

Briefing Note

A briefing on research from the Climate Science for Service Partnership (CSSP) Brazil for decision-makers

Science, policy and society: working together to mitigate extreme events across Brazil

Each year, on average, Brazil is affected by 216 flash floods, 717 droughts and 18 landslides, causing devastating losses to human life and costing the Brazilian economy more than 10 billion R\$ (see table below; CEPED UFSC, 2020). Such extreme events are becoming more common and scientists agree that this trend will continue under global warming (IPCC, 2013). Recent research into these extremes is helping to inform policy decisions in Brazil.

Mitigating extremes through collaboration

Collaboration between scientists, policy-makers and society is key for Brazil to adapt to the changes occurring due to climate change (Serrao-Neumann et al. 2021).

While it is clear that on a global level, action must be taken to limit global warming and adapt to increasing extremes, on a local level, the best mitigation actions to be taken can remain unclear.

Scientific research can solve this issue by using local weather and climate data to examine the changes that are occurring or to project the changes that will occur in a localised area.

These local climate projections can be used to evaluate the cost and benefit of different adaptation options. This type of local research into changing climates and extreme events is exactly what Jose Marengo and his colleagues at the National Center for Monitoring and Early Warning of Natural Disasters in Brazil (Cemaden) are doing. This briefing note gives an overview of some of their recent research on extreme events across Brazil.



Key findings

- Collaboration between scientists, policy-makers and society will help Brazil to adapt to changes occurring due to climate change.
- The climate in the Eastern Amazonia-Cerrado agricultural frontier is changing and the area may be unsuitable for further agricultural expansion.
- Long-term drought adaptation strategies would be useful in Northeast Brazil. Potential options include: improved water resource management; better education and switching to crop varieties that are more resistant to high temperatures and water scarcity.
- The risk from landslides and flash floods will increase under global warming, particularly in South, Southeast and Northeast Brazil. Risk maps have been created to allow mitigation strategies to be placed in areas most at risk.
- Investigation of how a heatwave worsened the 2020 drought in the Pantanal has helped to improve capacity to forecast drought.
- Scientists and decision-makers worked together on the METROPOLE project in Santos, Brazil, allowing informed policy decisions to be made, choosing adaptation strategies which had the greatest benefit.

Extreme events in Brazil	Flash floods	Landslides	Drought
Average number of events in Brazil per year 1995-2019	216	18	717
Average annual cost to Brazilian economy 1995-2019	2.2 billion R\$	250 million R\$	8 billion R\$
Regions of Brazil most at risk (% of events in Brazil 1995-2019 occurring in this region)	South (35%)	Southeast (63%)	Northeast (71%)
	Northeast (30%)	South (16%)	Southeast (14%)
	Southeast (26%)	Northeast (12%)	South (13%)

Data from CEPED UFSC (2020)

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Research is helping policy-makers deal with extreme events across Brazil



Understanding drought-heat interaction in the Pantanal



Comparing drought mitigation options in Northeast Brazil



Estimating future risk from landslides and flash floods



Investigating the changing climate of the Amazonia-Cerrado agricultural frontier



Evaluating flood adaptation strategies in Santos, Southeast Brazil

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South, Southeast and Northeast Brazil: Estimating future risk from landslides and flash floods

Global warming is predicted to cause changes in heavy rainfall patterns across Brazil, leading to an increased risk of landslides and flash floods. Marengo et al. (2021d) found that the South, Southeast, and east or coastal section of Northeast Brazil will be most at risk. These are densely populated areas with tourist resorts and key infrastructure, with the poorest and most vulnerable people living on the outskirts of large cities most exposed. The creation of landslides and flash flood risk maps are useful to allow mitigation strategies to be placed in areas most at risk, or where the adaptation would have the greatest positive impact. This work was supported by CSSP Brazil, Met Office, Cemaden and INPE. See Marengo et al. (2021d) for more detail.



Landslide in Santos city, Brazil.

Northeast Brazil: Comparing drought mitigation options

Marengo et al. (2021a) evaluated possible adaptation strategies to the drought that affected Northeast Brazil from 2012 to 2017. The drought played havoc with the local agricultural economy, with many of the poorest farmers and rural workers forced to rely on short-term government relief policies. By 2017, the drought had caused 2% of the land in Northeast Brazil to turn to desert – this is projected to rise to 54% by 2100, if global warming continues (Marengo et al. 2020). Longer-term adaptation strategies, such as switching to crop varieties that are more resistant to high temperatures and water scarcity, could help farmers in the region adapt to such changes. Other strategies, such as improved water resource management, better education and seasonal drought forecasting would also help to improve the adaptive capacity of local communities. This work was supported by CSSP Brazil, Cemaden, INPE UNSP and University of Leeds. See Marengo et al. (2020) and Marengo et al. (2021a) for more information.



The 2012-2017 drought in Northeast Brazil hit crops and dented the local economy.

Central West Brazil: Understanding drought-heat interaction

In the Pantanal region of Brazil – the world's largest tropical wetlands – recent drought caused a record number of wildfires in 2020, with one third of the area burned (Marengo et al., 2021b). This had significant impacts on the growth of crops in the region and caused the Paraguay river to fall to unusually low levels, stopping the transportation of crops for export along the river, causing major losses to the regional economy.

Research by Marengo et al. (2021c), found that the heatwave that affected Brazil from September to November 2020, intensified the drought already affecting the Pantanal, causing a compound drought-heat event.

While prolonged extreme temperatures, or heatwaves, are well known to cause illness and deaths, and droughts can lead to wildfires and water scarcity, destroying crops and natural vegetation, the effects of a so-called 'compound event' can be even worse.

Learning more about the interaction between heatwaves and drought will help improve our ability to accurately forecast droughts, allowing policy-makers to make informed decisions, choosing appropriate mitigating actions based on the forecast. This work was supported by CSSP Brazil, Met Office, Cemaden and INPE. Please see Marengo et al. (2021b) and Marengo et al. (2021c) for more information.

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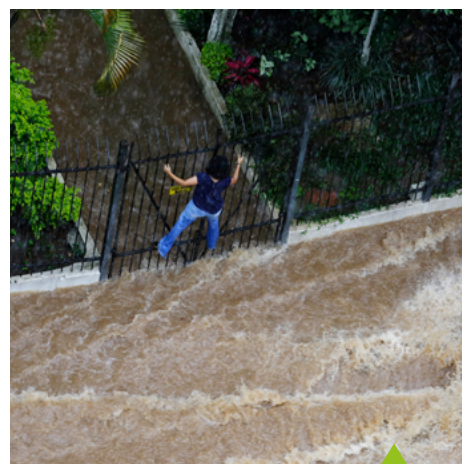
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Southeast Brazil: Evaluating flood adaptation strategies

In 2017 the METROPOLE project was successful in helping local stakeholders in the coastal city of Santos, Southeast Brazil, decide how to adapt to floods caused by rising sea levels. To tackle the city's growing problems, a group of scientists, policy-makers and residents came together to create the METROPOLE project (Marengo et al. 2017).

METROPOLE used sea level rise projections from research by climate scientists to estimate the cost and benefits of various adaptation strategies. State-of-the-art visualisation tools were then used to demonstrate the potential of each option. This allowed stakeholders to come to an informed decision, choosing flood adaptation strategies agreeable to all.

A key benefit of the METROPOLE project was how it highlighted the usefulness of research into weather extremes for informed policy decisions. This work was supported by Belmont Forum, Cemaden, INPE, USP, IG, Municip. Santos, UNICAMP, Univ. of South Florida and Kings College. See Marengo et al. (2017) for more information.



Flooding in Santos, Brazil.

North Brazil: Investigating the changing climate of the Amazonia-Cerrado agricultural frontier

Between the biomes of the Amazon rainforest and the Cerrado savannah, lies a transition region known as MATOPIBA, as it includes the states of Maranhão, Tocantins, Piauí and Bahia. Over the last 20 years, agriculture business has rapidly grown in MATOPIBA, with native vegetation destroyed to make way for cattle or crops such as soybeans. The region typically has a wet season, a dry season and seasons in-between. Research by Marengo et al. (2022) found that the climate of the region has changed over the last decade, with the dry-to-wet in-between seasons tending to be longer, warmer and drier. The authors also found that the onset of the dry season was occurring later than in previous decades. These changes are likely to reduce the productivity of crops in the area, making it less suitable for continued agriculture expansion. This work was supported by CSSP Brazil, Cemaden, INPE, Univ of Valencia and IRD-CNRS. See Marengo et al. (2022) for more information.



A stark example of deforestation in the Cerrado region of Brazil, to make room for soybean production.

Further reading

CEPED UFSC (2020) IPCC Fifth assessment report (2013), Chapter 1: Introduction. Marengo et al. (2021c), DOI: 10.1002/joc.7365

Marengo et al. (2017), DOI: 10.1007/s11069-017-2855-x Marengo et al. (2022), DOI: 10.1038/s41598-021-04241-4

Marengo et al. (2020), DOI: 10.1007/s11069-020-04097-3 Marengo et al. (2021d), DOI: 10.3389/fclim.2021.610433

Marengo et al. (2021a), DOI: 10.1002/cli2.17 Marengo et al. (2021b), DOI: 10.3389/frwa.2021.639204

Serrao-Neumann et al. (2021), DOI: 10.1038/s41558-021-01221-4