

Nationally Determined Contribution Analysis of Brazil and Some Global North and South Countries

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Abstract: The aim of the present study is to analyze Brazil's Nationally Determined Contribution (NDC) based on the NDCs of countries in the Global North (Germany and United States) and South (China and Namibia). This research is featured by its applied nature, qualitative approach and descriptive goal. According to the study's results, the assessed countries have taken different actions to reduce GHG emissions by 2030. Some of them have focused some particular sectors in comparison to the others due to their respective main emission sources. Countries in the Global North develop bolder proposals and Brazil is known for being less conservative in proposing targets given its several national emission offset fields; in other words, forest restoration. If commitments in countries' respective iNDCs are implemented to the letter, it could be enough to reach Target 13.2 of SDG 13.

Keywords: Global warming, Extreme events, Anthropogenic climate change, Mitigation policies, NDC.

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Introduction

According to the Evaluation Report of the Intergovernmental Panel on Climate Change (AR6) (IPCC, 2021, p. 7), “it is unequivocal to state that human influence affects the atmosphere, oceans and continents. Fast and widespread changes take place in the atmosphere, oceans, cryosphere and biosphere”. He goes on, and states that “the observed increase in greenhouse gas concentrations homogeneously distributed in the atmosphere since 1750 were unequivocally caused by human activities”.

If one bears in mind that GHG concentration increase in the atmosphere is the cause of global warming, it is necessary to find ways to mitigate this problem. Mitigation aims at reducing the emission of these atmospheric composites in order to contain climate changes and to, consequently, limit global warming (Sarkodie; Ahmed; Owusu, 2022).

Anthropogenic activities have several effects on terrestrial ecosystems, such as rising sea level, melting ice, ice loss in the Arctic Ocean, biological changes in species migration, oceans acidification, among other factors. Notably, heat extremes became more frequent and intense in most terrestrial regions since the 1950s, on the other hand, cold extremes became less severe and less frequent (IPCC, 2021).

The United States (USA) and China are the largest GHG emitters on the globe and, together, they contribute to aggravate climate change. These two countries account for 36.5% of global emissions (Pinto et al., 2022). Many nations in Europe also warn about what is referred to as climate alterations. In the last two decades, for example, Europe has witnessed a considerable increase in the frequency of droughts in anticipation of other extreme events that are expected to become increasingly frequent in the future. Their study blames consecutive dry events or anthropogenic actions as the main cause of such events (Hari *et al.*, 2020). Overall, European countries have been very concerned with the climate issue, and they corroborate the actions taken to fight climate changes (Torres; Jacobi; Leonel, 2020). Similarly, several countries on the African continent are adopting mitigating measures to fight climate changes. Climate Status in Africa 2020 Report points out the need for expanding mitigation measures on the continent by highlighting that further mitigation efforts remain necessary (ONU News, 2021).

Numerous extreme climate events in Brazil are reported as critical phenomena on a yearly basis, and they not only affect the human population in urban and rural areas, but also account for severe socio-environmental and economic consequences (Silva, 2015). IPCC reports released in 2021 and 2022 (AR6) show how Brazil remains vulnerable to climate changes (Artaxo, 2022).

Brazil has a vast territory and several ecosystems, besides a remarkable climatic variety and huge biodiversity. However, this rich profile is under alert due to the ecological imbalance deriving from the current developmental model and from climate changes. Therefore, currents, droughts and natural disasters will get more common and frequent, and they may reduce food production and crops, besides imposing critical economic scenarios if no effective actions are taken to fight these problems (Bonfim *et al.*, 2021).

The Paris Agreement holds goals aimed at reducing and controlling GHG emissions.

A highlight among of these agreements are the Nationally Determined Contributions (iNDC). Each country must formulate its iNDCs, which are voluntary contributions that must be reviewed every five years and reported to the UNFCCC Secretariat (Schmidt, 2023). Countries participating in this document set emissions reduction goals to be reached by 2030 (Vital, 2018). According Bichara and Oliveira (2023, p. 81), “iNDCs are voluntary measures to mitigate greenhouse gases issued by the States Parties to help limiting global warming”.

The iNDC of each participating country must be in compliance with SDG 13 of the 2030 Agenda, whose purpose is to “Take urgent measures to fight climate change and its impacts”. Goal 13.2 establishes “Integrate climate change measures, national policies, strategies and plans” (ONUBR, 2016, p. 34). When it comes to SDG 13, in particular, Brazil plays leading role in CO₂ emissions due to deforestation, and it poses great responsibility to the country for developing mitigation strategies and policies. Several authors argue that Brazil’s position due to its iNDCs is timid; it could be more outstanding and significantly help reducing or increasing Earth’s mean temperature (Bastidas; Isaac, 2019; Gallo; Albrecht, 2019; Wiltshire *et al.*, 2022).

According to a study carried out in Recife’s Metropolitan Region (Northeastern Brazil), it would be possible avoiding 36 million tons of emitted gases through relatively simple measures aimed at achieving proper urban waste management. This total corresponds to estimates targeting emission’s reduction by 52%, by 2030. This goal exceeds the 47% reduction targeted by the Paris Agreement. These numbers clearly exemplify the potential and limitations of goal development processes (Gama *et al.*, 2024).

Each country has different economic capabilities and GHG emission sources; therefore, it is quite challenging to compare the potential and achievements of goals proposed by different countries. However, it is mandatory to make efforts aimed at better understanding the limitations of iNDC proposals and their political convenience or lack of articulation possibilities.

Endorsing iNDC proposals and the emissions from countries accounting for different socioeconomic and political scopes is one way to understand this scenario in Global North and South countries. Accordingly, a broader approach can be carefully discussed and interpreted. Therefore, the following research questions emerged after selecting some countries in the Global North and South that participate in the Paris Agreement: i) Which are the government policies adopted as iNDC in Germany and the United States, in the Global North; and in Brazil, China and Namíbia, in the Global South, aimed at mitigating climatic changes? ii) Would these policies be enough to reach Goal 13.2 and the Sustainable Development Goals (SDGs), given the current environmental degradation and climate change framework?

The aim of the present study was to analyze Brazil’s Nationally Determined Contribution (iNDC) based on the iNDC of countries in the Global North (Germany and the United States) and South (China and Namibia). The target is to describe and compare policies aimed at mitigating GHG emissions in these countries.

Methodology

The study is featured by its applied nature and its goal is to “generate knowledge for practical application, aimed at solving specific problems. It involves truths and local interests” (Gerhardt; Silveira, 2009, p. 35). It also follows a qualitative approach, since it does not use statistical instruments for data analysis purpose (Zanella, 2013).

The following criteria have been established to select two countries to be assessed in each global hemisphere (South and North) within the universe of 183 countries that have presented their iNDCs for climate change mitigation at COP-21, in 2015:

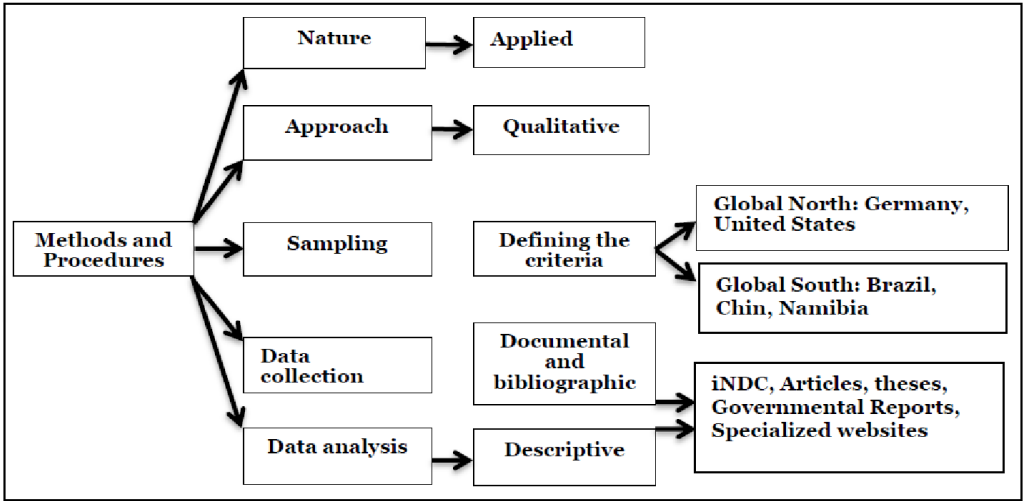
- i) Countries in the Global North accounting for different contributions to GHG emissions. One country in the European Union and the United States were chosen in order to meet this requirement. Germany (European Union) adopts a policy aimed at both protecting the environment and achieving sustainability (Ibiapina; Oliveira; Leocadio, 2021). The United States is currently the second largest GHG generator (Potenza *et al.*, 2023);
- ii) Three countries in the Global South accounting for different contributions to GHG emissions. Namibia, China and Brazil were chosen in order to meet this requirement. Namibia was chosen because it set its iNDC goals in 2015 (Africa NDC Hub, 2021). China was selected due to its audacious production system, which is already giving signs of natural resources’ depletion (Castro, 2017). Brazil was also chosen because its iNDC presented likely limited goals in 2015 (Gallo; Albrecht, 2019; Wiltshire *et al.*, 2022). Although Global North and South countries enhanced the reviews of their iNDCs in 2021, Brazil was still dubious about making updates in its contributions (Unterstell; Martins, 2022);

Documental and bibliographic analyses were the techniques applied for data collection in this research, as recommended by (Gil, 2019). The following documents were assessed in the current study: the iNDC of each assessed country, scientific articles, books, dissertations, theses, reports released by public organizations, research reports, websites specialized on subjects linked to official entities, among others.

The following descriptors were also used: iNDC, NDC, Greenhouse Gas Emissions, Climate Changes, Climate Policies, Climate Mitigation Policies. All descriptors were searched in Portuguese and English. Study data were collected in several platforms, namely: *Portal de Periódicos Capes*, Google Scholar, Scopus, Web of Science, and in webpages of governmental bureaus, governmental reports, among others. The study covered the years of 2015 to 2021, because they regard iNDC creation in 2015 and its update in 2021. Data analysis followed the descriptive approach, according to recommendations by Gil (2019).

Figure 1 provides a flow chart of the herein adopted method and the procedures used in the research, as previously described.

Figure 1 - Flowchart of the adopted method and the applied research procedures



Source: Elaborated by the authors, 2024.

Results

Climate Mitigation Policies in the Global North: Germany and United States

Germany

In March 2015, the European Union (EU) and its Member States presented their iNDCs, which were enacted after Paris Agreement ratification, in October 2016. In 2019, the European Council set the goal of achieving GHG neutrality by 2050, and this goal is in compliance with the Paris Agreement. In 2020, the European Council recognized that the economic and social situation emerging from the COVID-19 pandemic required actions to support the economic recovery of Member States. Yet, it was agreed that the Member States' expenditures had to be consistent with the idea of not jeopardizing the European Green Deal (NDC EU, 2020). The "EU Green Deal" rose as strategic to achieve sustainable development by combining decarbonization and economic growth (CNA, 2023). The EU and its Member States must update their iNDCs between 2021-2030 to achieve GHG emission neutrality by 2050. It must commit to achieve gross internal GHG emission reduction by 55% based on records from 2005 (NDC EU, 2020).

Chart 1 summarizes the commitments made by each German sector based on 2015 and 2021 iNDCs.

Chart 1 – Summary of Germany commitments

Sectors	Summary of commitments
Industry	Reducing carbon emissions by 62%, by 2030, in comparison to 2005 levels. Requiring license for each CO ₂ ton emitted by companies. These licenses are acquired through auctions.
Energy	Recording energy savings by 1.5%, by 2025, on a yearly basis. Increasing the renewable energy share in final energy consumption to 42.5%, by 2030. Achieving zero emission in buildings by 2050. Considering that: (i) fossil fuels currently account for more than 3/4 of EU GHG emissions; (ii) cooling and heating buildings account for 40% of all energy consumed in the EU.
Forests, agriculture and soil	Correct land and forest use, increasing carbon sinkholes by 15%, by 2030. Requiring companies to verify that products they sell have not contributed to forest degradation and/or deforestation, anywhere on the planet. Considering that: i) forests are natural carbon sinkholes and capture more carbon from the atmosphere than they release; ii) each year, forests belonging to the EU absorb approximately 7% of total GHG emissions.
Transport	Reducing CO ₂ emissions per kilometer from new passenger cars, vans and trucks sold in the EU by 2030, by taking 2021 as reference year. Targets: new cars: mean reduction by 37.5%; new vans: mean reduction by 31%; new trucks: mean reduction by 30%.

Source: Eurocid (2024), NDC EU (2020) and European Parliament (2023).

United States

The USA presented its iNDCs in 2015 at COP-21, when the country committed to reduce pollution by GHG emissions. According to this document, it intended to reduce its GHG emissions by 26%-28% in its entire economy by 2025, based on 2005 references (Grando, 2015). In June 2017, this country withdrew the Paris Agreement signed at COP-21 (Carfi; Donatob; Schiliró, 2019). It claimed that the climate agreement jeopardized its economy and posed risks to its workers. Despite the US withdrawal, the Paris Agreement came into force in November 2020 (Nações Unidas Brasil, 2021a). The United States aimed at prioritizing its economic interests to the detriment of the global environmental agenda after the Paris Agreement, and it represents a setback in this country's environmental issues (Sessa; Obregón, 2020).

Joe Biden committed to reduce US emissions by 2050 and to invest two trillion dollars to change the country's economy during the US political campaign for presidency in 2020. In February 2021, he announced the US return to the Paris Agreement in order to once again commit to its role in the global agreement (Oliveira; Brito; Nunes, 2022). The US return to the Paris Agreement was an opportunity for multinationals and agribusiness sectors to commit to the goal of bringing gross carbon emissions to zero by year 2050, which means modernizing their industries and facing the possibility of including

sustainable measures to their procedures for compensation purposes and for gaining credit in the carbon market (Pereira, 2021).

Although Biden has made the promise to provide US\$ 11.4 billion per year for climate financing aimed at developing countries by 2024 during the Glasgow conference, the American Congress only approved US\$ 1 billion for it, in March 2022. Another setback was observed in June 2022 when the US Supreme Court revoked the power of the Environmental Protection Agency to reduce GHG emissions in response to a claim by 20 car-producing states (Oliveira; Brito; Nunes, 2022).

Before the intense and frequent heat and the dry waves recorded in 2022, President Joe Biden, enacted the mega-package of US\$ 370 billion as resource to fight climate changes. These same funds were intended to invest in credit and subsidies for both renewed energy generation and for changing the country's energy matrix, as well as in increasing the power of multinational businesses in the energy sector (Oliveira; Brito; Nunes, 2022). With respect to the 2021 iNDC, it also aimed at reducing GHG emissions by 50%-52%, by 2030, based on 2005 levels. In addition to carbon dioxide, it also seeks to reduce methane and hydrofluorocarbons (NDC USA, 2021).

Chart 2 synthetically presents the commitments made by each US sector based on its 2021 iNDCs.

Chart 2 – Summary of commitments made by the US

Sectors	Summary of commitments
Industry	Supporting research, development, deployment and the commercialization of low- and zero-carbon processes and products. Developing and using hydrogen sources — from renewable energy, nuclear power and waste — to power up industrial facilities. Implementing the American Innovation and Manufacturing (AIM) Act to reduce the use of hydrofluorocarbons. Updating standards and investing in ruling out leaks from wells and mines, and across natural gas distribution infrastructures, in order to combat methane.
Energy	100% carbon pollution-free energy generation by 2035.
Forests, agriculture and soil	Supporting the scaling up of climate-smart agricultural practices, reforestation, rotational grazing and nutrient management. Forest management and protection. Wildfire prevention and restoration of fire-damaged areas. Supporting nature-based coastal resilience projects, including pre-disaster planning. Improving agricultural productivity through practices and technologies that reduce methane and N ₂ O emissions from agriculture. Implementing nutrient management techniques on agricultural lands.

Transport	Investing in transportation infrastructure to improve traffic flow. Encouraging the use of zero-emission personal vehicles, bicycles, trains and pedestrians to reduce the need for using vehicles. Supporting marine and aviation energy decarbonization; whereas the largest sources of emissions in the transportation sector in the U.S. are light vehicles (cars and light trucks), which are followed by heavy trucks, aircrafts, railroads and ships.
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Source: NDC USA (2021).

Climate Mitigation Policies in the Global South: Brazil, China and Namibia

Brazil

Brazil submitted its iNDCs to the Paris Agreement in 2015 and committed to reduce GHG emissions by 37%, by 2025, and by 43%, by 2030, based on 2005 levels (Romeiro; Genin; Felin, 2021). It suggested measures and policies focused on adapting to climate changes in order to increase the resilience of its populations, ecosystems, infrastructure and production methods, as well as to reduce vulnerabilities and protect ecosystem services. The social dimension was taken as essential and focused on protecting and securing the most vulnerable populations against the adverse impacts of climate change (iNDC Brasil, 2016).

The Brazilian government believed that adapting the iNDCs was essential to face the climatic changes and, consequently, their effects. Elaborating adaptation measures and policies to climate changes helps making populations, ecosystems, infrastructures and production methods resilient by reducing vulnerabilities and providing ecosystem services, as aforementioned. It is important bearing in mind the need for protecting and securing the most vulnerable populations from the negative impacts of climate change (iNDC Brasil, 2016).

Brazil developed the National Adaptation Plan, also known as PNA, to implement knowledge management systems, achieve technological development and create tools aimed at supporting adaptation actions at different governmental levels. PNA focuses on priority areas such as housing, slope sites and basic infrastructure (transportation, sanitation and health). The Brazilian government will pay special attention to the most vulnerable populations in order to improve their living conditions and to strengthen their capacity to face the impacts of extreme climate events (Brasil, 2024).

Brazil seeks to enhance its national water-security capacity by implementing the National Water Security Plan, and by conserving and sustainably using biodiversity by applying the National Strategic Plan for Protected Areas, as well as by enacting the Forest Code, mainly when it comes to these areas (Castro, 2022).

In December 2020, Brazil presented a new iNDC, but it held the same goals and indices provided in the previous proposal. However, there was a change in the 2005 GHG emission counting (SGE) after the Third National Inventory was disclosed. The second inventory on 2005 emissions recorded 2.1 billion tons of equivalent CO₂ dioxide

(CO₂e), whereas the third one showed increase to 2.8 billion tons of CO₂e (Romeiro; Genin; Felin, 2021). This 2020 iNDC allowed the country to emit more GHG than it was previously planned. This outcome made this goal less ambitious and led to criticism about the Brazilian position in the Global Agreement (Bastidas; Isaac, 2019; Gallo; Albrecht, 2019; Romeiro *et al.*, 2021; Wiltshire *et al.*, 2022).

The new emission reduction target disclosed by the country for 2030 should reach 57% or 43% in order to return to the same ambitious level set for 2015. It is worth highlighting that the 2020 iNDC did not mention climate adaptations. Although it tended to mention the social dimension, the Brazilian government did not make efforts to take care of, and protect, the most vulnerable communities to climate change (Romeiro *et al.*, 2021).

Brazil launched a new commitment at COP-26 on reducing its GHG emissions by 50%, by 2030 and on achieving these emissions' neutrality by 2050. These numbers were based on the 2005 baseline and on using the Fourth National Inventory of Emissions. In addition, the country committed to rule out illegal deforestation by 2028 and to support global methane reduction (Genin; Frasson, 2021).

Chart 3 synthetically presents the commitments of each Brazilian sector based on its 2015 and 2021 iNDCs.

Chart 3 – Summary of Brazil commitments

Sectors	Summary of commitments
Industry	There were no commitments made.
Energy	Creating and maintaining policies in the energy sector. Including the cost of carbon in the fuel pricing system. Reviewing electricity auction structures for fairer competition. Driving incentives for efficient ethanol gains in flex-fuel engines. Increasing renewable energy shares in the energy matrix. Increasing the use of straw and sugarcane tops to be used as energy source in producing 2nd generation ethanol (which emits 15 times less carbon into the atmosphere than first generation ethanol) and in bioelectricity. Creating the National Biofuels Policy (RenovaBio), which is focused on encouraging the production and consumption of biofuels and reducing GHG. Considering that i) in 2020, renewable energy sources accounted for approximately 48.4% of total energy demand; ii) in electricity demand, sharing renewable energy was close to 84.8%;iii) RenovaBio reduced in 2021 by 66.9MtCO ₂ in the country.
Forests, agriculture and soil	Ruling out illegal deforestation in the Amazon by increasing resources directed to federal environmental agencies and establishing a more accurate forest monitoring system by the Ministry of Defense. Implementing the Brazilian Forest Code to restore and recovery forests with native species. Creating the National Green Growth Program, prioritizing green initiatives, reducing emissions, rational use of natural resources, and the conservation and protection of forests, to cooperate in creating green job positions.

Transport	Mitigating GHG emissions through the Sectoral Plan for Transportation and Urban Mobility (PSTM). Increase in transportation infrastructure freight due to efficient use of clean energy. Mitigating GHG emissions through the Motor Vehicle Pollution Control Program (Proconve).
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Source: Bento and Vieira Filho (2023), Brazil Commitments (2021), NDC Brazil (2017, 2022).

According to Brazil's second document presented at COP-26, the country recovered nearly 28 million hectares of degraded pasture areas and will increase this total to 58 million hectares by 2030. On the other hand, the country canceled the largest operational biofuel program on the planet. Renewed energies contribute to 84% of the electric matrix, and it opened room for 380 thousand projects in the wind and solar energy generation field. In total, 16 million hectares of native forest were recovered and the solid waste management program reduced the number of dumps by 20% (Brazil's Commitments, 2021).

Degraded pasture areas are a big problem for the Brazilian livestock sector. According to MapBiomass (2022), of Brazil's 351 million hectares linked to the its productive matrix, 159 million are covered by pasture. However, approximately 52% of them showed some degradation degree (Jorge, 2024).

Thus, updating the goals Brazil has committed to at COP-26 basically means focusing on APP areas. Goals set by the country, in their turn, are quite limited given the total of degraded areas registered in the Rural Environmental Register of the Ministry of Agriculture, which is also known as CAR. When these goals were set, the country did not have the right conditions to recover a volume of degraded areas higher than the intended one. Actually, the country could set useful and challenging goals to highlight its real commitment to adapt to climate changes.

It is worth pointing out that the Brazilian government highlighted its National Program for the Conversation of Degraded Pastures in Agricultural Production Systems and Sustainable Forests at COP-28, in Dubai (Guzzo, 2023).

In December 2023, the Federal Government launched the National Program for the Conversion of Degraded Pastures in Agricultural Production Systems and Sustainable Forests (PNCPD) to recover 40 million hectares of degraded pastures within ten years. Chances are to double food production in the country without clearing new native-vegetation areas (Jorge, 2024).

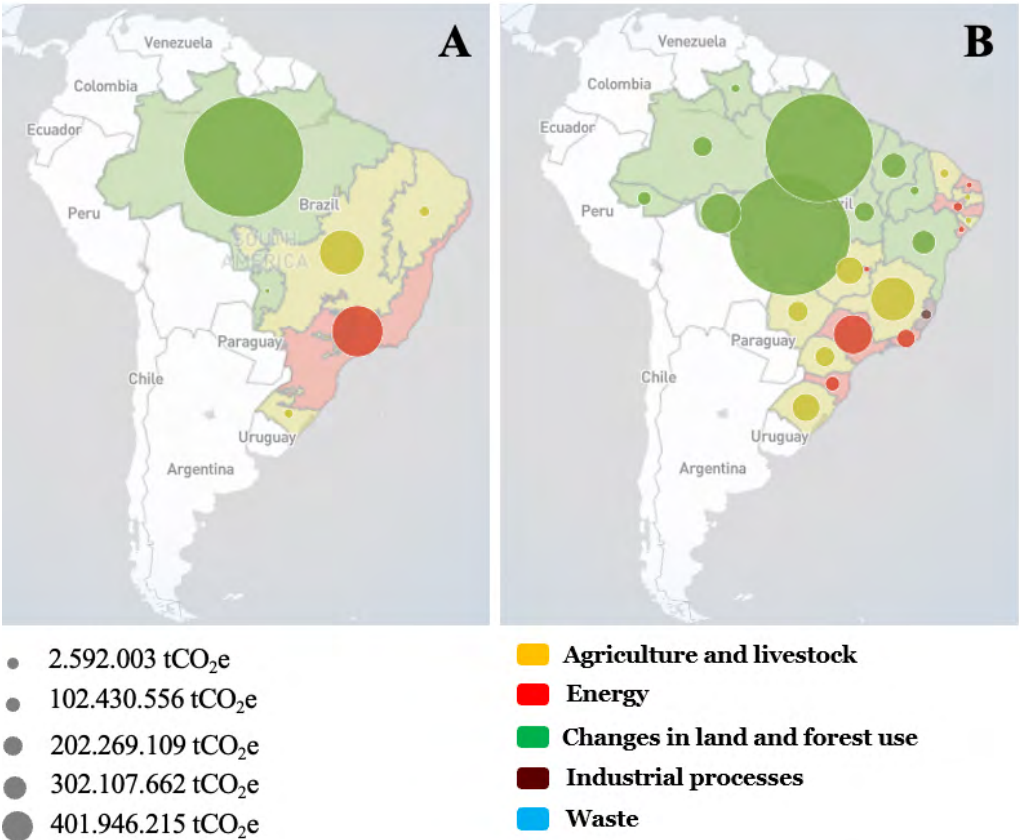
Amazon deforestation data decommissioning disclosed by the National Space Research Institute, also known as INPE, on November/18/2021, require attention to the country's lack of commitment to the climate agenda. Data evidenced the highest deforestation rates in the last fifteen years – more than 13 thousand km² of destroyed forests -; they were only disclosed and published after COP-26 (Genin; Frasson, 2021).

According to the System for Estimating Greenhouse Gas Emissions and Removal (SEGHG), CO₂ emissions are most worrisome in the Amazon, which is followed by the Atlantic Forest and *Cerrado* (Figure 2A). In 2019, the sector focused on changing land and forest increased the country's total emissions by 23%, and 94% of these emissions

resulted from deforestation - 87% of this total was recorded in the Amazon. The year of 2020 witnessed significant increase in records of the new *Cadastrros Ambientais Rurais* (CAR) [Rural Environmental Registers] by the Ministry of Agriculture and Livestock, and this outcome pointed towards land grabbing activities in this biome. Furthermore, the Brazilian government identified more than 60 million hectares of degraded pastures. The Brazilian iNDC committed to restore 1/4 of this total (15 thousand hectares) (SEEG, 2024).

When it comes to analyzing Brazilian states, Mato Grosso and Pará states have recorded the largest CO₂ emission areas due to changes in land and forest use (Brazil, 2023). The Southeastern region and part of the Northeastern one show significant interest in energy generation, whereas Minas Gerais faces serious challenges in the agricultural sector (Figure 2B). It is important observing that, in some cases, it is not enough to have well-developed environmental policies, but to implement them in order to achieve sustainable economic and social development. Yet, well-defined agricultural policies can play more important roles than environmental policies themselves.

Figure 2 - GHG emissions associated with changes in land and forest use



Source: SEEG (2024).

Deforested areas were expected to increase in five to six Brazilian biomes between 2021 and 2022, including the Atlantic Forest. The highest increases will assumingly be witnessed in the Amazon (increase by 190,433 hectares) and in *Cerrado* (increase by 156.871 hectares). Proportionally, the highest increases were observed in *Pampa* (27.2%) and in *Cerrado* (31.2%). Actually, 62.1% of the total deforestation recorded in 2022 took place in the Amazon (approximately 1.192.635 of deforested hectares) This number corresponds to 58% of the total deforested area in Brazil. *Caatinga* accounted for 18.4% of this total (140.637 hectares) and it means 6.8% of the total deforested area. *Cerrado* accounts for 659.670 hectares, and it means 8.3% of the total deforested area. Most of the Atlantic Forest area has been deforested (approximately 30.012 hectares), only less than 29% of its forest cover remains standing, and it regards approximately 1.5% of Brazil's total deforestation area. *Pampa* increased by 27.2% its deforested area between 2021 and 2022. *Pantanal* reduced the number of verified warnings (-8.9%), but it has increased by 4.4% in its deforested area within the same period (MAPBIOMAS, 2024a).

The number of wildfire events decreased in January 2023 in comparison to 2022 data. However, it has increased by 248% in it, in January 2024, in comparison to January 2023. Approximately 287 thousand hectares burned down in January 2023, whereas 1.03 million hectares came down to ashes in December 2022. In total, 941 hectares (approximately 91%) of this area are located in the Amazon, which was the biome most harmed by wildfire at that time, mainly at this regions' far Northern area. There was an increase by 266% in comparison to the previous month. *Pantanal* was the second most impacted biome, with approximately 40.626 hectares (MAPBIOMAS, 2024b).

China

The Chinese government announced its iNDCs in June 2015. The country is committed to reach the CO₂ emission peak before 2030 and to achieve carbon neutrality by 2060. It also plans to reduce CO₂ emissions per GDP unit by 60% to 65% in comparison to 2005 rates and to increase the non-fossil fuel participation in its energy matrix by 20%, as well as to expand the forest stock by 4.5 billion m³ starting from 2005, and to implement adaptation measures to face climate change risks (NDC China, 2021).

China updated its climate goals in October 2021, before COP-26; it kept some of its commitments and expanded others. The country restated its commitment to reach the CO₂ emission peak before 2030 and to reach carbon neutrality by 2060. It also aims to reduce CO₂ emissions per GDP unit by more than 65% in comparison to 2005 levels, to increase non-fossil fuel share in the energy matrix by 25%, to expand the forest stock by approximately 6 billion m³ starting from 2005 and to increase the total installed capacity of solar and wind energy to more than 1.2 billion kilowatts by 2030 (Mattos *et al.*, 2023).

Chart 4 synthetically presents the commitments made by each China sector based on its 2015 and 2021 iNDCs.

Chart 4 – Summary of China commitments

Sectors	Summary of commitments
Industry	High-quality development of low-carbon green industry. Building a green manufacturing system. Optimizing industrial structure and expanding clean production. Whereas: The iron and steel industry has implemented high-quality reforms for ultra-low emissions.
Energy	Increased investments in clean energy, given its large solar capacity. Replacement of the coal-based export economy with clean energy. Maintaining world leadership in the production of electric vehicles. Considering that: i) in 2022, the installation of wind, hydroelectric and solar capacity grew significantly when compared to coal; ii) in 2022, solar and wind energy generation grew 21% compared to 2021 and 13.8% of total electricity consumption; iii) in 2022, energy from coal reduced from 65%-70% to 58.4%.
Forests, agriculture and soil	Creating favorable conditions for forests, grasslands, soil and oceans to play their role in carbon sequestration. Maintaining natural and artificial forest cover. Implementing the National Forest Fire Prevention Plan (2016-2025) with the aim of strengthening the prevention and control of forest disasters. Considering that: i) the forest cover area in 2020 was equivalent to 220 million hectares and in 2022 it increased by 23% and forest carbon storage reached close to 9.19 billion tons; ii) between 2016 and 2019 there was a sharp and continuous decline in the average annual number of forest fires.
Transport	Implementation of the Green Transportation Standard System, established in 2016, containing 221 standards covering energy conservation and carbon reduction, ecological protection, pollution control, resource recycling, testing and evaluation, and supervision. Expansion of online bicycle rental services, now available in more than 360 cities, with more than 300 million registered users. Promotion of clean and low-carbon urban traffic.

Source: Bispo and Cechin (2023), NDC China (2021, 2022), Mistreanu (2022), Suy and Chi (2022) and Yuanling (2023).

Namibia

Namibia's government announced its iNDC in 2015, and it aimed at reducing GHG emissions by 89%, by 2030. In 2021, the country established a more ambitious goal, namely: increasing that rate to 91% by 2030 (Africa NDC Hub, 2021). It also committed to promote a green economy in order to achieve economic development based on protecting the environment (NDC Namibia, 2021).

However, the country is known for its significant vulnerability to climate changes that have been exacerbating extreme events such as floods and droughts (Odendaal, 2021). This scenario complicates its socioeconomic development due to its negative impact on ecosystems and natural resources (The Commonwealth, 2023). It is important observing that the country acts as carbon sink, because it absorbs more carbon than the amount emitted by its industries (Odendaal, 2021).

Chart 5 presents the summary of commitments made by each sector in Namibia based on its 2015 and 2021 iNDCs.

Chart 5 – Summary of Namibia commitments

Sectors	Summary of commitment
Industry	Replacing 23% clinker by other diluents in cement production in order to reduce GHG intensity.
Energy	Driving energy technologies through Namibia's National Renewable Energy Policy to reduce emissions and support cleaner practices. Replacing existing higher-emitting technologies by cleaner, lower-cost and more efficient technologies.
Forests, agriculture and soil	Reducing the rate of deforestation and clearing, because the country considers reforestation, agroforestry and urban forests essential for carbon and timber yield in light of best forest management practices. Restoring degraded savannah areas, reducing 2.3 MtCO ₂ eq in emissions by 2030. Fighting invasive thorn bushes in the savannah area in the central regions of the country, which contribute to land degradation, to prevent the expansion of animal and plant biodiversity, land yield and hinder ecotourism. Considering that: i) 45 million hectares have been impacted by forest invasion; ii) by 2030, 15.000 hectares will be recovered due to national support and approximately 20.000 hectares due to international support.
Transport	Replacing inefficient fuels by cleaner and more economical forms, i.e., replacing hydrocarbons by electricity or hydrogen. Reducing energy consumption and costs for end users, and reducing carbon emissions. Regulating GHG emission standards for light-duty and transportation vehicles.

Source: NDC Namibia (2021).

Results and discussions

All the herein assessed countries took the Forest Sector into consideration in their actions. They all adopted measures to protect forests, including actions against deforestation, forest conservation and their more rigorous monitoring, and forest-hazardous' control. Furthermore, the European Union and China have adopted measures regarding carbon sinkholes and sequestration as part of their strategies.

Forests, in addition to being home to several animal and plant species, are responsible for fighting climate change due to their ability to remove and capture the carbon found in the atmosphere, and it is also known as climate change mitigation (UN, 2024a). Brazil is clearly far from what could potentially be offered in iNDC terms, and it highlights that actions taken to avoid GHG emissions by changing land and forest uses are still relatively far from ideal. This finding points out that forest restoration strategies must be encouraged, as well as more favorable policies to keep carbon in forest systems through the carbon credit market and through reviewing more specific agricultural policies to limit the deforestation borders.

Brazil's dubious and timid position in both international negotiations and climate policy proposals at COP-26 was also addressed by Viola and Franchini (2022), and Marques (2023). Schmidt (2023) emphasized that concrete policies have been extremely modest, even after climate change severity was restated in IPCC reports.

All the herein assessed countries have assumed actions related to the energy sector, which, in addition to moving the economy, also supports societies. This resource's generation, as well as its use, are the two largest contributors to the global scenario, besides being practically responsible for 2/3 of global GHG emissions associated with anthropic activities (UN, 2024b). The most diverse actions have been considered by each of these countries, such as reducing energy consumption; implementing renewable energies; supporting research, development and marketing regarding carbon pollution-free electricity systems, among other elements.

An important initiative by the energy sector in recent years have stood out in Brazil, namely: use of biofuels. Using sugarcane straw and tip can be a strategy to generate second-generation ethanol and bioelectricity, a fact that can contribute to a cleaner energy matrix worldwide. Namibia is known for adopting green hydrogen, which can considerably reduce greenhouse gas emissions.

The transport sector was addressed by all countries assessed in the current study. This sector is vital for both the economy and human well-being, but it also has significant impact on both health and the environment (UN, 2024c). These countries have considered systems, programs and plans for this sector, mainly the United States and China, which must discuss the use of bicycles as alternative to other vehicles. The United States will adopt measures to decarbonize maritime and air transports. Namibia is implementing promising actions, such as replacing inefficient fuels by cleaner and more economical alternatives, as well as introducing new technologies to reduce fuel consumption per traveled kilometer.

Although 4 of these 5 countries take the industrial sector into consideration, and take actions heading towards it, it is clear that this sector was the least promising one, with fewer actions in comparison to the other assessed ones. Furthermore, Brazil finds itself lacking elements referring to the Industrial Sector. It can be seen as significant gap in the herein addressed scenario, since the country could best contribute to this field.

The Brazilian government only launched a new industrialization policy in January 2021, the so-called *Nova Indústria Brasil* – NIB [New Brazilian Industry], which is anchored in decarbonization. Actions planned for the next ten years include fortifying the country's reindustrialization process. Nearly R\$ 300 billion will be invested in financing by 2026, and this action aims sustainable growth combined to innovation in the national industry (Nova Indústria Brasil, 2024).

Overall, the herein assessed countries in the Global North and South are committed to elaborate and plan actions to achieve these measures. This profile opens room for Brazil to be more audacious and to enhance its global reviews and actions committed to reduce GHG emissions. In this case, the political and economic systems of the Global North and South were not determinants for predicting whether these countries are bold,

or not, in their respective negotiations. However, a factor internal to Brazil set the conditions for its timid iNDC. The current results suggest that States play important role in reducing gas emissions regardless of the addressed sectors, and it forces the creation of more effective political and economic security mechanisms by them.

The present results are close to SDG 13, mainly in Brazilian, which still has the potential to get much closer to it. Goal 13.2 in SDG 13 is linked to two indicators: 13.2.1, which refers to “Numbers of countries with Nationally Determined Contributions, long-term strategies, national adaptation plans and long-term strategies as reported in national and adaptation communications”. This indicator is intended to analyze how countries signing the Paris Agreement have taken actions to achieve what was proposed in their iNDCs. The second indicator, goal 13.2.2, refers to “Total greenhouse gas emissions per year” and is an intuitive item to analyze and monitor GHG emissions by countries in several sectors and to check whether they meet the proposals in their respective iNDCs” (Pessoa, 2022, p. 10). First, goal 13.2 (along with its indicators, 13.2.1 and 13.2.2) is in compliance with assumptions made by the assessed countries because they are synchronized with, and concern, the same subject, namely: fighting climate change.

Data collected from the assessed countries’ iNDCs and details on actions taken by each of their sectors highlight that they have taken actions and measures to reduce GHG emissions, and consequently, to modify these climate changes, which is the very target of the presented Goal. However, as for Brazil, it still has some opportunities to expand its contributions. Accordingly, if what was presented by the countries is taken into account, the policies described by them can contribute to improve climate change. Furthermore, they will be heading towards achieving Goal 13.2, which regards adopting actions and policies related to fighting climate change.

The greater use of Green Hydrogen is another interesting factor that can be adopted by the Brazilian government, as it was adopted by Namibia, another country in the Global South. It is of great value, besides being said to respect decarbonization. China and the US, the two largest GHG emitters on the globe, provide good examples of sustainable urban mobility aimed at reducing the carbon footprint. Encouraging bicycling, mainly in medium and large-sized Brazilian cities, must be a priority. Comparing actions taken by countries in different sectors can encourage the adoption of important measures that have not been considered by some countries.

Final considerations

The present study fulfilled a theoretical-empirical gap by discussing GHG emission reduction, which is a crucial issue in the given warnings on global warming and climate changes worldwide. It is paramount for the herein assessed countries to commit to help reducing these emissions.

Results have shown that these countries are taking several measures to reduce greenhouse gas emissions by 2030, by focusing specific fields due to their main emission sources. However, it was observed that some important points, such as biofuel, green

hydrogen and incentive to using bicycles as alternative to automobiles could be considered by all of them.

Countries in the Global North are bold in their proposals given their particular GDP features. Although their sectors are very different to those in Brazil, this country can be less conservative in proposing goals, since there are different fields to compensate the national emissions through forest restoration.

The present findings allowed concluding that commitments made in the respective countries' iNDCs have been put in place, and it can be enough to achieve Goal 13.2 of SDG13.

The study gathered selected information on the assessed countries' iNDCs in order to help better understanding their actions to reduce GHG emissions. Analyzing the actions of each country is crucial to assess whether it is effectively contributing to this reduction and whether it is in compliance with the established goals. It must be done to identify likely fields demanding farther steps towards achieving the set goals.

Comparing actions between countries is a differential of the present study because it allows analyzing what each country takes as actions by a given sector and how they suggest actions that can be adopted by other countries. It was possible identifying the priorities of each country, the discrepancies between them, the most important actions and other relevant aspect by comparing the actions by each sector.

The study has shown that just thinking about mitigation is not enough, it is necessary to overcome such thinking and moving forward seeking adaptations to achieve true transformations in the future. Accordingly, the statement by the UN Secretary General highlights the content of the 2022 IPCC report: "This IPCC report is a long list of unfulfilled climate promises. It is a shameful archive, cataloging the empty promises that place us firmly on the path to an uninhabitable world" (Guterres, 2022, s.p.).

Time is becoming increasingly short to implement open and effective measures. Mankind is living in a crucial period, and time management must be a priority concern for the collective future. Time is becoming a critical factor for the success of climate policies (Marques, 2023).

Future studies must prospect other documents to find out the countries that are truly engaged in putting proposals in their iNDCs in place.

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Análise da Contribuição Nacionalmente Determinada do Brasil e Alguns Países do Norte e Sul Global

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Resumo: O objetivo do estudo é analisar a Contribuição Nacionalmente Determinada (iNDC) do Brasil, tendo como base as iNDC de países do Norte Global (Alemanha e Estados Unidos) e do Sul Global (China e Namíbia). A pesquisa caracteriza-se pela sua natureza aplicada, abordagem qualitativa e objetivo descritivo. O estudo evidenciou que os países em questão têm adotado diversas ações para que ocorra a redução das missões de GEE até o ano de 2030. Alguns desenvolvem mais ações em dado setor do que outros devido as suas respectivas fontes emissoras principais. Os países do Norte Global estão mais audaciosos em suas propostas. O Brasil pode ser menos conservador na proposição de metas, uma vez que existem diversos campos a compensarem as emissões nacionais, i.e., restauração florestal. Se os compromissos assumidos na respectiva iNDC dos países for executado à risca, tais feitos podem ser suficientes para alcançar a Meta 13.2 do ODS 13.

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Artigo Original

Palavras-chave: Aquecimento global, Eventos extremos, Mudanças climáticas antropogênicas, Políticas mitigatórias, NDC.

Análisis de la Contribución Determinada a Nivel Nacional de Brasil y de Algunos Países del Norte y del Sur Global

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Resumen: El objetivo de este estudio es analizar la Contribución Nacionalmente Determinada (CND) de Brasil, a partir de las CND de países del Norte Global (Alemania y Estados Unidos) y del Sur Global (China y Namibia). La investigación se caracteriza por su carácter aplicado, su enfoque cualitativo y su objetivo descriptivo. El estudio puso de manifiesto que los países en cuestión han adoptado diversas medidas para reducir las emisiones de GEI de aquí a 2030. Algunos adoptan más medidas en un sector determinado que otros debido a sus respectivas fuentes principales de emisiones. Los países del Norte Global son más audaces en sus propuestas. Brasil puede ser menos conservador a la hora de proponer objetivos, ya que existen varios campos para compensar las emisiones nacionales, por ejemplo, la restauración forestal. Si los compromisos asumidos en las respectivas iNDC de los países se cumplen al pie de la letra, estos logros podrían bastar para alcanzar la meta 13.2 del ODS 13.

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