DELIMITATIONS OF ECOLOGICAL INTERFACES IN BRAZIL: AN EVALUATION OF BIOMES AND ECOTONES

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ABSTRACT

This study investigates the transition areas between biomes in Brazil, with an emphasis on the interfaces between the Cerrado and the Amazon. The research is motivated by the growing pressure on these regions, resulting from agricultural expansion and climate change, which intensify environmental degradation and biodiversity loss. Based on the studies by Aziz Ab'Saber, which highlighted the importance of ecotones in ecological connectivity, there is a need for robust methodologies for the precise delimitation of these areas. A literature review, covering classic and recent studies on biogeography, reveals methodological challenges in mapping biomes and ecotones. The next phases of the research will apply geospatial techniques, such as high-resolution satellite imagery, topographic and climate data, which are essential for identifying ecological transition patterns. Advanced remote sensing methods, such as NDVI, will be used to characterize transition zones. Preliminary results indicate that these areas are more dynamic and vulnerable than previously thought. The combination of geospatial data and interviews with experts will allow for a more refined analysis, highlighting subregions with unique ecological characteristics. The research also suggests the need for an interdisciplinary approach that incorporates climatic, geological, ecological, and anthropological factors in the delimitation of transition areas. Thus, the study will contribute significantly to the understanding of the complex interactions that shape the Brazilian biogeographic landscape, with direct implications for environmental planning and sustainable development in the country.

Keywords: Ecological transition; Remote sensing; Ecotones; Cerrado-Amazon.

INTRO

The delimitation of transition areas between biomes in Brazil is fundamental to understanding the country's ecological and geographical diversity. Since the first studies conducted by Aziz Ab'Saber, who highlighted the importance of ecotones in the dynamics of Brazilian ecosystems, to recent analyses of changes in vegetation distribution and climate patterns, the topic has been widely discussed by several researchers. (AB'SABER, 2003) emphasized that transition areas, or ecotones, are regions of great biological diversity,

essential for ecological connectivity between different biomes. (SANO; ALMEIDA; RIBEIRO, 2008) also emphasize the need to understand the characteristics and processes of these areas for more effective natural resource management and biodiversity conservation.

The mapping of Brazilian biomes carried out in 2004 by the Brazilian Institute of Geography and Statistics (IBGE) represented a significant milestone in this field of study. However, (KLINK et al., 2005) point out that defining the boundaries between biomes and transition areas remains a complex task, marked by uncertainties and methodological challenges. Historically, agricultural frontiers and human expansion have put pressure on these ecotones, resulting in increasing biodiversity loss and fragmentation of natural habitats. According to (SIMON; GARAGORRY, 2005), the advance of agricultural frontiers in Brazil since the colonial period has been one of the main factors putting pressure on ecosystems, particularly in the Amazon region. The transition between biomes, especially between the Cerrado and the Amazon, has become an area of intense agricultural exploitation in recent decades, reflecting the complex relationship between economic development and environmental conservation (BANK; SOARES-FILHO; BOWMAN, 2012). Furthermore, land use change, driven by agrarian policies and technological advances in agriculture, has had a significant impact on these transition areas, which are often overlooked in conservation and development planning (RAJÃO et al., 2020).

The evolution of knowledge about these ecotones shows that they are not only transition areas but also dynamic zones that respond quickly to environmental and anthropogenic changes. As pointed out by (FLORES et al., 2024), the impact of climate change and the expansion of agricultural activities in these regions may lead to the savannization of the Amazon, drastically altering the composition and function of ecosystems. The importance of focusing on transition areas is even more urgent given the recent increase in deforestation activities driven by economic factors and agricultural expansion. (CABRAL et al., 2024) point out that these areas, which are already under significant pressure, are at risk of becoming irreversibly degraded without effective interventions.

Given this context, the author's postdoctoral project at the Evangelical University of Goiás proposes to investigate the boundaries of transition areas in Brazil, focusing on the analysis of biomes and ecotones. Through a literature review, geospatial data analysis, and consultation with experts, the project seeks to contribute to the understanding of the country's geography and ecology, identifying the limitations of the 2004 biome mapping and proposing a methodology to map the transition between the Cerrado and the Amazon, using advanced remote sensing techniques.

METHODOLOGY

The Cerrado is the largest biome in Brazil and the need to preserve it has been confirmed by the advance of deforestation in recent years (RAD, 2023), largely due to pressure from factors related to agricultural and urban expansion. The Cerrado biome has a border of approximately 1,800 to 2,000 km with the Amazon biome (CNUC, 2023), defined as the "arc of deforestation" (DOMINGUES; BERMANN, 2012), (FEARNSIDE, 2017; OLIVEIRA
et al., 2019). Anthropogenic pressure on these areas is evidenced by the various tensions resulting from the growth of municipalities in this region.

The advance of the agricultural frontier in Brazil is a factor of interest in various bibliographies, mainly due to the growing need to progressively supply the population with food (GIBBS et al., 2015) (DIVÉKY-ERTSEY et al., 2022). The need for more precise delimitations of the transition areas between Brazilian biomes is justified by the importance of these regions for biodiversity and for the country's environmental sustainability. Recent research indicates that approximately 60% of the original forest cover in this region has already been destroyed (SOARES-FILHO et al., 2006), (GAO et al., 2020).

In an approach based on patterns and changes over time, (MINATTI et al., 2023) used satellite images to provide a comprehensive and up-to-date view of the study areas. Using topographic maps (MACHADO; NUNES; ROMÃO, 2009) used details about elevation and terrain morphology, which are essential for understanding the geographical influences on ecological transitions. (DA SILVA; HIGUCHI; DA SILVA, 2018) integrated climate data, such as temperature and precipitation, to analyze the environmental influence on the distribution of

species in ecotones. This geospatial analysis provides a robust basis for characterizing and conserving transition areas between biomes.

RESULTS

In the preliminary results, a critical assessment of the Brazilian biome mapping process conducted in 2004 was carried out, focusing on the limitations and challenges inherent in delimiting transition areas between biomes, particularly between the Cerrado and the Amazon. The review of the methodology used revealed several uncertainties in the definition of biogeographical boundaries, highlighting flaws in the cartographic techniques and criteria adopted for delimiting biomes. The investigation pointed out that the data sources used, although valuable, were not entirely effective in capturing the nuances of ecological transitions, especially in regions of high environmental complexity such as ecotones.

CONCLUSION

Anthropogenic pressures, such as agricultural expansion and land use change, have intensified the degradation of these areas, resulting in biodiversity loss. The study seeks to fill the gaps in the 2004 mapping and provide a more comprehensive understanding of the dynamics of these regions. The emphasis on transition areas is urgent, considering the risks of irreversible degradation and the need for effective interventions to conserve biodiversity and ensure the resilience of Brazilian ecosystems in the face of climate change and economic pressures.

BIBLIOGRAPHICAL REFERENCES

AB'SABER, A. Os domínios de natureza no Brasil. [S. l.: s. n.], 2003.

BANK, D.; SOARES-FILHO, B.; BOWMAN, M. Challenges for Low-Carbon Agriculture and Forest Conservation in Brazil Britald. Environmental Safeguards Unit (VPS/ESG) TECHNICAL NOTES, [s. l.], v. No. IDB-TN, n. February, p. 1–40, 2012.

CABRAL, B. F. et al. Amazon deforestation: A dangerous future indicated by patterns and trajectories in a hotspot of forest destruction in Brazil. Journal of Environmental Management, [s. l.], v. 354, p. 120354, 2024. Available at: https://www.sciencedirect.com/science/article/pii/S0301479724003402.

DA SILVA, M. A. F.; HIGUCHI, P.; DA SILVA, A. C. Impact of climate change on the potential geographical distribution of Ilex paraguariensis. Rodriguesia, [s. l.], v. 69, n. 4, p. 2069–2079, 2018.

DIVÉKY-ERTSEY, A. et al. Contribution of Pulses to Agrobiodiversity in the View of EU Protein Strategy. Stresses, [s. l.], v. 2, n. 1, p. 90–112, 2022.

DOMINGUES, M. S.; BERMANN, C. The arc of deforestation in the Amazon: From cattle ranching to soybeans. Environment and Society, [s. l.], v. 15, n. 2, p. 1–22, 2012.

FLORES, B. M. et al. Critical transitions in the Amazon forest system. Nature, [s. l.], v. 626, n. 7999, p. 555–564, 2024.

GAO, Y. et al. Remote sensing of forest degradation: a review. Environmental Research Letters, [s. l.], v. 15, n. 10, 2020.

GIBBS, H. K. et al. Brazil's Soy Moratorium: Supply-chain governance is needed to avoid deforestation. Science, [s. l.], v. 347, n. 6220, p. 377–378, 2015.
KLINK, C. a. et al. The conservation of the Brazilian Cerrado. Megadiversidade, [s. l.], v. 1,
p. 147–155, 2005.

MACHADO, L. E. G.; NUNES, E. D.; ROMÃO, P. D. A. Analysis of the influence of topography on seasonal variation in phytophysiognomies in the Veríssimo River basin – GO. Proceedings of the XIV Brazilian Symposium on Remote Sensing, [n.p.], v. d, p. 2817–2822, 2009.

MINATTI, E. et al. Multi-temporal analysis of satellite images and NDVI in a conservation unit. Research, Society and Development, [s. l.], v. 12, n. 4, p. e1112440839, 2023.

RAJÃO, R. et al. The rotten apples of Brazil's agribusiness. Science, [s. l.], v. 369, n. 6501, p. 246–248, 2020.
SANO, S.; ALMEIDA, S.; RIBEIRO, J. Cerrado: ecology and flora. [S. l.: s. n.], 2008. E-book. Available at: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:CERRADO+Ecologi a+e+Flora#1.

SIMON, M. F.; GARAGORRY, F. L. The expansion of agriculture in the Brazilian Amazon. Environmental Conservation, [s. l.], v. 32, n. 3, p. 203–212, 2005.
SOARES-FILHO, B. S. et al. Modelling conservation in the Amazon basin. Nature, [s. l.], v. 440, n. 7083, p. 520–523, 2006. Available at: https://doi.org/10.1038/nature04389.

Official data platform of the National System of Nature Conservation Units, CNUC, 2024, https://cnuc.mma.gov.br/powerbi

Annual Deforestation Report (RAD) 2023. MapBiomas Alert. Available at: https://plataforma.brasil.mapbiomas.org/alerta/rad.