The Silent Crisis: Climate Change, Water Scarcity, and Groundwater Depletion in Brazil

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Abstract:

Although Brazil has abundant water resources, some regions face severe and multifaceted water crises driven by irregular precipitation, overexploitation of groundwater, widespread deforestation, and inefficient water management. This study provides a comprehensive assessment of current water crises conditions across the country and evaluates the potential impacts of future climate change on water availability. Climate projections were assessed under two emissions scenarios—SSP245 and SSP585—based on bias-corrected CMIP6 data for three future periods: 2025–2050 (F1), 2050–2075 (F2), and 2075–2100 (F3). Results indicate substantial and progressive increases in average temperature across all scenarios and timeframes. Under SSP245, projected warming reaches approximately 1.02°C, 1.56°C, and 1.94°C for F1, F2, and F3, respectively; under SSP585, these increases intensify to 1.38°C, 2.43°C, and 3.66°C. The most significant warming is expected in Brazil's western and central regions. Precipitation trends exhibit marked spatial heterogeneity, while modest increases are projected in parts of the Northeast and South, reductions are anticipated in the northern and eastern coastal regions. These drier areas are also projected to face an increase in the average number of dry days per year, exacerbating drought risk and further destabilizing hydrological regimes. The compounding effects of rising temperatures and altered precipitation patterns pose a significant threat to hydrological equilibrium, primarily by reducing surface water availability and limiting groundwater recharge. Climate change is projected to directly reduce GWR by up to -666 mm/year. The Bauru-Caiuá Aquifer System is projected to experience the most severe reduction in GWR, with a decrease of up to -27.94%. Other aquifers, such as Bambuí Cárstico, Furnas, Guarani, Parecis, Ponta Grossa, and Serra Geral, are also expected to face significant reductions in recharge. These findings underscore the urgency of implementing adaptive and integrated water

resource management strategies to mitigate climate-related impacts and ensure long-term water security across Brazil. This work is part of the FAPESP Thematic Project SACRE | Integrated Water Solutions for Resilient Cities (processes 2022/05950-6 and 2022/15693-0).

Keywords:

Water crises, Groundwater overexploitation, Deforestation.