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PÓS-GRADUAÇÃO DINÂMICA DOS OCEANOS E DA TERRA UFF

ENVIRONMENTAL GOVERNANCE FOR THE PROTECTION OF THE AMAZON AND CERRADO BIOMES: WHAT HAS BRAZIL DONE?

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ABSTRACT

In 2009 and 2015, Brazil presented a set of targets aimed at reducing greenhouse gases for the years 2020, 2025, and 2030, including forest restoration and reforestation, within the Conference of the Parties to the United Nations Framework Convention on Climate Change and its Nationally Determined Contribution to the Paris Agreement. The implementation of public policies and technical measures for different sectors of the economy supports these targets. This study seeks to identify which technical or management measures are promoted to prevent and control deforestation in the Amazon and Cerrado biomes to mitigate greenhouse gas emissions. To this end, data with information on the change in land and forest use were taken and elaborated from the data of SEEG Brazil, TerraBasilis, and INPE. The results indicate that the commitment made in 2009 to develop sustainably without degrading nature and the fulfillment of Brazil's goals under the Paris Agreement in 2015 depend fundamentally on the Land and Forestry Change and Uses sector, either by combating illegal deforestation or by implementing reforestation activities. The results also indicate that, in the last three years, deforestation has reached 56 thousand square kilometers of native vegetation in the Amazon and Cerrado.

Keywords: Environmental Protection Policies; Climate Change; ABC Plan; Brazil.

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INTRODUCTION

Brazil is the largest country in South America, covering 47% of the South American territory (Brasil, 2021). In its territory, it has important biomes such as the Amazon, Cerrado, Pampa, Pantanal, Caatinga, and Atlantic Forest, with different climatic and environmental configurations (MMA, 2022). The Brazilian Amazon and Cerrado are of utmost importance for conserving the environment and providing ecosystem services. Yet, at the same time, Brazil ranks fifth among the largest climate polluters, with approximately 3.2% of the world total, behind only China, the USA, Russia, and India (SEEG, 2021).

The Amazon biome is formed by the Amazon, the second-largest river in the world and the largest in Brazil, harboring the largest tropical forest and river system in the world. It occupies 59% of the Brazilian territory and encompasses all eight states (Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima, and Tocantins) and part of the state of Maranhão. The Amazon provides a habitat for thousands of endangered rainforest species and plants, making it an invaluable region for biodiversity (Charity *et al*., 2016; IBGE, 2020).

The Cerrado biome is the second largest in South America, occupying an estimated total area of 2,036,448 km2 of the national territory, encompassing the Federal District and ten states (Goiás, Mato Grosso, Mato Grosso do Sul, Tocantins, Maranhão, Bahia, Piauí, Minas Gerais, São Paulo, and Paraná). It has two well-defined seasons: a dry season, which starts in April and May and lasts until September and October, and a rainy season, which starts between September and October and lasts until March and April, giving the biome various types of vegetation resulting from the diversity of soils and climates present in this region.

This entire ecosystem is extremely important for maintaining the earth's environmental balance, and therefore it is necessary to preserve the Amazon and Cerrado biomes for the planet's sustainability. Nevertheless, what has Brazil done to protect its Amazon and Cerrado biomes?

This study seeks to identify which technical or management measures are promoted to prevent and control deforestation in the Amazon and Cerrado biomes to mitigate greenhouse gas emissions.

THEORETICAL FRAMEWORK

Environmental Governance

At the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP-15), held in Copenhagen in 2009, Brazil committed to developing sustainably, using the resources available in nature without degrading it (de Oliveira *et al*., 2016). In the same year, it established Law No. 12.187, which created the National Plan on Climate Change (PNMC), the main instrument for environmental protection and mitigation of climate change in Brazil. Through the PNMC, sectoral plans for mitigating and adapting to climate change were established to consolidate a low-carbon economy. The main sectoral plans for climate change mitigation and adaptation are the Sectoral Plan for Climate Change Mitigation and Adaptation for the Consolidation of a Low Carbon Emission Economy in Agriculture (ABC Plan), the Action Plan for Preventing and Controlling Deforestation in the Legal Amazon (PPCDAM), and the Action Plan for Preventing and Controlling Deforestation in the Cerrado (PPCerrado).

In 2016, Brazil ratified its Nationally Determined Contributions (NDC) to the Paris Agreement at the United Nations Framework Convention on Climate Change (UNFCCC) (Brasil, 2017). The country determined as the NDC's main goal a 37% reduction in net greenhouse gas emissions by 2025, and a 43% reduction by 2030, assuming the year 2005 as the baseline. For the energy sector, it set a goal of increasing the biofuel share in the energy mix to 18% and reaching a 45% share of renewable fuels, expanding solar and wind energy sources' use in the energy mix to 28% and 33%, respectively, by 2030. For the land use and change sector, it is intended to restore and reforest 12 million hectares of forest to strengthen the low-carbon agriculture program through the restoration of an additional 15 million hectares of degraded pastureland and to achieve zero illegal deforestation in the Brazilian Amazon by 2030 (Brazil_NDC, 2021).

ABC Plan for Low Carbon Emission Agriculture

The ABC Plan is a public policy that presents actions to stimulate and monitor the adoption of good practices to prevent deforestation, reduce emissions, and generate resilience in production systems without compromising the sector's productivity and growth (do Amaral *et al*., 2011). Several programs have been incorporated into the ABC Plan.

In the Degraded Pasture Recovery program, soil mismanagement causes it to lose vigor, productivity, and its natural ability to recover. Furthermore, as the degradation process advances, there is a loss of vegetation cover and an increase in CO2 emissions. The strategy is to promote the recovery of pastures in order to contribute to the mitigation of greenhouse gases (Brasil, 2012).

The Crop-Livestock-Forestry Integration (ILPF) and Agroforestry Systems (SAFs) programs are sustainable strategies that integrate agricultural, livestock, and forestry activities

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carried out in the same area through intercropping or rotational cultivation and seek collaboration among the components of the agroecosystem. These systems contribute to the recovery of degraded areas, the maintenance and reconstitution of forest cover, good agricultural and cattle-raising practices, the promotion and generation of employment and income, the improvement of social conditions, and the reduction of greenhouse gas emissions (GHG) (Brasil, 2012).

The no-till farming system ("no-till") program consists of technological processes for agriculture aimed at contributing to soil and water conservation, increasing fertilization efficiency, improving the cost-benefit ratio, reducing fossil energy consumption and pesticide use, and, most importantly, mitigating GHG (Brasil, 2012).

In the Planted Forests program, the strategy is to promote reforestation actions in the country, contributing to CO_2 capture (Brasil, 2012). In the program for adapting to climate change, the strategy adopted is to invest more effectively in agriculture, promoting diversified systems and the sustainable use of biodiversity and water resources, with support for the transition process, production organization, a guarantee of income generation, and vulnerability identification (Brasil, 2012).

Action Plan for the Deforestation Prevention and Control in the Amazon and Cerrado

The Brazilian biomes were created in 2003 by the Brazilian Institute of Geography and Statistics (IBGE) and the Ministry of Environment to define the geographical distribution of Brazil. The government adopts the geographical region known as "Legal Amazon" to develop its prevention actions, incorporating the Cerrado biome.

The Amazon and Cerrado biomes have high biodiversity and are of vital importance for nature and water conservation, representing more than 73% of the national territory (MMA, 2018). The Action Plan for Preventing and Controlling Deforestation in the Amazon (PPCDAm) and the Action Plan for Preventing and Controlling Deforestation and Burning in the Cerrado (PPCerrado) are the main actions for the implementation of the National Policy on Climate Change, which focuses on mitigating greenhouse gas emissions related to land use, land use change, and forest (MMA, 2018).

The PPCDAm seeks to reduce deforestation by creating favorable environments for sustainable development. Since its creation in 2004, important advances have been made in the fight against deforestation. Over the first decade, the greatest result of this effort was undoubtedly the reduction in the deforestation rate from 27,772 km² in 2004 to 4,429 km² in 2012, a reduction of more than 84% (TerraBrasilis, 2022; INPE, 2021). This Plan was structured to tackle the causes of deforestation in a comprehensive way and involves initiatives organized in three strategic axes: (1) land and territorial planning; (2) environmental monitoring and control; and (3) fostering sustainable production activities.

During the three execution phases (2004–2008; 2009–2011; and 2012–2015), the PPCDAm contributed to a drastic reduction in the deforestation rate in the legal Amazon (TerraBrasilis, 2022; INPE, 2021). The success in reducing deforestation in the Amazon rainforest, an unquestionably relevant region for the planet's climate and biodiversity, contributed to PPCDAm's international recognition, leading the country to the position of reference in reducing GHG emissions. In 2013, the Ministry of the Environment took over the coordination of the plan and added a fourth axis of action focused on regulatory and economic instruments in 2016.

The fourth phase of implementation (2016-2020) aimed to create mechanisms for access to credit for sustainable agriculture that encourage the forest-based economy and contribute to the development of a productive matrix, economically competitive, and with the least possible impact on the forest, in addition to establishing sectoral partnerships (MMA, 2018).

The Cerrado is considered one of the richest savannas in the world in biodiversity and the most productive region in Brazil (de Souza *et al*., 2020). The PPCerrado aims to halt deforestation, monitor the Cerrado biome, increase the effectiveness of forest management instruments, and promote sustainable development in the region. This plan has several actions organized into macro-objectives and structured into thematic axes.

The first phase of the PPCerrado (2010–2011) included three thematic axes (monitoring and control, protected areas and land use planning, environmental education, and promoting sustainable, productive activities). These themes guided the strategies developed and the implementation of their activities (MMA, 2011).

The second phase of the PPCerrado (2014–2015) focused on the need to establish instruments and policies for monitoring land use, following the strategic axes (sustainable production, monitoring and control, protected areas, and land use planning) (MMA, 2014). According to the Ministry of Environment, between 2003 and 2008, the average annual deforestation of the Cerrado was 14.2 thousand km² (Brasil, 2009). Rausch *et al*. (2019) point to the expansion of soybean production as the main activity of Cerrado conversion into agricultural areas, occupying approximately 1.3 million hectares of native vegetation between the years 2003 and 2014.

The third phase of the PPCerrado (2016-2020) focused on the strategic axis of the second phase, including new efforts to develop norms and economic, fiscal, and tax instruments to combat deforestation and forest degradation in the Legal Amazon, promoting the maintenance of its ecosystem services through the fostering of an economic development model that considers the conservation of biodiversity and water resources (MMA, 2018).

METHODOLOGY

This research is theoretical in the context of the literature and the survey and treatment of spatial data. Its technical procedures are classified as a bibliographical study since it will deal with data and verifications coming directly from works already carried out on the researched subject. According to the objectives, it is classified as exploratory and descriptive because it will seek specific information and characteristics of what is being studied (Gil, 2005).

The data on land and forest use change presented and analyzed were taken and elaborated from SEEG Brazil, TerraBasilis, and INPE data. The System of Estimates of Emissions and Removals of Greenhouse Gases (SEEG) is promoted by the Climate Observatory, a network of more than 70 non-governmental organizations with a socio-environmental profile aiming to discuss the issue of climate change in the Brazilian context. The TerraBrasilis portal is a platform developed by INPE for access, consultation, analysis, and dissemination of geographic data generated by the institute's native vegetation monitoring projects, such as the Project for Monitoring Deforestation in the Legal Amazon by Satellite (PRODES) and the Real-Time Deforestation Detection System (DETER). **Figure 1** shows the domain area of the Amazon and Cerrado biomes.

This study highlights the main technical and managerial measures promoted in the country to prevent and control deforestation in the Amazon and Cerrado biomes and analyzes agricultural activity and its relation to the loss of forest cover in the Amazon and Cerrado.

RESULTS AND DISCUSSION

In the year when the world economy came to a halt and caused an almost 7% reduction in global GHG emissions due to the COVID-19 pandemic, Brazil took the opposite path and increased its GHG emissions by 9.5% (SEEG, 2022). This increase can be explained by the change in land use, forestry, and the agricultural sector, as shown in **Figure 2**.

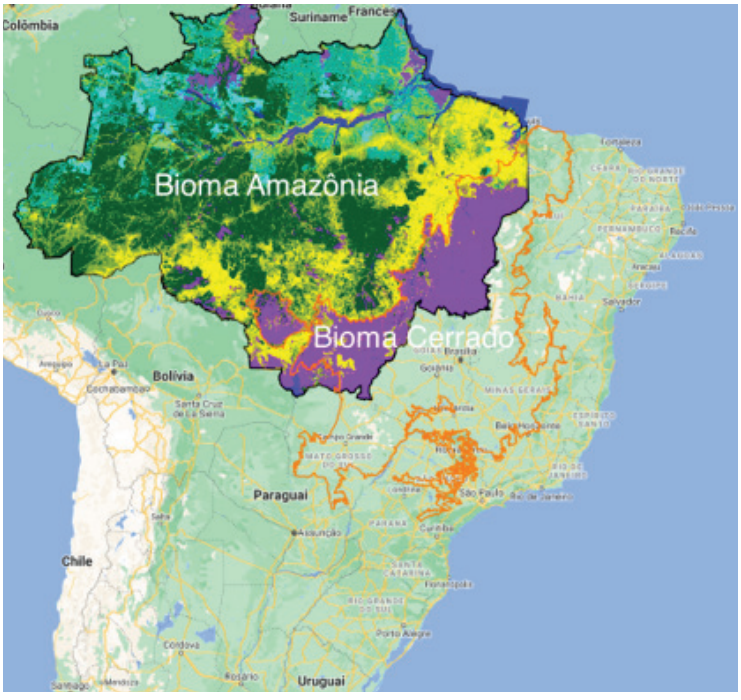

Figure 1. Legal Amazon and Cerrado dominated area
Legend: Amazonia Biome; Cerrado Biome
Source: TerraBrasilis (2022)

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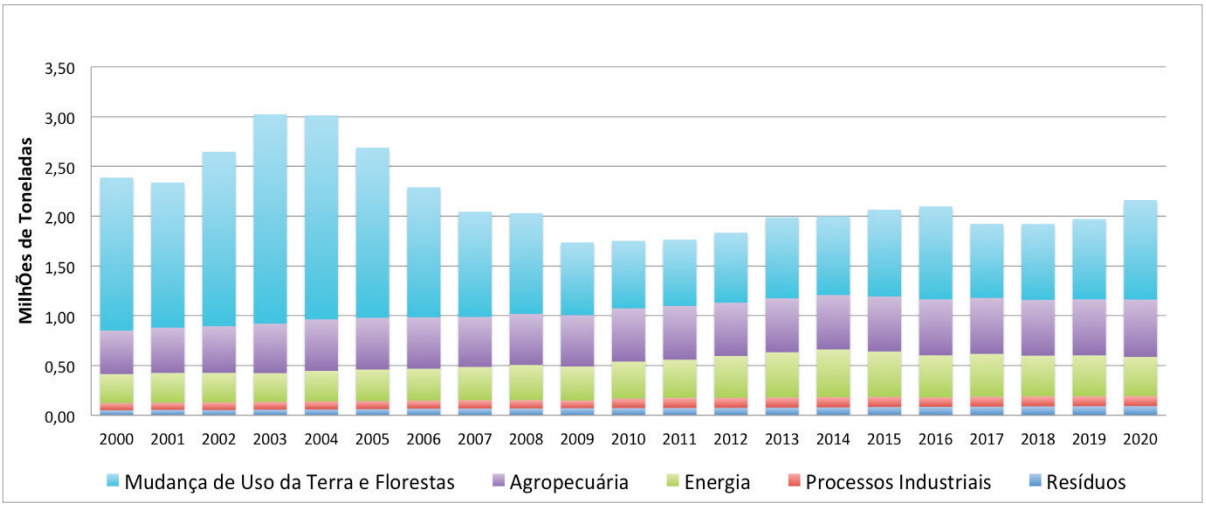

Figure 2. Brazil's greenhouse gas emissions from 2000 to 2020 (GtCO2e)
Legend: Million Tonnes; Change in Land use and Forests; Agriculture and cattle-raising; Energy; Industrial Processes; Waste
Source: SEEG (2022)

Land change and use were responsible for 46% of gross GHG emissions in 2020, dumping 990 million tons of CO_2 into nature (SEEG, 2021). The main factor explaining land use change was deforestation in the Amazon and Cerrado.

Since 2004 and 2009, when public policies such as PPCDAm and PPCerrado were created to combat deforestation in the Amazon and Cerrado, they have significantly contributed to slowing down the deforestation rate. This drop reached 4.6 thousand km2 in 2012 compared to 2004, which was 27,772 thousand km2 of deforestation, as shown in **Figure 3**. Public policies and strengthening environmental control actions played an important role in forest protection and were critical to the drop seen until 2017.

From 2018 on, an increase in emissions was observed year after year. Most emissions are due to land use change, mostly consisting of deforestation in the Amazon biome, which had a deforestation rate of 13,235 km2 in 2021, the highest in 15 years (TerraBrasilis, 2022).

In Cerrado, it was not much different. Data from TerraBrasilis show that deforestation in the biome was more than 8.5 thousand km2 in 2021, the highest accumulated deforestation since 2016. **Figure 4** presents the annual deforestation in the Cerrado biome.

This set of ecosystems is important for maintaining the Earth's environmental balance, and it is therefore necessary to preserve it. But how can it be protected with the verified weakening of public policies in the country?

Researchers say that investing in the value of an intact forest is important and outweighs the income generated by activities that cause deforestation, be they livestock, agriculture, or mining (Oliveira *et al*., 2021; Costanza *et al*., 2014).

Cheng (2020) and IEA (2021) state that different Nationally Determined Contributions (NDCs) have been developed and mapped to combat climate change and achieve CO2 neutrality. Brazil's NDCs presupposes the implementation of targets to achieve the commitments made by the country at the 21st Conference of the Parties in Paris (UNFCCC, 2015) which have subsequently been updated. **Table 1** presents the contributions to Brazil's emissions reduction targets to combat climate change.

According to the IEA (2021), to follow through with the CO2 emission reduction plan, investments in research, forest preservation, and the adoption of renewable energy sources must be the focus to close the gap and achieve zero net carbon emissions.

Brazil has created means to mitigate and adapt to climate change to consolidate a low-carbon economy. These actions are supported by existing policies in the country, such as the National Fund on Climate Change (Law 12,114/2009), the National Policy on Climate Change (Law 12,187/2009), and the Native Vegetation Protection Law (Law 12,651/2012). It has also ratified international treaties related to environmental protection and the Paris Agreement, which was transformed into federal law by Decree No. 9,073 on July 5, 2017.

In addition, the Action Plan for Preventing and Controlling Deforestation in the Legal Amazon (PPCDAm), the Action Plan for Preventing and Controlling Deforestation and Burning in the Cerrado (PPCerrado), and the Ten Year Energy Expansion Plan (PDE) were created. Its NDC was updated for

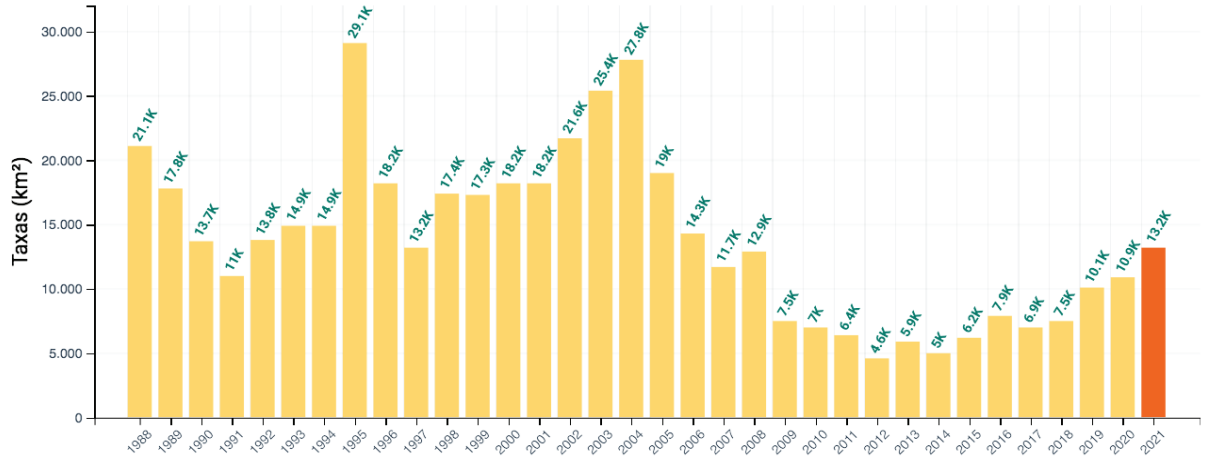

Figure 3. Annual Deforestation in the Legal Amazon
Legend: Rates (Km2)
Source: TerraBrasilis (2022)

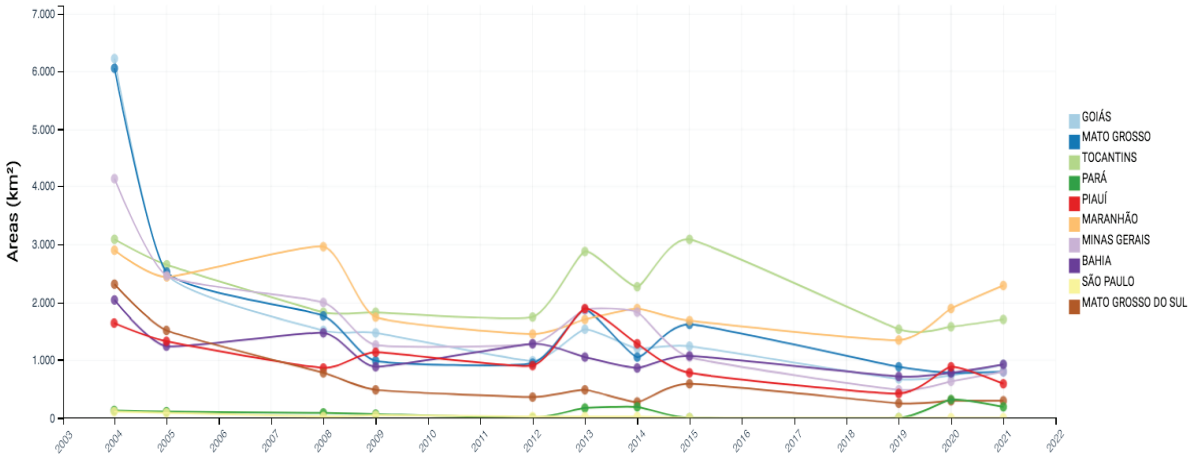

Figure 4. Annual deforestation in the Cerrado
Legend: Areas (Km2)
Source: TerraBrasilis (2022)

2025 and 2030, in which targets to reduce emissions by 37% by 2025 and 43% by 2030 compared to 2005 levels are set (Table 1). The country has encouraged the expansion of renewable energy sources in the Brazilian electricity matrix, reaching an 83% share by 2021, as shown in Figure 5.

Brazil also updated its Low Carbon Emission Agriculture Plan, better known as the ABC Plan, creating the ABC+ Plan in 2021. This plan seeks to reduce carbon equivalent emissions by 1.1 billion tons in the agricultural sector in 2021–2030. Carbon equivalent emission is a measure used to compare the emissions of different GHGs based on their global warming potential.

The first phase of the ABC Plan was in effect between 2010 and 2020 and included techniques such as no-till farming, recovery of degraded pastures, animal waste treatment, integration systems, planted forests, and bio-inputs. The new ABC+ Plan includes new technologies, such as bio-inputs, irrigated systems, and intensive cattle finishing, that may offer options for producers to increase their resilience, productivity efficiency, and economic, environmental, and social gains.

Despite these initiatives for environmental protection and GHG reductions, the country has taken controversial measures, promoting the systemic dismantling of environmental regulations. This dismantling highlighted the main Brazilian GHG emissions and showed that they differ from the emissions of many other countries, mainly due to forest deforestation, their main emission factor.

Of the sectoral plans developed, one of the most important, which would provide most of the expected emission

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Table 1. Nationally Determined Contributions

Nationally Determined and National Level Contributions to Emission Reductions from Brazil							
Until 2030							Until 2050/2060
Reduce 37% in net GHG emissions by 2025.	Reduce GHG emissions by 43% compared to 2005 levels.	Increase the share of biofuels in the energy matrix to 18%.	Obtain a total amount of 45% renewable fuels.	Restore and reforest 12 million hectares of forests; Achieve zero illegal deforestation in the Brazilian Amazon; Achieve 10% efficiency gains in the electric sector.	Expand the use of non-hydro renewable energy sources in the energy matrix to 28% and 33%.	Strengthen the Low Carbon Agriculture Program by restoring more than 15 million hectares of degraded pastureland.	Climate neutrality by 2050.

Source: Brazil_NDC (2021)

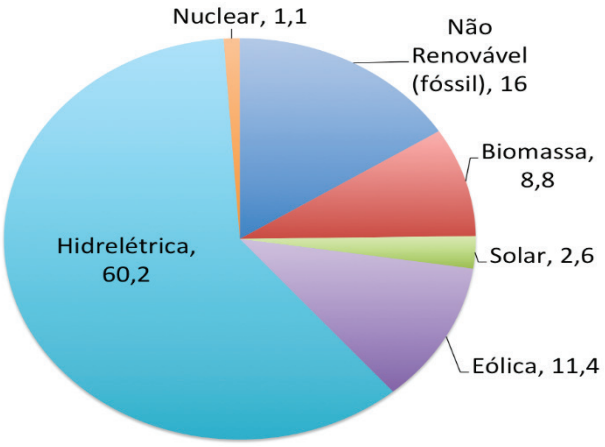

Figure 5. Participation of the energy sources in the installed capacity
Legend: Nuclear: 1.1; Non-Renewable: 16; Biomass: 8.8; Solar: 2.6; Wind: 11.4; Hydroelectric: 60.2
Source: EPE (2022)

reductions, was to cut the deforestation rate in the Amazon, reaching 2020 with a maximum of 3,925 km2 of deforestation per year. However, according to PRODES/INPE and TerraBrasilis, we will arrive in 2020 with deforestation of approximately 10,851 km2 and in 2021 with 13,235 km2 (INPE, 2021; TerraBrasilis, 2022).

This information confirms that Brazil still needs to execute the PNMC to achieve a low-carbon economy. For Climate Action Tracker, Brazil's climate targets and policies are highly insufficient and not consistent with the Paris Agreement temperature limit (Clima Action Tracker, 2021).

CONCLUSION

To fulfill the goal of the work, we sought to identify which technical or management measures are being promoted to prevent and control deforestation in the Amazon and Cerrado biomes to mitigate greenhouse gas emissions. The path taken by the policy, federal legislation, and action plans to prevent and control deforestation (PPCDAm and PPCerrado) in the country indicates that evident advances have occurred at the technical and management levels, i.e., in the construction of instruments, both in terms of institutional structure and in the supervision and monitoring of the ecosystem. Environmental law enforcement actions based on the remote monitoring system (DETER) and the project for monitoring deforestation in the Legal Amazon by satellite (PRODES), which rapidly surveys changes in forest cover to support enforcement actions and control deforestation and forest degradation, were one of the main instruments and innovations in Brazilian public policy.

By developing means to strengthen the conservation of the Amazon Rainforest and the Cerrado and expand sources of renewable energy, the country protects a precious environmental asset and all those who depend on it, thus increasing its productive capacity and gaining competitiveness in global markets. This allows the country to advance

towards a leading position in global climate action, have a predominantly renewable energy matrix, demonstrate its commitment to environmental issues by ratifying important International Agreements, and publish national environmental laws for developing and preserving the environment.

Solid policies and commitment to the environment are necessary to protect the Amazon and Cerrado biomes. However, the Brazilian population and the international community have observed a scenario of dismantled monitoring, control, and environmental inspections, as well as uncontrolled illegal logging, leading to unprecedented levels of deforestation in the Legal Amazon.

The accumulated deforestation in the Amazon and Cerrado biomes in 2019, 2020, and 2021 was higher than the average in the last decade. In the year the world economy halted because of COVID-19, Brazilian emissions increased by 9.5%, while globally, they fell by 7%.

The research showed that Brazil had put forward NDCs to meet the Paris Agreement and national public policies to reduce its emissions. However, its NDCs are classified by the Climate Action Track as "highly insufficient."

The closure of the Action Plan to Prevent and Control Deforestation in the Amazon (PPCDAm), the Action Plan to Prevent and Control Deforestation and Burning in the Cerrado (PPCerrado), and other agencies responsible for environmental enforcement such as PRODES and DETER point to a trend towards greater deforestation and, consequently, an increase in greenhouse gas emissions. Brazil must address the protection of the Amazon and Cerrado biomes with the utmost urgency and responsibility.

Brazil has a great responsibility as a holder of the largest Amazon territory. It must, therefore, preserve nature, its biodiversity, and human health. To do this, it must control deforestation and actively and constantly watch over its preservation.

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