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BRAZIL AND THE GLOBAL CLIMATE AGENDA: STRATEGIES, PROGRESS, AND CHALLENGES IN A WARMING WORLD

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ABSTRACT

This article explores the historical and current landscape of climate change discussions worldwide and in Brazil, emphasizing the greenhouse effect's critical role in sustaining life and the harmful impacts resulting from the rise in greenhouse gas (GHG) emissions since the Industrial Revolution. The creation of the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC) laid the foundation for global agreements such as the Kyoto Protocol and the Paris Agreement. Brazil has played a key role in these negotiations, adopting voluntary and legal commitments to mitigate emissions, particularly through the National Policy on Climate Change (PNMC). Major emitting sectors include energy, agriculture, land use, and waste. Efforts to reduce deforestation in the Amazon and Cerrado biomes have significantly contributed to emissions reductions. The text presents Brazil's primary environmental laws, institutional frameworks, and sectoral action plans aimed at fostering a low-carbon economy. While important progress has been made, the country still faces challenges in balancing economic growth with climate justice and environmental conservation. The upcoming COP30 in Belém will be critical for reinforcing Brazil's leadership in global climate governance and advancing strategies to limit global warming to 1.5ºC above pre-industrial levels.

Keywords: Climate resilience, Environmental justice, Carbon neutrality, Socio-environmental Governance, Energy transition.

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1. INTRODUCTION

The greenhouse effect is essential for human survival. Through this natural phenomenon, a portion of the solar energy that reaches the Earth's surface is reflected and, instead of returning to space, is retained in the atmosphere, making it warmer. This process allows the planet to maintain temperatures suitable for life. Without this warming, Earth's average temperatures would be around -18ºC, making life as we know it impossible.

The beginning of the Industrial Era in the 18th century marked a turning point in world history—not only through technological development but also due to changes in societal consumption patterns, which began to demand increasing amounts of natural resources, significantly amplifying environmental impacts. One major impact of this development has been the increased emission of gases that alter the composition of the atmosphere. So-called greenhouse gases (GHGs), crucial to the Earth's energy balance, have increased exponentially since 1750, mainly due to the combustion of fossil fuels resulting from human activities. In Brazil, the primary source of GHG emissions is deforestation, followed by emissions from agriculture and livestock—especially through enteric fermentation in cattle, which releases methane, and from the use of nitrogen fertilizers. The energy sector ranks third, primarily due to fossil fuel combustion in transportation and industry.

There is no longer scientific doubt: the planet's rising temperature results from the increasing concentration of carbon dioxide and other greenhouse gases in the atmosphere since the mid-19th century. In 2023, the European climate monitoring service Copernicus reported that global temperatures had reached 1.48ºC above pre-industrial levels, indicating that the threshold to avoid more severe impacts could be surpassed as early as 2024 or within this decade.

In response, countries began to discuss joint solutions to address the issue, starting with the establishment of the **Intergovernmental Panel on Climate Change (IPCC)** in 1988 and the **United Nations Framework Convention on Climate Change (UNFCCC)** in 1992. The IPCC, created under the United Nations, is a scientific body composed of researchers from various countries and institutions, which periodically publishes comprehensive reports summarizing the current scientific understanding of climate change.

Since its first report in 1990, the IPCC has presented likely scenarios for the future. The sixth and most recent assessment report, released in 2022, increased the level of certainty that global warming is caused by human activity and is accelerating. In addition to the rise in average global air and ocean temperatures, widespread melting of snow and ice and a rise in global sea levels have been observed.

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The UNFCCC aims to mobilize signatory countries and coordinate global efforts to address the climate emergency. These nations meet at the **Conferences of the Parties (COPs)**, which have established an ongoing process of yearly progress.

One of the most significant milestones was the **United Nations Conference on Environment and Development** (Rio-92 or Earth Summit), held in Rio de Janeiro in 1992. A key outcome was the adoption of the UNFCCC, which was ratified in 1994 and entered into force in Brazil that same year. From this Convention emerged the **Kyoto Protocol**, adopted during the third COP in Kyoto, Japan, in 1997. These two treaties form the backbone of the multilateral climate change regime.

The Convention is based on the principle of *common but differentiated responsibilities*, which states that while all nations must implement national measures to address the causes and impacts of climate change, the obligations differ depending on historical contributions. The main goal of the Convention is "the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

Under this agreement, the Kyoto Protocol established legally binding emission reduction targets exclusively for developed countries (Annex I Parties). During its first commitment period (2008–2012), these countries were required to reduce their emissions by approximately 5% compared to 1990 levels. A second commitment period, from 2013 to 2020, was agreed upon; however, the countries that participated in this phase were responsible for only 15% of global emissions.

The principle of differentiated responsibility stems from the historical fact that developed nations have emitted far more GHGs since the Industrial Revolution and should thus bear greater obligations. Accordingly, developed countries were assigned binding emission reduction targets, while developing nations adopted voluntary commitments. To support emission reductions and promote the adoption of cleaner technologies in developing countries, the **Clean Development Mechanism (CDM)** was established. Through this mechanism, developed countries could purchase carbon credits generated by CDM projects in developing nations and count them toward their reduction targets. The Kyoto Protocol entered into force in 1997 and now has 192 signatory countries.

In 2015, at **COP 21 in Paris**, the **Paris Agreement** was adopted. Under this accord, 196 countries submitted their intended contributions to limit global warming to well below 2ºC, based on each country's social and economic context. Brazil committed to reducing GHG emissions by 37% below 2005 levels by 2025 and by 43% by 2030. To achieve these targets, Brazil pledged to increase the share of sustainable bioenergy to approximately 18% of its energy mix by 2030, restore and reforest 12 million hectares of forests, and ensure that 45% of its total energy mix comes from renewable sources.

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In 2023, during the **28th UN Climate Change Conference (COP 28)** in Dubai, United Arab Emirates, the first **Global Stocktake** of the Paris Agreement took place. It revealed that global temperatures had already risen by 1.1ºC by 2022 and that warming continues to accelerate. This conference provided a critical review, enabling nations to identify gaps in their strategies and strengthen their emissions reduction targets.

The upcoming **COP 30**, scheduled to be held in **Belém, Brazil**, in 2025, carries the vital mission of reinforcing global actions and commitments in response to the climate emergency. This international gathering will be crucial for efforts to limit global warming to a maximum of 1.5ºC above pre-industrial levels—a threshold considered essential to prevent the most catastrophic impacts of climate change.

Thus, the objective of this paper is to examine the main international agreements on climate change, Brazil's participation, and the actions undertaken by the Brazilian government over time to reduce and/or mitigate greenhouse gas emissions.

2. HISTORY OF CLIMATE CHANGE DISCUSSIONS IN THE WORLD AND IN BRAZIL

By the end of the 20th century, countries began to discuss solutions to contain the growing problem of climate change. This process was marked by the creation, in 1988, of the Intergovernmental Panel on Climate Change (IPCC), and in 1992, of the United Nations Framework Convention on Climate Change (UNFCCC). The IPCC is a scientific body under the UN, composed of researchers from various countries and scientific institutions, which periodically publishes reports synthesizing the state of scientific knowledge.

The environmental impacts caused by the industrialization process began to be perceived more intensely after 1950, especially due to catastrophic effects on human health and the environment, such as the "Smog" phenomenon in England, which caused approximately 8,000 deaths; the contamination of Minamata Bay in Japan; and the widespread use of DDT-based pesticides (dichlorodiphenyltrichloroethane), which caused ecological and public health damage (Marques, 2005).

In 1968, a group of scientists formed the Club of Rome and initiated mathematical projections on the effects of population growth on pollution and the depletion of natural resources, publishing the report *The Limits to Growth*, which served to raise global awareness. From that point onward, the United Nations, national governments, and the scientific community intensified efforts to address environmental issues. The first major milestone was the United Nations Conference on the Human Environment, held in Stockholm in 1972. This was the first global meeting that directly linked human activities to environmental degradation, and its legacy continues to shape international environmental cooperation.

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Twenty years later, in 1992, the United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro—known as the Rio Earth Summit (Rio-92). One of its most important outcomes was the adoption of the UNFCCC, which entered into force in Brazil in 1994. From this Convention arose the Kyoto Protocol, signed during the third Conference of the Parties (COP 3) in Kyoto, Japan, in 1997. These two agreements form the foundation of the international climate regime.

The UNFCCC is based on the principle of common but differentiated responsibilities, meaning that all countries must take action, but with varying degrees of obligation according to their historical contributions to global emissions. The main objective of the Convention is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

The Kyoto Protocol introduced legally binding targets for emission reductions. From 2008 to 2012, during the first commitment period, these countries were expected to reduce their emissions by about 5% compared to 1990 levels. A second commitment period was agreed upon, covering 2013 to 2020, but the countries that signed on represented only about 15% of global emissions.

The rationale behind the principle of differentiated responsibilities is that developed countries bear greater historical responsibility, as they began emitting during the Industrial Revolution. Consequently, developing countries were assigned only voluntary targets. To support emissions reductions and promote cleaner technologies in the Global South, the Clean Development Mechanism (CDM) was created. Under this mechanism, developed countries can purchase carbon credits generated by CDM projects implemented in developing countries, which count toward their emission reduction targets. The Kyoto Protocol came into force in 1997 and currently has 192 signatory countries.

The UNFCCC gathers its Parties annually in global conferences (COPs) to assess implementation progress and to negotiate new commitments. These decisions, which must be made by consensus, are binding for all signatory countries. Over the years, several key summits have significantly influenced the course of climate governance. The Copenhagen Summit (COP 15, 2009), though it fell short of expectations, set the stage for broader commitments. The Paris Agreement, adopted at COP 21 in 2015, represented a landmark moment, as nearly all countries pledged to reduce emissions in order to keep global warming well below 2°C, aiming for 1.5°C. Brazil played a central role in the negotiations and committed to reducing its greenhouse gas emissions by 37% by 2025 and by 43% by 2030, based on 2005 levels.

At COP 26 in Glasgow (2021), Brazil updated its pledge, announcing carbon neutrality by 2050 and aiming to eliminate illegal deforestation by 2028. Despite challenges and criticism, especially regarding enforcement in the Amazon, Brazil remains an influential player in global climate policy.

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Its role has been shaped by international expectations and domestic political shifts, yet the country continues to occupy a strategic position in discussions related to forests, biodiversity, renewable energy, and agroecological transitions.

Brazil has also contributed to the negotiation of technical mechanisms such as carbon markets and nature-based solutions, reinforcing its importance in the global effort to address climate change (Vale et al., 2022). Still, this text would benefit from a deeper discussion of other significant summits, such as the Bali Road Map (2007), the Durban Platform (2011), and more recent climate finance negotiations. Furthermore, it is essential to highlight Brazil's active engagement in coalitions of developing countries, such as the BASIC group (Brazil, South Africa, India, and China), and its leadership in regional initiatives like the Amazon Cooperation Treaty Organization. These examples reflect Brazil's dual identity as both a major emitter and a key environmental actor with the capacity to influence the international climate agenda.

3. HISTORICAL CONFERENCE OF THE PARTIES (COPs)

The Conference of the Parties (COP) is the supreme decision-making body of the United Nations Framework Convention on Climate Change (UNFCCC). It brings together the signatory countries annually in global conferences to examine and adopt the decisions necessary to ensure the effective implementation and advancement of the Convention. COP decisions are collective and consensual, requiring unanimity among all Parties, and are sovereign and binding for all signatory countries.

The COP is also responsible for periodically reviewing the obligations of the Parties and the institutional mechanisms established by the Convention. It promotes and facilitates the exchange of information regarding measures adopted by the Parties to address climate change and its impacts. Furthermore, the COP fosters and guides the development and periodic refinement of comparable methodologies to be defined for the preparation of greenhouse gas inventories — both emissions by sources and removals by sinks. The COP is also tasked with examining and adopting regular reports on the implementation of the Convention.

Since the adoption of the UNFCCC at the 1992 Earth Summit in Rio de Janeiro, the COP has served as the primary forum for international climate negotiations. Over the years, the COPs have become increasingly complex and politically significant, reflecting the growing urgency of the climate crisis (Table 1). They have served as platforms for major international agreements, such as the Kyoto Protocol in 1997 and the Paris Agreement in 2015, and for the development of mechanisms like the Clean Development Mechanism (CDM), Nationally Determined Contributions (NDCs), and the Global Stocktake.

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Table 1: Overview of UNFCCC COPs (1995–2024).

Cop	Year	Host City / Country	Key Highlights	Concepts / Actions Introduced
COP1	1995	Berlin, Germany	Adoption of the Berlin Mandate.	Set the stage for future binding commitments.
COP3	1997	Kyoto, Japan	Adoption of the Kyoto Protocol.	Binding GHG reduction targets for developed countries.
COP7	2001	Marrakesh, Morocco	Marrakesh Accords finalized operational rules for Kyoto Protocol.	CDM and carbon markets.
COP13	2007	Bali, Indonesia	Bali Action Plan initiated post-Kyoto negotiations.	Long-term cooperative action framework.
COP15	2009	Copenhagen, Denmark	Political agreement but no legally binding deal.	Introduced the 2°C target.
COP16	2010	Cancún, Mexico	Creation of the Green Climate Fund.	Climate finance and adaptation mechanisms.
COP21	2015	Paris, France	Adoption of the Paris Agreement.	Universal NDCs, 1.5°C ambition, transparency framework.
COP24	2018	Katowice, Poland	Katowice Rulebook agreed to operationalize Paris Agreement.	Enhanced transparency and reporting.
COP26	2021	Glasgow, UK	Glasgow Climate Pact; stronger NDC pledges and net-zero targets.	Phasing down coal, climate finance goals, methane pledge.
COP27	2022	Sharm El-Sheikh, Egypt	Creation of the Loss and Damage Fund.	Focus on climate justice and support for vulnerable countries.
COP28	2023	Dubai, UAE	First Global Stocktake and call for phase-out of fossil fuels debated.	Emphasis on adaptation and just transition.
COP29	2024	Baku, Azerbaijan	Focus on climate finance architecture and NDC updates.	Implementation pathways for 2025 targets.

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Some COPs have been especially pivotal in shaping the global climate agenda. COP3 (Kyoto, 1997) introduced binding emission reduction targets for developed countries. COP15 (Copenhagen, 2009) marked a political turning point, although it failed to produce a binding agreement. COP21 (Paris, 2015) was a historic milestone, as it led to a universal accord with the goal of limiting global temperature rise to well below 2°C above pre-industrial levels, with efforts to keep it under 1.5°C. More recently, COP26 (Glasgow, 2021) and COP27 (Sharm El-Sheikh, 2022) have emphasized climate finance, just transition, and the establishment of the Loss and Damage Fund to assist vulnerable nations (UNFCCC, 2022; IPCC, 2023).

Despite the progress, challenges remain in terms of implementation, transparency, and ambition. The COP process is complex, involving negotiations between nearly 200 countries with diverse economic, political, and environmental interests. However, it remains a vital mechanism for global cooperation, transparency, and the periodic ratcheting-up of climate commitments.

After 2022, global greenhouse gas (GHG) emissions continued to rise, undermining the targets established under the Paris Agreement. According to Friedlingstein et al. (2025), fossil fuel-related CO_2 emissions increased by 0.8% between 2023 and 2024, reaching approximately 37.4 $GtCO_2$ per year, driven mainly by coal and natural gas consumption. Total GHG emissions reached around 55.4 $GtCO_2$ e in 2023, with significant contributions from methane (CH_4) and land-use change-related CO_2, particularly due to deforestation and wildfires exacerbated by the El Niño phenomenon (Crippa et al., 2024). The natural carbon sinks also showed signs of deterioration, with the weakest terrestrial carbon uptake ever recorded, leading to the highest annual atmospheric CO_2 growth since measurements began—an increase of 3.7 ppm in 2023–2024 (Global Carbon Project, 2025). In response, scientists have emphasized the need for annual emission reductions of over 12% to maintain a viable pathway to limit global warming to 1.5°C, as outlined in the "Carbon Law" framework (Rockström et al., 2017).

In the Latin American context, Brazil has taken on a leading role in the lead-up to COP30, which will take place in Belém, Pará, in 2025. As part of its preparatory efforts, the federal government announced in June 2025 a set of 30 climate goals, including the elimination of illegal deforestation by 2030, expansion of renewable energy capacity, and doubling of energy efficiency in the industrial sector (RBA na COP, 2025). Simultaneously, the Ministry of Science, Technology and Innovation (MCTI) established an inter-institutional Working Group with 17 technical agencies—including INPE, Embrapa, and Cemaden—to coordinate Brazil's scientific contributions to COP30 and secure a lasting legacy in the Amazon region (MCTI, 2025). Additionally, Embrapa launched the initiative "Journey for the Climate," focused on low-carbon agriculture, the development of sustainable technologies, and the engagement of civil society and private sector actors (Embrapa, 2025). These actions highlight Brazil's alignment with international climate governance trends that emphasize ambition, transparency, and multistakeholder participation.

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4. BRAZILIAN PUBLIC POLICIES AND EFFORTS FOR GREENHOUSE GAS MITIGATION

In Brazil, the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol are in force with the status of ordinary law. Their principles underpin domestic public policies, particularly through the action of the National Congress. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), issued by the United Nations (UN), served as a global warning about the urgent need for multilateral action to address the root causes of climate change.

In response, in 2007, the Brazilian National Congress created the Joint Special Committee on Climate Change (Comissão Mista Especial sobre Mudanças Climáticas – CMEsp), tasked with monitoring and overseeing public policies related to climate issues. During its operation in 2007 and 2008, the committee produced a report containing 51 recommendations and introduced eight draft bills addressing the subject.

The accumulation of greenhouse gases in the atmosphere is the main driver of ongoing climate change, a phenomenon that began during the Industrial Revolution. Anthropogenic emissions vary in volume among countries, with distinct historical responsibilities. This disparity supports the current notion of "common but differentiated responsibilities," which guides the obligations of developed and developing countries under the UNFCCC framework. For Brazil, aligning its climate action with socioeconomic growth within the paradigm of sustainable development remains a crucial challenge.

The real socioeconomic capabilities of individual nations and their willingness to tackle both the causes and consequences of climate change are questions that remain at the center of today's climate debate. Each country must seek to formulate appropriate responses and organize coherent strategies.

Although Brazil does not have quantified emission reduction obligations under the UNFCCC—given its relatively minor historical contribution to the accumulation of greenhouse gases—the country has been striving to identify a path that ensures both effective climate mitigation and the well-being of its population.

To this end, Brazil has implemented multiple initiatives and continues to pursue additional solutions aimed at harmonizing economic growth with measures that directly or indirectly benefit the climate. Certain indicators, such as per capita emissions and emissions per territorial area, as shown in the graphs that follow, demonstrate Brazil's relatively modest current contribution to the problem when compared to developed and emerging economies worldwide (SEEG, 2023).

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For the country's development to occur on sustainable grounds, governmental actions directed at the productive sectors must increasingly promote the efficient use of natural, scientific, technological, and human resources. Promoting high-performance standards across economic sectors, based on best practices, can help reduce the carbon intensity of Brazil's GDP, enhance the competitiveness of Brazilian products in global markets, increase income, and generate economic surpluses that improve overall social well-being.

Furthermore, efforts toward energy efficiency and conservation are essential strategies for reducing consumption, preventing additional energy generation, and curbing greenhouse gas emissions. The implementation of a National Energy Efficiency Policy is projected to reduce electricity consumption by approximately 10% by the year 2030, equivalent to a savings of 106 TWh. In a conservative estimate, this reduction could avoid the emission of 30 million tons of CO_2 in that year alone (EPE, 2022; IEA, 2023). Over the years, Brazil has created a robust legal framework to support its environmental and climate policy (Table 2). These laws range from foundational principles to specific actions aimed at conservation, emissions mitigation, and sustainable development.

Table 2: Key Environmental Laws in Brazil – Concepts and Actions

Year	Law / Policy	Description / Objective	Key Concepts and Actions
1981	Law 6.938 – National Environmental Policy	Establishes the framework for environmental protection and sustainable development in Brazil.	Environmental licensing, pollution control, preservation of ecosystems.
1998	Law 9.605 – Environmental Crimes Law	Defines criminal and administrative sanctions for harmful acts against the environment.	Accountability, criminal prosecution, enforcement mechanisms.
2009	Law 12.187 – National Policy On Climate Change	Establishes principles, guidelines, and instruments to address climate change nationally.	GHG inventories, sectoral mitigation plans, carbon markets.
2010	Law 12.305 - National Solid Waste Policy	Establishes guidelines for integrated waste management.	Reverse logistics, waste hierarchy (reduce, reuse, recycle), extended producer responsibility.
2012	Law 12.651 – Forest Code (Reform)	Regulates the use and protection of native vegetation on rural properties.	Legal Reserve, Permanent Preservation Areas (APP),

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			Rural Environmental Registry (CAR).
2022	Decree 11.075 – Regulation of Carbon Market	Regulates Article 6 of the Paris Agreement for the Brazilian carbon credit market.	Emission trading system (ETS), MRV (Monitoring, Reporting, Verification).
2020	National Energy Efficiency Plan	Guides the implementation of measures to reduce energy consumption and improve efficiency in key sectors.	Energy labeling, building codes, incentives for low-carbon technologies.
2020	Decree 10.375 - National Bioinputs Policy	Encourages the production and use of bioinputs in agriculture.	Biological control, sustainable practices, agroecology.

5. CLIMATE VULNERABILITY, JUSTICE AND THE ROLE OF NON-GOVERNMENTAL ACTORS IN BRAZIL

Despite Brazil's progress in establishing legal and institutional frameworks to address climate change, significant challenges remain concerning social vulnerability, equity, and climate justice. The impacts of climate change, such as severe droughts, floods, sea-level rise, and heatwaves, do not affect the population uniformly. On the contrary, they disproportionately impact socially marginalized groups such as Indigenous peoples, traditional communities, quilombola populations, and residents of urban peripheries.

The concept of climate justice implies that climate-related public policies should not only aim to reduce emissions but also confront structural and historical inequalities that make certain groups more susceptible (Schlosberg & Collins, 2014). In Brazil, Indigenous peoples such as the Yanomami, Guarani-Kaiowá, and Munduruku are affected not only by a changing climate but also by illegal deforestation, predatory mining, and weak enforcement of their land rights (Artaxo, 2023). Many of these populations depend directly on natural ecosystems for their livelihoods, making them especially vulnerable to changes in rainfall patterns, watercourses, and biodiversity resulting from global warming (Brondízio et al., 2016).

Urban areas are also regions of high vulnerability. Informal housing sectors, commonly referred to as favelas, often occupy environmentally risky areas, such as hillsides or riverbanks, more prone to landslides and flooding. These places frequently lack basic infrastructure for stormwater drainage, water supply, and sanitation, intensifying health hazards associated with extreme climate events (Maragno et al., 2020). Social inequality worsens the response capacity of these communities to disasters, emphasizing the urgency of just and inclusive adaptation strategies.

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Addressing these inequalities demands more inclusive governance. However, several of Brazil's climate policies have historically followed a centralized approach, with limited participation from local populations in their formulation or execution (Viola & Basso, 2020). In this context, civil society organizations have played a fundamental role in promoting community-based resilient solutions. Institutions such as Instituto Socioambiental (ISA), Fundação Grupo Esquel, and WWF-Brazil have supported the recognition of Indigenous lands, strengthened agroecological practices, and implemented local climate adaptation actions.

The private sector has also expanded its role in climate strategies, often driven by international market demands and by investors who consider environmental, social, and governance (ESG) criteria. Large companies in the soy and livestock sectors have adopted voluntary commitments to deforestation-free supply chains (Nepstad et al., 2014). Municipal governments, especially in large urban centers such as São Paulo and Rio de Janeiro, have also advanced their environmental agendas. Municipal Climate Action Plans (PMAC) have been developed to incorporate mitigation and adaptation measures into sectors like transport, energy, sanitation, and housing (ICLEI, 2022). Nevertheless, smaller and rural municipalities often face technical constraints and limited resources to implement similar actions, highlighting the importance of multilevel collaboration and federal support.

The notion of transformative climate Governance, which combines social justice, civic participation, and environmental sustainability, should guide the formulation of future public policies in the country. Including the voices of Indigenous peoples, rural women, vulnerable families, and other marginalized populations in the climate debate is a matter not only of justice but also of effectiveness. More participatory policies tend to be more context-sensitive, socially legitimized, and resilient to political changes (Ayers et al., 2020). As Brazil seeks to establish itself as a global reference in environmental policy, especially with its expected leadership at COP30 in Belém (2025), it must ensure that its climate actions are both scientifically grounded and committed to social justice.

6. ACTION PLANS FOR THE REDUCTION OF GREENHOUSE GAS EMISSIONS

Brazil is a strategic country for implementing actions aimed at minimizing greenhouse gas emissions. To this end, it voluntarily adhered to the Kyoto Protocol, which came into force in 2005 and was mandatory only for developed countries. Brazil also hosted the 1992 Earth Summit (Rio 92), a landmark event for climate change issues that brought important outcomes for the country's future (Table 3). Moreover, Brazil participates annually in the Conference of the Parties (COPs), which addresses various environmental aspects such as biodiversity and climate change.

Following its participation in the COPs, Brazil established in 2009 the National Policy on Climate Change (Política Nacional sobre Mudança do Clima – PNMC) through Law 12,187, officially

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committing to a voluntary reduction of greenhouse gas emissions between 36.1% and 38.9% of projected emissions by 2020, under the framework of the United Nations Framework Convention on Climate Change (UNFCCC) (MMA, 2016).

To fulfill this commitment, Decree No. 7,390/2010 mandated the development of Sectoral Plans including actions, indicators, and specific emission reduction targets, along with mechanisms for monitoring compliance. These plans were to be finalized by April 2012. The Sectoral Plans were designed for both mitigation and adaptation to climate change, aiming to consolidate a low-carbon economy through gradual reductions in anthropogenic emissions across various sectors, such as electricity generation and distribution, urban public transportation, industry, health services, and agriculture and livestock (Table 4) (MMA, 2016; Silva et al., 2021).

Table 3: Timeline of Brazil's Participation in International Climate Agreements and Treaties

Year	Event / Agreement	Brazil's Role and Highlights
1992	Earth Summit (Rio 92)	Hosted the United Nations Conference on Environment and Development; signed the UNFCCC.
1997	Kyoto Protocol	Voluntarily adhered, despite binding targets applying only to developed countries.
2009	Copenhagen COP15	Participated actively in negotiations, advocating for common but differentiated responsibilities.
2009	National Policy on Climate Change (PNMC)	Established by Law 12,187; formalized voluntary emissions reduction commitments.
2015	Paris Agreement (COP21)	Signed and ratified; committed to reducing emissions by 37% below 2005 levels by 2025 and 43% by 2030.
2021	Glasgow COP26	Updated commitment to reach carbon neutrality by 2050; pledged to eliminate illegal deforestation by 2028.
2022	Sharm El-Sheikh COP27	Supported Loss and Damage Fund; emphasized adaptation and finance for vulnerable countries.

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Table 4: Sectoral Mitigation and Adaptation Plans to Reduce Climate Change under Law No. 12.187/2009 and Their Main Objectives. Source: MMA (2016).

Sectoral Plans	Objectives
Action Plan for the Prevention and Control of Deforestation in the Legal Amazon – PPCDAm (2004)	✓ Reduce deforestation; ✓ Establish a sustainable development model for the Legal Amazon.
Action Plan for the Prevention and Control of Deforestation in the Cerrado – PPCerrado (2009)	✓ Reduce CO_2 emissions from land use and forest change in the Cerrado by 40% by 2020.
Ten-Year Energy Expansion Plan – PDE (2010)	✓ Increase the share of alternative energy sources (wind, biomass, and small hydropower plants) in the electricity sector by 2020.
Low-Carbon Agriculture Plan – ABC Plan (2010)	✓ Align with Brazil's commitments under the UNFCCC; ✓ Voluntary national target to reduce between 1.168 and 1.259 billion tCO_2eq from the projected 2020 total (3.236 billion tCO_2eq).
Sectoral Mitigation Plan for Climate Change in the Manufacturing Industry – Industry Plan (2010)	✓ Promote energy efficiency and cogeneration in the industry; ✓Strengthen voluntary initiatives by private sector associations and companies to reduce emissions; ✓ Facilitate the development and use of sustainable technologies.
Low-Carbon Mining Plan – PMBC (2010)	✓ Support national voluntary targets under the National Policy on Climate Change; ✓ Promote awareness of GHG emissions from the mining sector; ✓ Transform best practices into national standards; ✓ Support small mining companies in adopting mitigation and adaptation strategies; ✓ Integrate the mining sector into national climate policies; ✓ Develop investment strategies for SMEs.
Sectoral Transport and Urban Mobility Plan for Climate Mitigation – PSTM (2010)	✓ Expand knowledge on CO_2 emissions from transport and urban mobility and their mitigation potential; ✓ Support decisions on shifting to more efficient transport modes; ✓ Highlight social and environmental co-benefits of public and non-motorized transport; ✓ Help quantify national mitigation

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	efforts based on ongoing initiatives; ✓ Strengthen institutional coordination to overcome barriers in the transport sector.
Health Sector Plan for Mitigation and Adaptation to Climate Change (2010)	✓ Establish adaptation measures for the SUS (Brazilian Unified Health System); ✓ Strengthen the capacity of health services to respond to climate threats; ✓ Contribute to a low-carbon economy in the health sector.

After the creation and implementation of the Sectoral Plans, reductions in CO_2-equivalent emissions have already been observed across several Brazilian productive sectors from 1995 to 2012 (Table 5). According to the Ministry of Science, Technology and Innovation (MCTI, 2014), the implementation of mitigation actions led to a reduction in overall emissions, particularly due to the significant decline in deforestation under the Land Use and Forestry sector. Notably, emissions in the Cerrado and Amazon biomes decreased by 39.2% between 1995 and 2005, and by 85.1% from 2005 to 2012.

For many years, the expansion of agricultural and livestock frontiers, illegal land grabbing, logging of native hardwoods (Reydon, 2011), and mining activities have posed major threats to the survival of the Amazon Rainforest. To curb this degradation, the Brazilian government launched the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm). The plan is based on three strategic pillars: Land and Territorial Management, Monitoring and Control, and Promotion of Sustainable Activities.

Table 5: CO_2eq Emissions by Sector for the Years 1990, 1995, 2000, 2005, 2010, and 2014. Source: MCTI (2014).

Sector	1990	1995	2000	2005	2010	2014	Δ 2005–2010	Δ 2010–2014
Energy	187,739	227,604	298,611	328,377	371,086	469,832	+18.7%	+26.6%
Industrial Processes	52,537	63,065	71,674	77,943	89,947	94,263	+11.7%	+4.8%
Agriculture	303,772	335,775	347,882	415,724	407,067	424,473	+3.7%	+4.3%
Forestry	815,965	1,940,420	1,343,136	1,179,067	349,173	233,140	–81.7%	–33.2%
Waste	29,061	33,677	38,517	41,887	54,127	62,787	+19.0%	+16.0%
Total	1,389,074	2,600,543	2,099,820	2,042,998	1,271,399	1,284,496	–53.5%	+1.0%

Note: Gg = thousands of tons.

Between 2004 and 2008, the Land and Territorial Management component led to the creation of new protected areas, resulting in 25 million hectares of conservation units. From 2009 to 2011, the Monitoring and Control phase was implemented, including DETER, a real-time deforestation

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detection system. Managed by INPE, DETER monitors changes in Amazon forest cover and issues alerts to environmental enforcement agencies like IBAMA (INPE, 2014).

The Promotion of Sustainable Activities component is still undergoing development. Long-term reductions in deforestation cannot rely solely on enforcement measures, as these do not alter the structural dynamics of land occupation. Lasting success will require investments in land governance and incentives for production models that do not depend on native vegetation clearing.

According to the Ministry of the Environment, PPCDAm actions have contributed significantly to reducing Amazon deforestation rates. Between 2004 and 2016, the deforestation rate dropped by more than 70%, as seen in Figure 1. These results positioned Brazil as a global leader in combating deforestation and reducing greenhouse gas emissions.

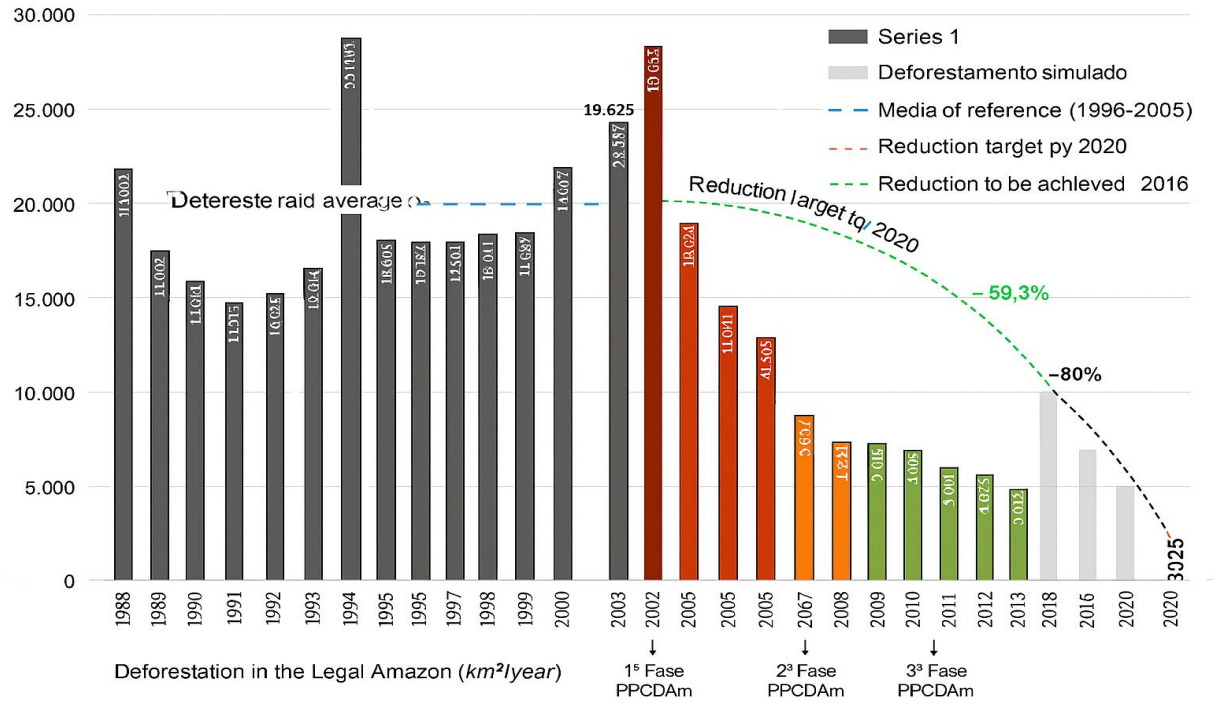

Figure 1: History of the deforestation rate in the Legal Amazon (PRODES/INPE). Source: MMA (2017).

Even with a visibly considerable reduction in the deforestation rate until 2012, it's necessary to invest more in land and territorial regularization programs, aiming for the appropriate use and occupation of space to prevent continued deforestation in the Amazon. Regarding deforestation, in addition to the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon – PPCDAm, the Action Plan for the Prevention and Control of Deforestation in the Cerrado

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(PPCerrado) is also of fundamental importance for Brazil. The PPCerrado encompasses the country's commitment to a 40% reduction in Cerrado deforestation emissions by 2020, assumed by Brazil at the 15th Conference of the Parties. According to the MMA, this biome is still difficult to measure, as the plan is quite recent, and the last data obtained is from the 2011 and 2012 period, showing a 54% reduction in deforestation. Its recent phase was launched on December 15, 2016, and will bring new actions to combat deforestation. Figura 2, provided by the Ministry of the Environment below, illustrates the history of deforestation in the Cerrado and the estimated reduction for 2020.

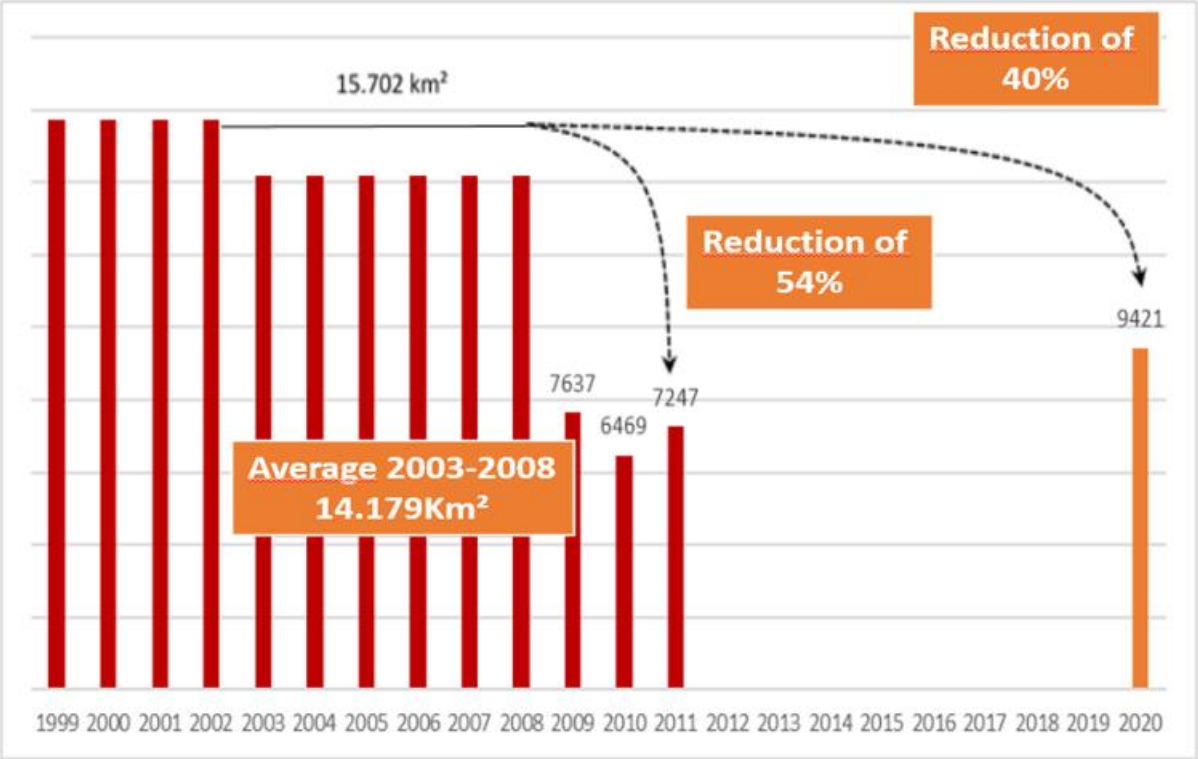

Figure 2: Monitoring of Deforestation in the Cerrado Biome (2010-2011). Source: MMA (2016).

Currently, GHG emissions in Brazil and worldwide originate from various sectors, including energy, industrial processes, waste treatment, agriculture and livestock, and land use. The Energy Sector accounts for emissions due to fuel burning and fugitive emissions from the oil, gas, and coal industries. In the Industrial Processes sector, emissions resulting from industrial production processes that are not a result of fuel burning are considered. The Agriculture and Livestock sector considers emissions from enteric fermentation in cattle, animal waste management, agricultural soils, rice cultivation, and the burning of agricultural residues. In the Land Use Change and Forests

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sector, emissions and removals resulting from changes in carbon quantities, whether from plant biomass or soil, are considered, encompassing all possible transitions between various sectors. And, in the Waste Treatment sector, emissions from the disposal and incineration of solid waste and the treatment of effluents, both domestic/commercial and industrial, are considered. Figure 3 presents the Annual Estimates of Greenhouse Gas Emissions and sectoral comparisons released in 2016 by the National Emissions Registry – SIRENE. It's possible to analyze that forest conversion and land use historically remained the main contributors to emissions until 2010. However, the energy sector is currently emitting a large proportion of GHGs, becoming the primary sector for greenhouse gas emissions.

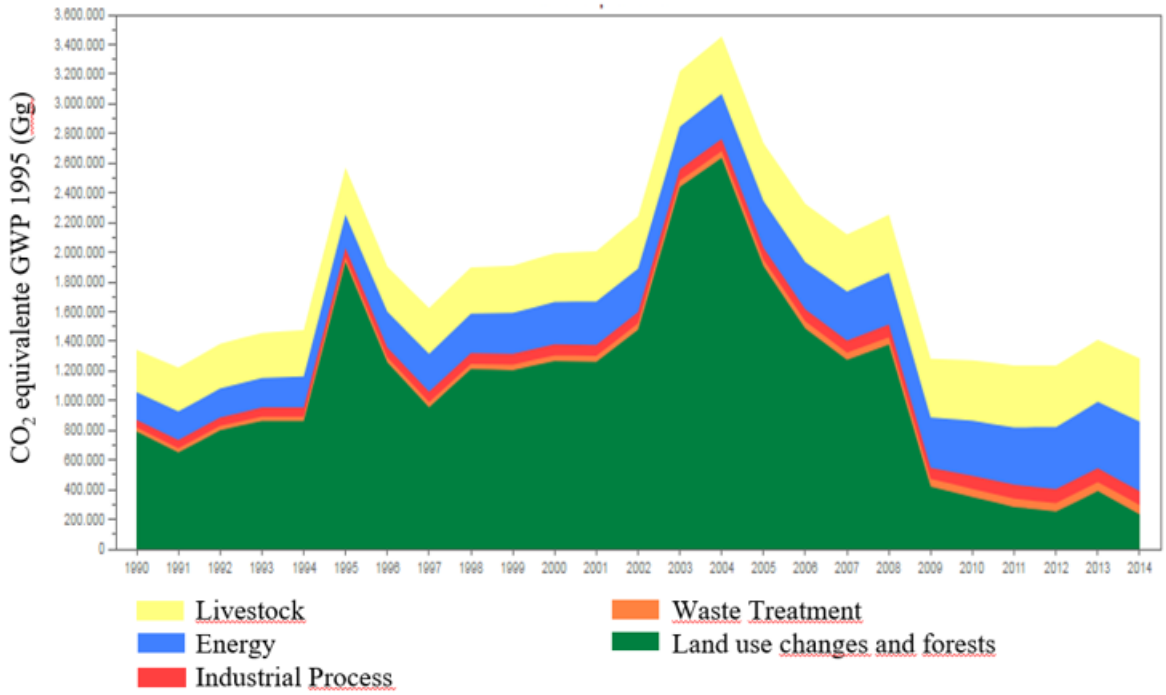

Figure 3: Estimate of National Emissions Registry (MCTI, 2016).

The year 2009 was marked by an international economic crisis, which reflected in a reduction in fossil fuel consumption. This impacted various sectors of the economy, such as the Energy Sector and Industrial Processes Sector, especially in the pig iron and steel industries. The Chemical Industry saw significant reductions from 2005 to 2014 due to project activities under the Clean Development Mechanism (CDM) in adipic acid and nitric acid production industries. Emissions related to the agriculture and livestock sector are due to enteric fermentation in cattle, producing methane, and the application of synthetic fertilizers with strong nitrous oxide emissions. The Land Use Change and Forests sector was marked by significant reductions in greenhouse gas emissions due to substantial decreases in deforestation since 2004, with emissions currently dominated by

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the Atlantic Forest and Cerrado Biomes. In the Waste Treatment sector, the largest emissions are related to the treatment of industrial effluents, followed by solid waste disposal and domestic effluent treatment (MCTI, 2016).

Based on the results presented so far, Brazil has experienced a small setback regarding emissions. The year 2010, right at the beginning of the implementation of Decree No. 7390/2010, which foresaw the elaboration of Sectoral Plans with the inclusion of actions, was the most prominent in terms of emission reduction. New hopes are placed on the last Conference of the Parties, the 22nd Conference of the Parties (COP 22) on climate change, which recently took place on November 7, 2016, in Marrakech, Morocco.

7. FINAL CONSIDERATIONS

In light of the escalating climate emergency, it is clear that coordinated global action is essential to mitigate the effects of climate change and ensure a sustainable future for coming generations. The trajectory of international agreements—from the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) to the Paris Agreement—demonstrates the international community's commitment to setting targets, creating mechanisms, and fostering cooperation toward a low-carbon development model. Within this framework, the role of developing countries—particularly Brazil—is of strategic importance, both for their rich biodiversity and carbon sequestration capacity and for the socio-economic challenges they face.

Brazil has emerged as a key player in climate negotiations, taking on ambitious voluntary commitments and implementing public policies such as the National Policy on Climate Change (PNMC), sectoral mitigation plans, and deforestation control programs. These experiences show that economic growth, social equity, and environmental preservation can be aligned through the enhancement of natural resources, stronger environmental institutions, and the promotion of sustainable practices across key productive sectors. However, the effectiveness of these initiatives depends heavily on consistent political will, adequate resource allocation, and the engagement of civil society, private stakeholders, and local governments.

Brazil holds a pivotal position in global climate diplomacy, serving as a connector between the agendas of industrialized countries and the difficulties encountered by emerging nations. Its extensive biodiversity, comparatively clean energy matrix, and leadership in environmental negotiations grant it a unique responsibility in confronting climate change. Simultaneously, the country faces the task of reconciling its mitigation targets with the alleviation of social disparities and the advancement of environmental justice. The formulation of cohesive, inclusive, and scientifically based public strategies is crucial to ensure a resilient development pathway. In this scenario, Brazil has the capacity not only to lead by good practice but also to constructively shape the course of international climate governance.

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Looking ahead, Brazil must strengthen its leadership in the global climate agenda—particularly as it prepares to host COP 30 in Belém in 2025. This event represents a crucial opportunity to reinforce concrete commitments toward limiting global warming to 1.5°C. Achieving this will require not only increased ambition in climate policy but also enhanced monitoring and transparency mechanisms, investment in science-based and nature-based solutions, and a focus on social justice. Building a sustainable future demands political courage, innovation, and international cooperation—principles that must guide Brazil's climate action in the years to come.

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