Dossier: Adaptation to extreme climate events and socio-environmental resilience: impacts, challenges, and strategies

Dossiê: Adaptação a eventos climáticos extremos e resiliência socioambiental: impactos, desafios e estratégias

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The intensification of extreme climate events is one of the clearest signs of the unfolding climate crisis (IPCC, 2021). Rising global average temperatures have increased the frequency and severity of heatwaves, droughts, wildfires, storms, and floods, with growing economic, social, and ecological impacts. These events do not affect everyone equally: their consequences are unevenly distributed, reflecting and deepening pre-existing vulnerabilities (Muñoz *et al.*, 2025). In Brazil, low-income populations, traditional communities, Indigenous and Quilombola peoples, family farmers, and residents of peripheral urban areas face disproportionate risks due to both higher physical exposure and limited adaptive capacity (Suárez; Bello; Campbell, 2024). Gender, race, age, and public health conditions are also crucial to consider.

Inequality is therefore a central vector of climate risk — and within this context, justice and equity must guide the implementation of the adaptation agenda. Adapting to new climatic conditions means not only protecting infrastructure and ecosystems, but also addressing historical asymmetries and ensuring that the benefits of climate action are shared fairly and inclusively.

In the early years of the United Nations Framework Convention on Climate Change (UNFCCC), established in 1992, the emphasis was on mitigation, while adaptation was seen as a residual response, necessary only to deal with potential future impacts. The prevailing belief was that mitigation efforts would be enough to prevent the worsening of climate change, mirroring the success of the Montreal Protocol in protecting the ozone layer. This perception changed significantly with the Paris Agreement in 2015, which recognised that mitigation efforts, although essential, would not be sufficient to contain all the impacts of climate change. Since then, adaptation has rapidly gained political and technical prominence, driving debates on planning, finance, and the monitoring of actions at multiple scales. COP30, held in Belém in 2025, marked a decisive turning point. Among the central issues discussed

were the definition of global targets to assess adaptation progress — the Global Goal on Adaptation (GGA) — and climate finance for adaptation.

Adaptation is more than an isolated action: it is a systemic process. It involves both immediate responses to risks and structural transformations aimed at reducing exposure, moderating vulnerabilities, and building socio-environmental resilience. Adaptation unfolds across multiple scales — from local to global — and depends on the articulation of traditional knowledge, scientific understanding, technology use, behavioural change, and the implementation of supportive public policies. Its effectiveness is linked to the ability to understand risks, anticipate impacts, and plan integrated responses. It requires a shift away from a "disaster economy", where spending on recovery and reconstruction is counted positively in indicators such as GDP, towards an "adaptation economy" grounded in prevention and resilience (Do Lago, 2025).

In this sense, adaptation is not only technical but also social and cultural. It involves reorganising ways of life, strengthening community networks, and valuing local and traditional knowledge (Dorji *et al.*, 2024). Technological strategies such as early warning systems, resilient infrastructure, and agricultural innovation are fundamental. However, they must be complemented by ecosystem-based approaches that recognise nature's role in reducing climate risks (Morecroft *et al.*, 2019). Likewise, social technologies and traditional management practices offer effective pathways to foster socio-environmental resilience, particularly in rural areas and low-income urban contexts (Lindoso *et al.*, 2017).

Strengthening resilience requires acknowledging that adaptation is a continuous, dynamic and often uncertain process. Actions should be planned based on climate scenarios and adjusted as new information and experience emerge. This demands flexible, collaborative institutions capable of learning from their territories and incorporating multiple voices into decision-making, including the exchange of both local and international experiences. The integration of sectoral policies — such as urban planning, water resources, agriculture, and health — is equally essential, as climate impacts cross institutional and geographical boundaries (Di Giulio *et al.*, 2025). Technical and scientific knowledge must engage with empirical and community knowledge, recognising the diversity of adaptive actions which, while not always sufficient to address all impacts, remain necessary.

The Dossier **"Adaptation to extreme climate events and socio-environmental resilience: impacts, challenges, and strategies"** aims to contribute to this debate. It brings together studies that explore different dimensions of adaptation — from risk and vulnerability assessments to the evaluation of public policies, local practices, and adaptive technological and institutional innovations. The articles cover different Brazilian regions (South, North, and Southeast) and illustrate the theme through emblematic disasters such as the historic floods in Rio Grande do Sul (2024), as well as recurrent events such as extreme river levels in the Amazon and hydro-geological disasters in the Serrana region of Rio de Janeiro.

By articulating interdisciplinary perspectives, the special issue highlights that adaptation is simultaneously a scientific, political, and ethical challenge. Understanding how human societies and ecosystems can coexist, respond, and transform in the face of a changing climate demands cooperation, solidarity, and long-term vision. The reflections gathered here may inspire new approaches and policies that strengthen socio-environmental resilience and promote a fairer, safer, and more sustainable future.

In the opening article of the issue, *"Ups and downs of public attention on climate change: the southern Brazil floods through Anthony Downs's issue-attention cycle"*, Lefèvre *et al.* examine public attention during the 2024 disaster in the State of Rio Grande do Sul by analysing the media coverage of a major news outlet. They reflect on the short-lived yet significant "window of opportunity" opened by the social and media repercussions in the weeks following the disaster for implementing more assertive adaptive actions.

The second article, *"Social action to address the climate catastrophe of May 2024 in the Porto Alegre Metropolitan Region: developing a contingency plan to build socio-environmental resilience at the Filhos de Sepé settlement"*, Schreiner *et al.* describe the impacts and analyses the collective community process involved in drafting a contingency plan. The study provides important evidence and reflections on the role of social organisation, community-based strategies, and engagement with public policies in building climate resilience among historically vulnerable populations.

The article *"Climate change and the adaptive adjustments of traditional extractive communities in the Médio Juruá territory, Central Amazon"* illustrates the dynamics of impact and response among Amazonian extractivist communities facing rising temperatures and hydrological disasters. Through semi-structured interviews and content analysis, Guimarães *et al.* identify elements of the relationship between climate and daily practices, perceptions of environmental change over recent decades, and a catalogue of autonomous responses to these changes.

In the fourth article, *"Perceived impacts of natural disasters in the Serrana Region of Rio de Janeiro, as reported by members of support organisations"*, Maia *et al.* discuss the perceptions of actors involved in disaster response regarding the impacts of hydro-geological disasters on populations in the mountainous municipalities of Rio de Janeiro. The results show that impacts cut across multiple dimensions of affected people's quality of life — not only the immediate and visible ones, such as loss of housing and the challenges of securing temporary shelter or safe long-term accommodation, but also subtler consequences with long-term effects, including impacts on mental health.

Finally, the fifth and sixth articles contribute to the development of systems for assessing urban climate risk. In *"Municipal climate vulnerability in Western Paraná (2012–2024): a multivariate approach for territorial planning"*, Piacentini *et al.* apply statistical methods to cluster municipalities in the State of Paraná according to socio-economic typologies and climate-risk profiles. The discussion highlights the potential of this approach to support territorial planning and guide more effective adaptive public policies, emphasising the local specificity of exposure and vulnerability, and the need for contextualised adaptation planning.

The article *"Spatial distribution of socio-environmental vulnerability in urban flood-prone areas in the Municipality of Araruama-RJ"* uses the municipality of Araruama (Rio de Janeiro) as a case study. Combining socio-economic data, spatially explicit information on flood susceptibility, and media reports, Silva *et al.* produce an intra-municipal map of climate risk. By integrating social and biophysical vulnerability, the work highlights the spatial heterogeneity of climate risk and the inherently context-specific nature of adaptation as a political process.

Enjoy your reading!

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