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Climate challenges and opportunities in the Brazilian Cerrado

What is the Cerrado and why is it important?

T. Reis, G. Russo, V. Ribeiro, P. Moutinho, A. Guimarães, M. Stabile, A. Alencar, A.C.Crisostomo, D. Silva, J. Shimbo.

The Cerrado is a Brazilian savannah that covers about 24% (2 million km^2) of the country's territory (Figure 1). This biome bears essential ecological functions in terms of hydrological balance, biodiversity and carbon stocks, which are mutually dependent. The Cerrado hosts 8 of the 12 hydrological regions in Brazil, including the Guarani Aquifer, the second largest underground reservoir in the world[1]. It is also a global biodiversity hotspot with around 4,800 plants and vertebrate species only found in this biome[2,3]. The Cerrado is an important carbon reservoir, still stocking around 32 $GtCO_2$[4] (Figure 1). Cerrado accounts to about 60% of Brazil's annual crops output (e.g. soybeans, maize and cotton). This area has expanded by 87% between 2000 and 2015[5] and large scale agriculture in the Cerrado has become fundamental for Brazil's economic development, trade and commercial balance.

The Cerrado is a key biome for Brazil's economic development, food production, maintenance of water cycles, preservation of biodiversity, and for global climate change mitigation and adaptation. Notwithstanding its importance, the biome is often overlooked within the national and international climate change debates[6,7]. The current rate of conversion in the Cerrado is not sustainable, releasing a previously unaccounted volume of carbon dioxide[6].

1. WHY IS THE CERRADO THREATENED?

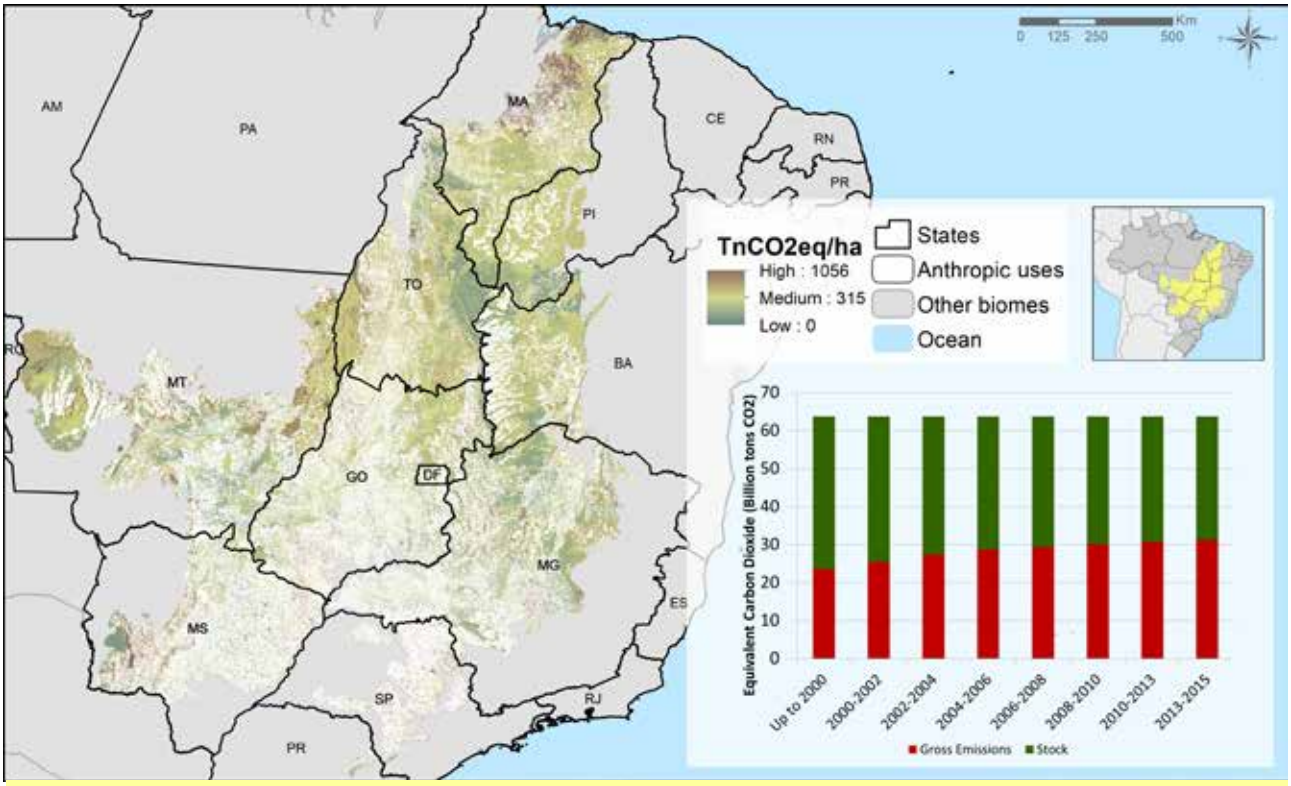
The high conversion rate of the Cerrado for pasture and croplands over the last decade jeopardizes its resilience[8,9,10], especially in the Matopiba frontier region[11]. The biome lost 236 thousand km^2 between 2000 and 2015[8] and the associated emissions amounted to 8.16$GtCO_2$[8,4]. This is equivalent to 3,6 years of Brazil's 2016 gross emissions[12]. The urgency for addressing Cerrado's loss can be seen by the comparison with Amazon's deforestation in the same period: 208 thousand km^2 from 2000 to 2015 in an area that is more than twice the size of the Cerrado's. Cerrado's loss threatens Brazil's NDC targets[13], as reductions in the Amazon are being compensated by emissions increase in the neighboring biome[6].

2. WHAT ARE THE MAIN CONSERVATION GAPS AND THREATS FOR CERRADO?

Lack of protected areas: the small percentage of public protected areas (7.7%[14]) is insufficient for controlling disordered agricultural expansion and to dismantle land-grabbing and speculation. This conservation gap should be filled by the establishment of new public conservation areas, increasing the total percentage of Cerrado under protection to at least 17%, as prescribed by the UNCDB Aichi targets.

Insufficient land use enforcement: the Forest Code, the primary national legislation for land use regulation of rural establishments, defines that only 20% to 35% of a farm must be kept as protected native vegetation – a lower percentage when compared to the 80% required in the Amazon biome[15]. It still implies an environmental cost for farmers. The remaining 65% to 80% of a farm can be legally converted. Considering no new conversion is needed in Brazil for increasing agricultural production, two measures must be taken to prevent further clearing on farms, both legal and illegal: (i) economic incentives provisioned by the Forest Code, which are still missing regulation and implementation by federal and state governments, should be put in place immediately, and (ii) enforcement against illegal conversion should be strengthened.

Knowledge and information gaps: the Cerrado's full potential as a carbon sink and storage is still uncertain. The role of Cerrado's vegetation in water balance, both in terms of supporting the recharge of aquifers and the relationships with rainfall formation, is not fully understood[16]. It is critical for the agricultural sector as well as the population to understand the relationships between Cerrado's vegetation and rainfall patterns. Recent changes in precipitation patterns are already affecting agricultural productivi-



Quantitative of carbon stored in litter, dead wood, soil, above and below the ground, Source: Brazil's Third National Communication[4]

ty in many parts of the Cerrado[16]. The biodiversity potential for cosmetic, pharmaceutic, food and other industries has not been widely assessed. A public and regular monitoring instrument of Cerrado's deforestation and land use is essential for providing full and transparent information to all relevant stakeholders. It is fundamental to increase public and private investment for science, innovation and monitoring to fill these gaps.

Disordered agriculture expansion: agriculture has expanded disorderly in Cerrado. While expansion in southern Cerrado has occurred predominantly over pasture or other croplands[9] with inefficient use, in the northern frontier region of Matopiba the increase has taken place mostly over native vegetation[10], despite the availability of suitable lands already cleared and inefficiently used. Also, 13% (around 4.74 thousand km^2) of the croplands in 2014/2015 were located in areas with low climate suitability[17], i.e., irregular precipitation patterns which mean higher risks for growing crops. This disordered expansion menaces the health and lives of urban and rural populations, water supply, global climate, and food production itself, once the removal of native vegetation disturbs the water cycle and regularity[16].

Demand from agricultural commodities markets: 63% of total soy production in Cerrado was exported in 2015[18]. 50% of all exports went to China and 8% to European countries[18]. In terms of gross CO_2 emissions coming from the loss of native vegetation for soy production in these areas, exports emitted 1.24 billion and 580 million tons for China and Europe respectively[19]. They total 1.83 billion tons of CO_2, which is almost as much (80%) as Brazil's gross GHG emissions in 2016[12]. This means a strong deforestation and emissions pressure on the Cerrado coming from international demand for soy, led mainly by China and Europe.

3. THE OPPORTUNITIES IN THE CERRADO AND HOW TO BENEFIT FROM THEM?

The knowledge about Cerrado's capacity as a carbon sink and stock is still incomplete. The role of Cerrado for local and regional hydrological cycles, precipitation patterns and how changes in the land use and cover affects agricultural production are still incipient. The potential of Cerrado's biodiversity for various industries is also far from fully explored. Investing in science and innovation in various fields about the Cerrado is fundamental. This must be done as quickly as possible, as more than 50% of native vegetation in the Cerrado has already been converted to other uses.

The biome also needs public policies for planning and territorial intelligence. The creation of new public protected areas, increasing the current 7.7% to at least 17% in

compliance with the UNCDB Aichi targets, is an opportunity to mitigate the perverse dynamic of land-grabbing and speculation on undesignated public lands, associated with expansion of agriculture over native vegetation. If this policy is coupled with territorial planning and incentives for efficient land use, there is the potential to reorient expansion towards underutilized areas, generating a benefit for Brazil and the global environment, society and economy.

At the same time, there is a significant opportunity to use market forces to drive expansion for a more sustainable and efficient land use. There are about 30 million hectares of Cerrado lands open, with high or medium soil and climate suitability for croplands[5] which are currently under inefficient uses. A multi-stakeholder pact, setting criteria and deforestation barriers in supply chains has enormous potential to contribute with public efforts for this purpose. Similar initiatives in the Amazon such as the Soy Moratorium and Soja Plus Program have shown that it is possible to decouple soy production increase from deforestation and drive expansion towards already converted areas[20].

1. Lima, J. Silva, E. (2005). Estimativa da produção hídrica superficial do Cerrado brasileiro. In: Scariot, A. Silva, J. Felfili, J. (Orgs). Cerrado: ecologia, biodiversidade e conservação. Brasília: Ministério do Meio Ambiente. p. 60-72. Available at http://www.mma.gov.br/estruturas/chm/_arquivos/17_Sumario.pdf.

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3. Myers, N. Mittermeier, R. Mittermeier, C. Fonseca, G. Kent, J. (2000). Biodiversity hotspots for conservation priorities. Nature, v. 403, pp. 853-858.

4. MCTI (2016). Terceiro Inventário Brasileiro de Emissões Antrópicas. Available at http://sirene.mcti.gov.br/documents/1686653/1706739/MCTI_TCN_SUMARIO+EXECUTIVO_port.pdf/7aad0f1d-332b-45b4-9fda-88e9efb049fd.

5. Carneiro Filho, A. and Costa, K. (2016) 'The expansion of soybean production in the Cerrado: paths to sustainable territorial occupation, land use and production', p. 28. Available at: http://www.inputbrasil.org/wp-content/uploads/2016/11/The-expansion-of-soybean-production-in-the-Cerrado_Agroicone_INPUT.pdf.

6. Noojipady, P. Morton, D. Macedo, M. Victoria, D. Huang, C. Gibbs, H. Bolfe, E. (2017). Forest carbon emissions from cropland expansion in the Brazilian Cerrado biome. Environmental Research Letters, v. 12. doi:10.1088/1748-9326/aa5986.

7. Critical Ecosystem Partnership Fund (2017). Ecosystem Profile: Cerrado Biodiversity Hotspot. Available at: http://www.cepf.net/SiteCollectionDocuments/cerrado/Cerrado-Technical-Summary-EN-Updated.pdf.

8. INPE & Funcate (2017). Prevenção e controle do desmatamento. Brasília: Ministério do Meio Ambiente. Available at: http://combateaodesmatamento.mma.gov.br/.

9. 88% of agriculture expansion between 2000 and 2015 in southern Cerrado was on pasture or other crop lands[5].

10. 65% of agriculture expansion between 2000 and 2015 in northern Cerrado (Matopiba) was on native vegetation[5].

11. The Cerrado portion in the states of Maranhão, Tocantins, Piauí and Bahia (Figure 1).

12. Based on SEEG data. Available at: http://plataforma.seeg.eco.br/total_emission.

13. The Brazilian NDC does not include any mandatory goal for the reduction of the Cerrado conversion rates. In case Brazil maintains the annual 0,51 billion tons of CO_2 emissions[6,7] from Cerrado conversion until 2025, that compromises almost 40% of Brazil's NDC target.

14. Instituto Socioambiental (ISA). Conservation Areas in Brazil. Available at https://uc.socioambiental.org/en/mapa.

15. Azevedo, A. Reis, T. (2016). Brazil's Forest Code: Assessment 2012-2016. Brasília: Amazon Environmental Research Institute. Available at: http://ipam.org.br/bibliotecas/brazils-forest-code/

16. Spera, S. A. et al. (2016) 'Land-use change affects water recycling in Brazil's last agricultural frontier', Global Change Biology, p. n/a-n/a. doi: 10.1111/gcb.13298.

17. IPAM, in preparation.

18. Trase Platform. Available at: https://trase.earth/

19. These figures were calculated using the total land use area occupied by soybean in the 2015/2016 crop season that was exported to these destinations[18] multiplied by the average CO_2 density per hectare per municipality using a carbon map provided by Brazil's Third Communication to the UNFCCC[4].

20. Gibbs, H. K. et al. (2015) 'Brazil's Soy Moratorium', Science, 347(6220), pp. 377–378. doi: 10.1126/science.aaa0181.

Tiago Reis
Researcher
tiago.reis@ipam.org.br

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