Effect of Drought Gradients in Amazon Rainforest: at twenty years (2002-2022)

Caroline Lorenci Mallmann [1], Waterloo Pereira Filho [2], Edimar Pereira dos Santos Junior [3], Rafael Zini Ouriques [4], Florian Wittmann [5], Flávia Machado Durgante [6]

[1] Dep. Geoscience, Geography, Federal University of Santa Maria, Brazil – carolinemallmann15@gmail.com
[2]Dep. Geoscience, Geography, Federal University of Santa Maria, Brazil - waterloo@ufsm.br
[3]Dep. Geoscience, Geography, Federal University of Santa Maria, Brazil – edimarj87@gmail.com
[4]Dep. Geoscience, Geography, Federal University of Santa Maria, Brazil – rafaziniouriques@gmail.com
[5]Dep. of Geography and Geoecology, Karlsruhe-Institute of Technology, Germany - florian.wittmann@kit.edu
6 Dep. of Geography and Geoecology, Karlsruhe-Institute of Technology, Germany - flavia.durgante@kit.edu

Keywords: Google Earth Engine, Time Series, Standardized Precipitation and Evapotranspiration Index, Normalized Difference Vegetation Index, Enhanced Vegetation Index.

1. Introduction

The Amazon basin is the largest hydrological basin in the world and covers an area of approximately 7 million km². This basin is located on the equator zone covered with tropical forest, where approximately 68% of the basin is located in Brazil. In this portion, the vegetation is distributed into approximately 70% upland tropical forest and around 30% complex systems of predominantly forested wetlands (Junk et al. 2011). These different forest ecosystems have different adaptations to the environmental and climatic regime. As upland forests answer directly to precipitation (Phillips et al. 2009; Durgante et al. 2023), the wetlands need to survive the monomodal flood pulse that can occur for more than 5 months (Junk et al. 2011). In that case, these different ecosystems can respond differently to climate change conditions. Extreme climate events are affected by the position of the Intra-Tropical Convergence Zone (ITCZ) and also by the El Niño Southern Oscillation (ENSO) (Marengo & Espinoza 2016). These events produce both pronounced droughts and periods of extreme pluviometry precipitation that, combined with human actions (deforestation and forest fires) on the landscape, promote the degradation of ecosystems. Recent research has shown that the Amazonian flora and fauna are continuously and increasingly affected by extreme events. This impact tends to have a lasting effect on them, as extreme events increase (Chaudhari et al.,2019; Esquivel-Muelbert et al.,2018; Barichivich et al.,2018). One of the observed consequences is the increase in tree mortality in periods of extreme drought, like what happened in the central and eastern portions of the Amazon basin in the years 2005 (Phillips et al., 2009) and 2010 (Lewis et al.,2011). In these contexts, we need to use different ways to understand how the Amazon Forest ecosystem is responding to climate change conditions such as high temperatures and drought conditions. In this sense, this work proposes to evaluate the difference in the spectral response of vegetation in the last 20 years (2002-2022) along a pre-established drought gradient in the Amazon region.

2. Methodology

2.1 Study Area

Four sites, which comprise a longitudinal hydroclimatic gradient (west-east), were designated in the ATTO, Trombetas, Tapajós, and Xingu (Figure 1). The selected study area is the target of investigation for the Amazon Tall Tower Observatory (ATTO) in the *Hydrotraits* project, which aims to explore the vulnerability of tree species and forest ecosystems to climate change.

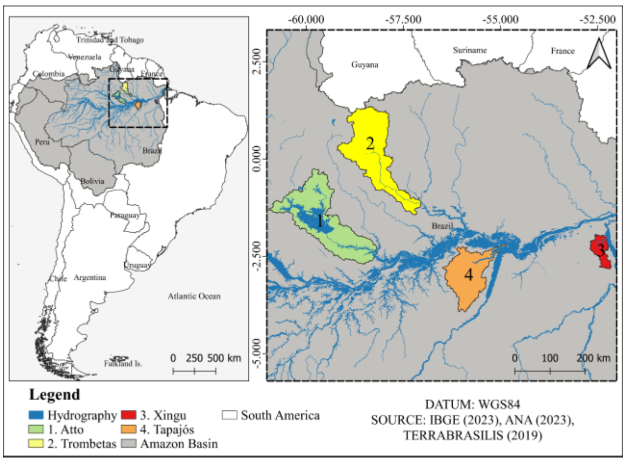

Figure 1. Localization Map of the Sites.

2.2 Vegetation Indices

Two widely used vegetation indices in studies related to seasonal and climatic variations were selected (Asner and Alencar, 2010; Maeda et al., 2016; Branco et al., 2019). The Normalized Difference Vegetation Index (NDVI) (Rouse et al., 1974) and Enhanced Vegetation Index (EVI) (Huete et al., 1994).

2.3 Drought Index

The Standardized Precipitation-Evapotranspiration Index (SPEI) was applied, a standardized variable that expresses the deviations of the current climate balance (precipitation minus evapotranspiration) about the long-term balance (Zhao et al., 2017).

2.4. Data acquisition

Products available in the Google Earth Engine (GEE) platform catalog was used: (1) The SPEIbase product (Figure 2) offers robust long-term information on drought conditions on a global scale. (2) The MCD43A4 products generated by the Terra and Aqua sensors with a spatial resolution of 500 meters. The MCD43A4 product provides adjusted bidirectional reflectance values in 7 bands.

2.5. Statistical analysis

To compare the variability of indices across various sites, we implemented an analysis of variance using the Kruskal-Wallis test. Subsequently, the Wilcoxon significance test was employed to determine the statistical significance of the results. To evaluate the trend analysis of the indices throughout the time series, we used the Mann-Kendall test, which is a non-parametric test that allows the detection of trends in time series data.

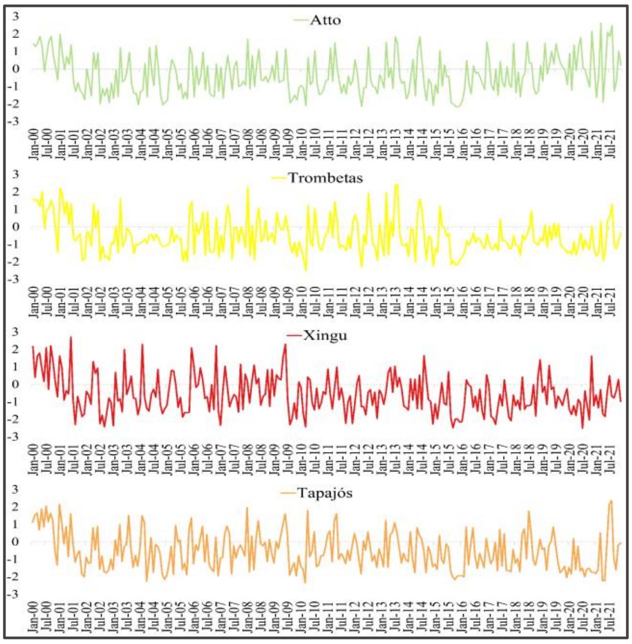

Figure 2. Time Series of the SPEI Index at the Sites.

2.6. References

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