientists at the Stockholm Resilience Center — first reported by Rockström et al. in 2009 (1) and later expanded by Steffen et al. in 2015 (2) and Richardson et al. in 2023 (3) — Earth functions within nine planetary boundaries that allow humanity to continue developing and thriving for future generations. The studies show that these boundaries are increasingly being violated, with worsening trends in areas such as climate change; biosphere integrity (including biodiversity loss and species extinction); depletion of the stratospheric ozone layer; ocean acidification; disruption of biogeochemical cycles (such as phosphorus and nitrogen); land-system changes (such as deforestation); freshwater overuse; atmospheric aerosol loading (tiny particles in the air that affect climate and living organisms); and the introduction of novel entities, such as plastic, which has already been detected in human milk and brain tissue (4). Currently, six of the nine boundaries have been transgressed, and it is clear that they are interdependent (Figure 1).

What is the relationship between mental health and planetary health?

Physical and mental health are intrinsically linked to planetary health. The literature

highlights rising global temperatures and increasing air pollution, largely caused by the burning of fossil fuels and forest fires — such as those that occurred in Brazil in September 2024. These factors have been associated with higher rates of anxiety, depression, psychosis, suicide, violence, and increased use of mental health services.

Prolonged stress resulting from the direct experience of extreme climate events and their consequences — including food and water insecurity, forced migration, poverty, and cultural disruption — leads to significant mental health burdens. These include post-traumatic stress disorder (PTSD), anxiety, mood disorders, and substance use.

In a systematic review and meta-analysis, Braithwaite et al. (5) identified an association between long-term exposure to fine particulate matter (PM2.5) and depression, as well as possible associations between long-term PM2.5 exposure and anxiety, and between short-term PM10 exposure and suicide.

Two recent studies present alarming findings (6,7). One, conducted in the United States, and the other in China, are population-based studies that show a strong association between rising PM2.5 levels and suicide. The 2023 U.S. study reported that a 13% increase in PM2.5 from forest fires was associated with a 2% rise in suicide rates in rural areas already affected by high suicide incidence. The Chinese study, which covered the entire country, found that a one standard deviation (SD) increase in PM2.5 was linked to a 25% increase in weekly suicides as an immediate effect. The authors concluded that there is likely a neurobiological impact on emotional regulation and impulsivity. They also noted that China's Air Pollution Prevention and Control Action Plan contributed to a nationwide decline in suicide rates.

Additionally, awareness of current and future risks associated with the climate crisis, combined with inadequate leadership responses, can give rise to distressing climate-related emotions. While these

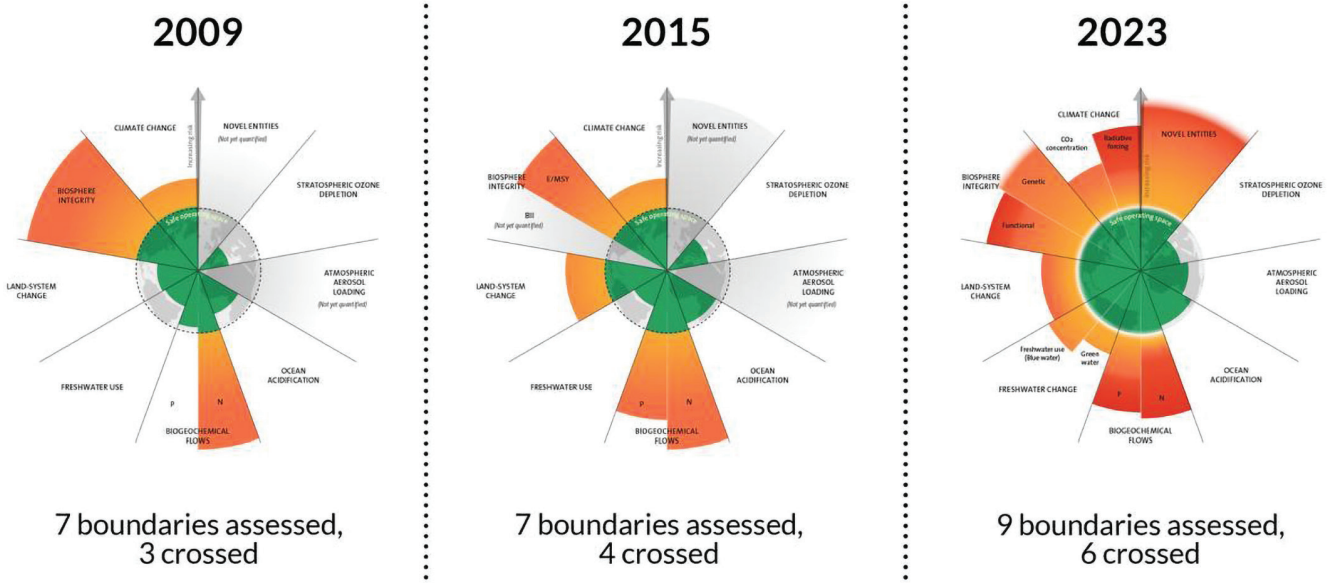

Figure 1. Azote for Stockholm Resilience Centre, based on analysis in Richardson et al. (3).

emotions are not necessarily pathological and may even foster resilience, they still pose a threat to mental health and well-being (8).

The emerging field of planetary health emphasizes the intrinsic connection between humans and nature, recognizing that humans are part of nature. It offers a new perspective on health by seeking the highest possible level of well-being, and by highlighting the need for international equity. This approach calls for balancing the management of human political, economic, and social systems with the Earth's natural systems, which define the boundaries within which humanity can thrive (9).

The impacts of floods on mental health

Although various climate-related disasters affect human health in different ways, floods warrant particular attention, as they are the most frequent global disaster and are responsible for significant economic, structural, and environmental losses (10). Data from the past 30 years indicate that, compared to other natural disasters, floods have disproportionately affected human populations. Between 1980 and 2009, approximately 2.8 billion people were affected by flood events, with 4.5 million left homeless, around 540,000 deaths, and 360,000 injuries (11).

Population growth, climate change, and environmental degradation have increased human vulnerability to floods. This results not only in higher morbidity and mortality but also in indirect consequences such as displacement, extensive damage to agriculture and property, and adverse effects on human health (12). Most flood-related fatalities occur in developing countries, and with the projected rise in extreme rainfall events due to climate change, both the frequency and severity of floods are expected to increase in the future (13).

Drowning is the leading cause of mortality during floods, but other significant health effects often emerge in their aftermath. Systematic reviews have shown that floods can trigger or worsen mental health disorders. One review reported increased rates of PTSD, anxiety, depressive symptoms, and the use of alcohol and tobacco, as well as significantly reduced psychological well-being and quality of life in areas affected by river flooding (14-16).

However, few studies have investigated the long-term mental health impacts of floods. Most research focuses only on the first year after the disaster and lacks medium- or long-term follow-up (14,17). Although factors such as the scale of the disaster, extent of losses, pre-existing mental health conditions, and socioeconomic status likely influence outcomes, there is a clear gap in research addressing these variables and in identifying potential mediators and confounders. There is also a lack of research on specific populations (e.g., women, children, individuals with disabilities or pre-existing conditions, Indigenous communities, and older adults) despite preliminary evidence suggesting that these groups are disproportionately affected by climate change (18-21).

Moreover, while flood-related mortality varies depending on the region, level of economic development, and event severity, most deaths occur in densely populated and less developed countries. However, a review on climate change and health in urban informal settlements (22) identified only one relevant study from Latin America, which examined the mental health effects of floods in Peru (23). Other reviews did not include any studies from South America, with

most of the available research concentrated in southern and eastern Asia. This highlights a significant lack of published research on the mental health impacts of ecological disasters in Global South countries (24).

Recent environmental disasters in RS, southern Brazil

Southern Brazil is the most disaster-prone region in the country and experiences nearly all types of climatic phenomena annually, including flooding, drought, cyclones, frost, and landslides (25) (Figure 2). A study conducted in the area of the Uruguay River, a major waterway in RS, identified more than 25 significant flood events between 1980 and 2005, which displaced residents and caused damage to infrastructure and agriculture. During this period, a state of public calamity was declared seven times, highlighting the high vulnerability of populations living near the riverbanks (26). More recently, following three years of drought in RS, the state experienced three consecutive floods — in September and November 2023, and May 2024 (Figure 3). The May 2024 floods further revealed RS's

Figure 2. Distribution of major natural disasters across the macro-regions of Brazil. Disaster categories include flooding, drought, flash flood, wildfires, windstorm, tornado, cyclone, frost, hail, and rock/soil landslide. Source: Guia de preparação e respostas do setor saúde aos desastres (25).

vulnerability to natural disasters, affecting 469 of the state's 496 cities and impacting approximately 2.3 million people — nearly one-fourth of the population — displacing 600,000 of them. This catastrophic scenario required an immediate and effective response. In the absence of adequate governmental support, volunteers mobilized spontaneously, establishing shelters and playing a crucial role in assisting those left homeless. The prolonged exposure to such a severe situation — with floodwaters receding only after one month — may have had a significant impact on the mental health of the affected population. Even individuals who were not initially displaced, as well as volunteers supporting the response, were also directly or indirectly affected by the extreme weather event (27).

Follow-up of the September and November 2023 floods

Floods cause immediate life-threatening and traumatic experiences with long-term consequences. This is illustrated by the summary of several cases followed by one of the authors (CS) in Roca Sales, a city of 11,000 inhabitants near Porto Alegre, which was devastated by a cyclone and flood in September 2023. The event was associated with El Niño and ocean warming. The entire city, not only the poorer areas near the river, was left in ruins, covered in mud, with overturned vehicles, debris from homes, and fallen trees. The local hospital was also completely destroyed.

Figure 3. Guaíba Lake exceeds 5 meters. Public Market is surrounded by water, and a boat is seen on Borges de Medeiros Avenue, Historic Center of Porto Alegre, state of Rio Grande do Sul. Mateus Bruxel, RBS Agency, April 5, 2024.

A child developed anxiety and refused to eat whenever it rained, associating rainfall with the traumatic event. These behaviors, such as restlessness and fear, were observed during follow-up assessments, highlighting the lasting psychological effects of natural disasters on children and the need for timely mental health interventions.

One of the most dramatic cases was that of a woman with a prior history of depression and suicidal behavior who witnessed her husband drown without being able to help. She was rescued by a helicopter along with her two daughters. Initially, she exhibited intense grief, a worsening of depressive symptoms, and suicidal ideation (28). However, despite the initial severity of her condition, consistent with known risk factors, she gradually showed significant improvement throughout treatment and follow-up. Her case illustrates the potential for recovery, even in individuals with pre-existing mental health conditions, when timely and appropriate psychiatric support is provided.

Another case involved a middle-aged woman who began psychiatric treatment after losing her daughter and granddaughters in the flood. Her daughter's body was found only months later, which intensified her pain and deepened her sense of helplessness in the face of death. She alternated between episodes of anger and sadness. She has been receiving support from the local mental health and social assistance team and has benefited from follow-up care, though she has refused medication. Instead, she expressed a desire to speak with someone who could help her process her grief and adapt to her loss. At present, she continues with her life in a city left devastated by the disaster.

Victims' experience at the shelters during the RS floods of May 2024

> "*I dream almost every night that I am drowning and wake up with severe pain in my arms.*"
>
> "*I can't go out by car, driving has become a torture, and I keep imagining getting stuck on a street if it starts raining.*"
>
> "*If I look at the marks left on the walls, showing how high the water rose, my heart races, and I get scared that I might relive it all again.*"
>
> "*Stormy days are very difficult; I can't concentrate on work.*"

These are the words of a patient directly impacted by the floods in Canoas, one of the most severely affected cities in RS. She received care during a period in which volunteer physicians provided prescription renewals and clinical and mental health support to flood victims. Three months after the disaster, her anxiety and depression had significantly worsened, accompanied by symptoms of hopelessness, anhedonia, and stress — likely indicating PTSD. She was prescribed an antidepressant, referred to psychotherapy, and advised to attend regular follow-up appointments.

This case underscores a critical issue in the aftermath of such disasters: beyond the immediate trauma, survivors must continue to grapple with ongoing fear, helplessness, and uncertainty — especially as natural disasters become increasingly frequent.

The value of qualitative data

Why does qualitative data such as the above matter? Qualitative studies provide essential insights into the unique emotional and psychological impacts of floods — insights that quantitative data alone often cannot capture. This is particularly important in low- and middle-income countries, where vulnerabilities differ significantly. In a review by Fernandez et al. (14), the authors identified a notable gap in qualitative research from developing countries, as all included studies had been conducted in the Global North. It is therefore essential for the Global South to contribute more actively to this body of research, ensuring that the voices of those affected by floods in these regions are also heard. Such studies not only shed light on the personal experiences of flood survivors but also provide a deeper understanding of how these disasters affect mental health in developing contexts. Findings from qualitative research often align with those from quantitative studies, reinforcing the importance of a comprehensive approach. The use of mixed-methods research is crucial to fully understand flood-related mental health outcomes and to develop mental health interventions and policies that address the specific needs of these populations (14).

Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS)'s Mental and Planetary Health research projects

Our research group has previously published two studies on this topic. The first is a case report describing the experience of a psychiatrist providing mental health care in Roca Sales, a small city in southern Brazil that was severely affected by a cyclone and flood in September 2023 (28). The second study analyzes the mental health response during the May 2024 floods in RS, focusing on the implementation of structured interventions at a shelter established by PUCRS (27). A multidisciplinary team developed a crisis intervention and management workflow that included risk stratification, integration of mental health records into the national e-SUS system, and an equitable strategy for medication distribution.

Another study currently being developed by PUCRS's Mental and Planetary Health research team focuses on the mental health evaluation of volunteers who worked during the flood period. The study includes validated questionnaires to assess symptoms of anxiety, depression, eco-anxiety, and resilience. Its primary goal is to identify these symptoms in order to contribute to evidence-based public policies for crisis management. Additionally, the study aims to identify protective factors that enhance resilience, promoting these factors as part of public health strategies to improve community preparedness and mental health in future crises. This research project is currently under review by the designated ethics committee of PUCRS under protocol no. 86236924.8.0000.5336.

Furthermore, recognizing that in disaster contexts both the population and professionals are equally affected, new and creative approaches are necessary. Our group is currently testing an alternative intervention based on a broader concept of community: the Families Befriending Families Project, which aims to foster emotional support during disasters. The project emerged from the recognition that many families living far from the disaster zone also experience emotional distress and wish to help in ways that go beyond donating goods or money. The underlying hypothesis — that

nonprofessional individuals can provide meaningful support and, in doing so, also benefit emotionally from the act of helping — is being tested in a pilot study, which has shown promising preliminary results. The idea originated from the personal experience of one of the authors (OGF), who, while treating families, faced the emotional challenge of being unable to return to Porto Alegre during the flood. Confronted with a sense of helplessness, she sought a way to offer support from a distance — drawing on her personal and professional experience to transform that feeling into a meaningful initiative for those in need.

Recommendations

Based on current literature, governmental disaster response guidelines, and our research group's experience during the recent floods in RS, several key recommendations emerge for strengthening mental health responses in disaster scenarios (25,27,29).

First, community-based interventions should be prioritized, as affected populations often rely on their communities for support. This highlights the importance of establishing community centers capable of providing psychological, financial, and housing assistance (17,30,31).

Additionally, training community members in high-risk flood areas is an effective preparedness strategy, as it strengthens community resilience and supports recovery from flood events (31-33). The absence of flood warnings has been associated with higher levels of anxiety and PTSD symptoms when compared to situations where warnings were issued 12 hours or more in advance. This underscores the need for early warning systems and broad access to emergency alerts, particularly in high-risk areas (34).

Furthermore, displacement and the loss of a sense of home and community represent significant secondary stressors that influence long-term mental health outcomes. This reinforces the need for policies that prioritize rapid housing solutions for affected populations (34). Temporary housing facilities should meet basic humanitarian standards, including adequate provisions of food, water, sanitation, clothing, and recreational activities to help restore a sense of normalcy (29).

Support for grief and psychological stressors should be made available, particularly for vulnerable populations such as children, older adults, and individuals from low socioeconomic backgrounds. Long-term mental health services must be structured to address conditions such as PTSD and prolonged grief disorder, ensuring continuity of care beyond the initial emergency phase. Special attention should also be given to individuals with pre-existing mental health conditions, as disasters and disruptions in treatment may exacerbate their symptoms. For those requiring specialized care, access to trained mental health professionals and psychiatric medications must be guaranteed (25,28,29).

Acknowledging the psychological burden of disaster response on volunteers is also essential. Support strategies for frontline workers should include early identification of professional burnout (35).

Finally, governmental guidelines emphasize the need for a coordinated, multidisciplinary approach in emergency shelters to optimize the allocation of human and material resources within healthcare settings. Establishing a structured workflow for crisis management — including risk stratification, integration of mental health records with national health systems,

coordination between healthcare professionals and volunteers, and equitable distribution of medications — can help ensure efficient and fair care in disaster scenarios. The use of digital platforms, such as the e-SUS system, facilitates information sharing and continuity of care, particularly for individuals with pre-existing health conditions (25,28,36).

By integrating these psychosocial interventions into disaster response plans, it is possible to reduce the psychological burden on affected populations and strengthen community resilience in future crises (27,29).

Conclusions

The disastrous consequences of the May 2024 floods in Rio Grande do Sul were the result of both natural events — whose intensity and frequency have increased due to climate change — and human errors, such as the lack of adequate maintenance of anti-flood infrastructure in Porto Alegre, the state capital. According to the World Bank, the Organization for Economic Cooperation and Development (OECD) estimates that adapting infrastructure to climate change will require an average annual investment equivalent to 0.8% of Brazil's gross domestic product (GDP) between 2022 and 2030 (37). Although substantial, this investment could prevent even greater economic losses in the future.

Mental health professionals must be aware of the interface between mental health and planetary health. This includes understanding, for example, the effects of heat waves on patients using psychiatric medications (38) as well as the eco-anxiety related to climate change that can negatively affect mental well-being. It is also important to recognize how these emotions can be identified and transformed into positive action — an approach that may be supported by a climate-aware therapist.

Furthermore, although anxiety and other emotional responses to climate-related changes are not always pathological, they can trigger mental health disorders or exacerbate pre-existing conditions. Each new climate event places additional stress on already vulnerable populations, compelling them to confront uncertainty and fear. The insecurity of living in disaster-prone areas, combined with insufficient governmental response, underscores the relevance of this issue for health professionals and highlights the need for continued research in the field. Given the projected increase in climate-related impacts, understanding the emerging mental health demands has become urgent. The reality is clear: climate change is already reshaping our daily lives, our perception of human influence on the environment, and the pressing need for immediate interventions to support the mental health of populations under constant exposure.

In conclusion, both local and planetary action are urgently needed. Additional attention to preparedness and mitigation strategies — especially in less developed countries, where the majority of floods occur — can reduce the impact of future flood events (11). Developing prevention strategies and emergency responses that focus on the social dimensions of climate disasters, that are both effective and sensitive to vulnerabilities, and that are built in collaboration with affected populations and local institutions using creative psychotherapeutic approaches is a challenge we must confront. As stated in the São Paulo Planetary Health Declaration, a great transformation in human behaviors is necessary: "This great transition demands

a rapid shift in how we produce and consume food, energy, and manufactured goods; requires rethinking the way we design and live in the world's cities; and insists we heal our relationship with nature and to each other. Such a paradigm shift requires participation of every sector, every community, and every individual" (9).

In *Ideas to Postpone the End of the World*, Indigenous writer and philosopher Ailton Krenak argues that the current environmental crisis is rooted in society's concept of "humanity" as something separate from the Earth itself. This perception, he suggests, has served to justify the exploitation of nature (39). We, as humans, cannot continue to forget that we are part of nature. The perception of humanity as dissociated from nature may represent an unrecognized mental illness — one that most of us are currently experiencing.

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