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Carolinna Maria Silva Martins

THE 21st CENTURY TRIAD:

Agriculture, Climate Change and Food Security

Belo Horizonte
2023

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Tese apresentada ao Programa de Pós-Graduação em Relações Internacionais da Pontifícia Universidade Católica de Minas Gerais, como requisito parcial para obtenção do título de Doutora em Relações Internacionais.

Orientadora: Prof. Dra. Matilde de Souza
Coorientador: Dr. Renato de Aragão Ribeiro Rodrigues

Área de concentração: Política Internacional
Linha de pesquisa: Instituições Internacionais e Segurança

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Prof. Dra. Matilde De Souza (Orientadora) – PUC Minas

_____

Dr. Renato de Aragão Ribeiro Rodrigues (Coorientador) – UFF

_____

Prof. Dra. Ana Flávia Barros-Platiau – UnB (Banca Examinadora)

_____

Dr. Haroldo Machado Filho – Sistema Nações Unidas no Brasil (Banca Examinadora)

_____

Dr. Danny Zahreddine – PUC-Minas (Banca Examinadora)

_____

Prof. Dr. Thiago de Araújo Mendes – PUC-Minas (Banca Examinadora)

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To my moms, Andréa, Zaíra and Dadá
Para minhas mães, Andréa, Zaíra e Dadá

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RESUMO

O uso da terra é uma das principais causas do aumento da instabilidade climática, que marca a transição do Holoceno para o Antropoceno. A agropecuária tem um papel importante neste cenário, participando como causa das alterações climáticas e tendo um potencial de mitigação considerável – através da gestão da terra, se sustentável ou não. Além disso, o setor é identificado como um dos que mais sofrerá com o impacto das alterações climáticas, com uma consequente queda na produção agrícola e empobrecimento do solo, o que irá influenciar consideravelmente a segurança alimentar. Assim, a agropecuária influencia e é influenciada pela mudança do clima, gerando um impacto direto na segurança alimentar - formando uma Tríade. Neste ponto, o Brasil atua como um potencial produtor e fornecedor de alimentos ao mesmo tempo que possui atuação visível no Regime Internacional de Mudança do Clima. Assim, objetivo da tese é, elucidar as articulações e trade-offs entre as esferas da Tríade e sua influência na formulação da política externa brasileira. O período temporal analisado foi de 2001 a 2010 e de 2011 a 2020. Como aparato teórico, utilizou-se Tsebelis e o desenvolvimento dos jogos aninhados. Para isso, foram identificados os atores que faziam parte de cada esfera e a análise de sua influência na política externa brasileira através de eventos-chaves selecionados ligados à Tríade. Isso permitiu a análise descritiva desses eventos e a coleta de dados quantitativos. Para o tratamento dos dados quantitativos, utilizou-se o K-Means para clusterizar. Como resultado, observou-se 9 clusters para cada período temporal analisado. através dos clusters a confirmação da hipótese desta tese, de que se os atores da Tríade tiverem interesses comuns, haverá maior probabilidade de uma articulação da Tríade e de uma proposta comum para a formulação da política externa. Por outro lado, se os interesses forem divergentes, essa articulação será mais difícil e, muito provavelmente, a formulação da política externa será favorável à esfera da Tríade alinhada aos interesses do Executivo. No primeiro período, os nove clusters encontrados mostraram que houve uma maior convergência de interesses e isso influenciou na formulação da política externa, através do comportamento e acordos assumidos pelo Brasil no Regime Internacional de Mudança do Clima. No segundo período, houve uma mudança de direcionamento político no Brasil que mostrou que as divergências de interesse levavam ao benefício do grupo alinhado ao Executivo, no caso, a Agropecuária. Concluímos que elucidar as múltiplas arenas em que as esferas da Tríade estão envolvidas e a sua influência na formulação da política externa brasileira pode ajudar a sugerir propostas e estratégias para o Brasil que sejam política, ambiental e economicamente viáveis.

Palavras-chave: mudança do clima; agropecuária; segurança alimentar; Conferência das Partes; K-means.

ABSTRACT

Land use is one of the main causes of the increase in climatic instability, which marks the transition from Holocene to Anthropocene. Agriculture has an important role in this scenario, participating as the cause of climate change while having considerable mitigating potential - through land management, if sustainable or not. In addition, the sector is identified as one of those that will suffer the most from the impact of climate change, with a consequent fall in agricultural production and impoverishment of the soil, which will considerably influence food security. So, agriculture influences and is influenced by climate change and directly impacts food security - forming a Triad. At this point, Brazil acts as a potential food producer and supplier while also having a visible role in the International Climate Change Regime. Thus, the objective of the thesis is to elucidate the articulations and trade-offs between the spheres of the Triad and their influence on the formulation of Brazilian foreign policy. The period analyzed was from 2001 to 2010 and from 2011 to 2020. As a theoretical framework, we used Tsebelis and the development of nested games. To this end, the actors that were part of each sphere were identified and their influence on Brazilian foreign policy was analyzed through selected key events linked to the Triad. This allowed the descriptive analysis of these events and the collection of quantitative data. For the treatment of quantitative data, K-Means was used for clustering. As a result, nine clusters were observed for each period analyzed. The clusters confirm the hypothesis of this thesis, that if the actors of the Triad have common interests, there is a greater probability of a Triad articulation and a common proposal for the formulation of foreign policy. On the other hand, if the interests are divergent, this articulation will be more difficult and, most likely, the formulation of foreign policy will be favorable to the Triad sphere aligned with the interests of the Executive. In the first period, the nine clusters found showed that there was a greater convergence of interests, and this influenced the formulation of foreign policy, through the behavior and agreements assumed by Brazil in the International Climate Change Regime. In the second period, there was a change of political direction in Brazil that showed that divergences of interest led to the benefit of the group aligned with the Executive, in this case, Agriculture. We conclude that elucidating the multiple arenas in which the Triad spheres are involved and their influence on Brazilian foreign policymaking can help to suggest proposals and strategies for Brazil that are politically, environmentally, and economically viable.

Keywords: climate change; agriculture; food security; Conference of the Parties; K-Means.

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ABRAF	Associação Brasileira de Florestas Plantadas (Brazilian Association of Planted Forest Producers)
ABC	Agricultura de Baixo Carbono (Low Carbon Agriculture)
AF	Agroforestry Systems
AFOLU	Agriculture, Forestry and Other Land Use
ANA	Agência Nacional de Águas (National Water Agency)
ANPII	Associação Nacional dos Produtores e Importadores de Inoculantes (National Association of Producers and Importers of Inoculants)
APP	Área de Proteção Permanente (Permanent Preservation Areas)
ATER	Programa de Assistência Técnica e Extensão Rural (Technical Assistance and Rural Extension Program)
BNF	Biological Nitrogen Fixation
CDM	Clean Development Mechanism
CH_4	Methane
CNA	Confederação da Agricultura e Pecuária (Confederation of Agriculture and Livestock of Brazil)
CNI	Confederação Nacional de Indústria (National Confederation of Industry)
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CONAMA	Conselho Nacional do Meio Ambiente (National Council of the Environment)
CONTAG	Confederação Nacional dos Trabalhadores na Agricultura
COP	Conference of the Parties
CPMI	Comissão Mista de Inquérito (Mixed Parliamentary Inquiry Commission)
CTNBio	Comissão Técnica Nacional de Biossegurança (National Technical Biosafety Commission)
CUT	Central Workers Union (Central Workers Union)
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation)
FAO	Food and Agriculture Organization of United Nations
FBMC	Fórum Brasileiro de Mudança do Clima (Brazilian Forum on Climate Change)
FC	Forest Code

FEBRAPDP	Federação Brasileira de Plantio Direto na Palha (Brazilian Federation of Planting Directly in Straw)
FHC	Fernando Henrique Cardoso
FIESP	Federação das Indústrias do Estado de São Paulo (Federation of Industries of the State of São Paulo)
FPA	Frente Parlamentar da Agropecuária (Parliamentary Front for Agriculture)
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GMO	Genetically Modified Organisms
IBAMA	Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute of the Environment and Renewable Natural Resources)
ICCR	International Climate Change Regime
ICLFS	Crop-Livestock-Forestry Integration System
ICMBio	Instituto Chico Mendes de Conservação da Biodiversidade (Chico Mendes Institute for Biodiversity Conservation)
IFAD	International Fund for Agricultural Development
ILAC	Latin American and Caribbean Initiative for Sustainable Development
IMF	International Monetary Fund
INCRA	Instituto Nacional de Colonização e Reforma Agrária (National Institute for Colonization and Agrarian Reform)
INESC	Instituto de Estudos Socioeconômicos (Institute of Socioeconomic Studies)
INPE	Instituto Nacional de Pesquisas Espaciais (National Institute for Space Research)
IPCC	Intergovernmental Panel on Climate Change
LUC	Land-use Change
MAPA	Ministério da Agricultura, Pecuária e Abastecimento (Ministry of Agriculture, Livestock and Supply)
MDA	Ministério do Desenvolvimento Agrário (Ministry of Agrarian Development)
ML	Machine Learning
MPV	Medida Provisória (Provisional Measure)
MST	Movimento dos Trabalhadores sem Terra (Landless Workers' Movement)
NAMAs	Nationally Appropriate Mitigation Actions
NASA	National Aeronautics and Space Administration
NDC	National Determined Contributions

N_2O	Nitrous Dioxide
NGO	Non-governmental organizations
NTS	No-Tillage System
OCB	Organização das Cooperativas do Brasil (Organization of Cooperatives of Brazil)
OECD	Organization for Economic Cooperation and Development
PAA	Programa de Aquisição Alimentar (Food Acquisition Program)
PPCDAm	Prevenção e Controle do Desmatamento na Amazônia Legal (Action Plan for the Prevention and Control of Deforestation in the Legal Amazon)
PEB	Política Externa Brasileira (Brazilian Foreign Policy)
PCdoB	Partido Comunista do Brasil (Communist Party of Brazil)
PFL	Partido da Frente Liberal (Liberal Front Party)
PGR	(Procuradoria Geral da República (Federal Prosecutor's Office)
PMDB	Partido do Movimento Democrático Brasileiro (Brazilian Democratic Movement Party)
PNE	Plano Nacional de Energia (National Energy Plan)
PNMC	Política Nacional sobre Mudança do Clima (National Policy on Climate Change)
PNRA	Plano Nacional de Reforma Agrária (National Plan for Agrarian Reform)
PNRH	Política Nacional de Recursos Hídricos (National Water Resources Policy)
PSDB	Partido da Social Democracia Brasileira (Brazilian Social Democracy Party)
PSOL	Partido Socialismo e Liberdade (Party of Socialism and Freedom)
PRONAF	Programa Nacional de Fortalecimento da Agricultura Familiar (National Program for the Strengthening of Family Farming)
PRTB	Partido Renovador Trabalhista Brasileiro (Brazilian Renewal Workers Party)
PSL	Partido Social Liberal (Social Liberal Party)
PT	Partido dos Trabalhadores (Workers' Party)
PTB	Partido Trabalhista Brasileiro (Brazilian Workers Party)
RL	Reserva Legal (Legal Reserve)
SBPC	Sociedade Brasileira para o Progresso da Ciência (Brazilian Society for the Advancement of Science)
SISAN	Sistema Nacional de Segurança Alimentar e Nutricional (National System of Food and Nutritional Security)
SISNAMA	Sistema Nacional de Meio Ambiente (Environmental National System)

SO_2	Sulfur Dioxide
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USGS	United States Geological Survey
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization
WG	Working Group
WTO	Word Trade Organization
WWF	World Wildlife Fund

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PREAMBLE

In 2017, the world gathered in Fiji to share experiences and help to make wise decisions to inspire a global response to climate change. Under an ancient tradition, Fiji proposed a special way to communicate that would approach governments and civil society: the Talanoa Dialogue and its concept of shared ideas, skills, and experiences through the storytelling – the act of telling stories[1]. Thus, people would share stories about the impact caused by climate change in their communities, the increasing risks to human and food security, and the actions to respond to these threats (UNFCCC, 2021).

Bringing the Talanoa Dialogue to the climate negotiations is a way to approach the involved ones through empathy and in a safe place to share their stories by answering three main inputs: where we are, where we want to go and how we will get there (UNFCCC, 2021). This allows us to build strong stories – with beginning, middle, and end – that fascinate; to build journeys that we can identify ourselves; to make choices that can represent us.

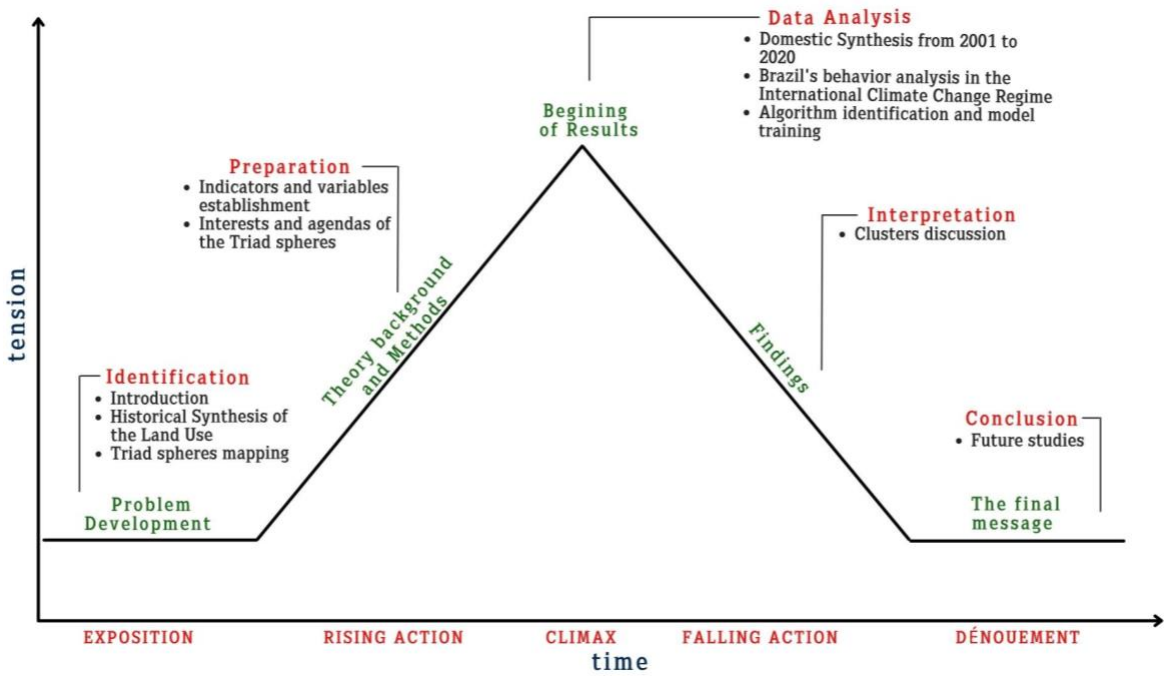
Stories can bring people together and give meaning to their lives by narrating situations in which we recognize our values, beliefs, ethics, laws, and customs. Through this recognition, it is possible to find solutions to common problems, such as climate change. But for this, it is necessary to tell the story, sharing a world of possibilities and experiences (Xavier, 2015).

Intending to use the fundamentals of Talanoa and storytelling, I build this thesis through stories shared across books, political documents, scientific articles, and other methods and techniques. I believe that academic research must have the capacity to attract people beyond the walls of the educational and research institution and give sense to the lives of the researchers and for those whose research is done. In other words, academic research should have a knot to be unraveled (Pollock, 2021).

With this point of view, the thesis writing process was based on storytelling content, incorporating a fictional five-act structure described by Gustav Freytag (1900) known as Freytag's Pyramid: exposition, rising action, climax, falling action, and dénouement (Figure 1).

[1] In 2018, in the first semester of my doctoral, I studied a discipline named Global Climate Change: science, management, and policy. In this discipline, I was introduced to Talanoa Dialogue – by Professor Thiago Mendes – and the art to tell stories making people get into each other's lives. That was the moment I realized how narrative can be used in various fields, including Academia.

Figure 1 - The writing process of storytelling in the thesis



Source: elaborated by the author based on Freytag (1900)

The storytelling content is incorporated in thesis structure according to tension in time (Pollock, 2021). The Part I shows the story rising to its climax, the high point of tension, and is guided by two main aspects: what the story is about and why it deserves to be told. The low tension is presented in the exposition, that is, the section that occurs the presentation of the story and the events that drives the arising of the problems. In this step it happens the enunciation of the thoughts and the definition of the work trajectory.

Besides, every story is someone's search for something. In other words, it has some behaviors. Then, when the tension starts to rise is when the characters' object of desire is identified, which is observed through their choices. Through these choices it is possible to identify their interests, where they act, how they behave. Here are identified the divergence and convergence of interests: the action of the story where the situation gets complicated, the problems get worse leading to a serious "crisis" and the characters taking action to solve them. This is called the character's "arc" or, in the thesis, the games they play and in which arenas they act.

The Part II starts showing the climax, the section in which the hypothesis is tested and the collected data analyzed. This is where the problem is solved, showing the analysis of the results found and how the protagonists' games can influence other games (the correlations), how the environment responds to their actions, the consequences of their behavior, the impact

of their choices. Then, the discussion marks the falling action, bringing the interpretation and discussion of the thesis, aimed to understand what this story communicate and what is the learning. And, finally, the dénouement shows the final message of the story, and presents the importance of the thesis, the difficulties, the results, and how, by telling this story, an important transformation can occur - either in the world or in people's thinking.

The use of storytelling in academics papers has been increasing (Pollock, 2021; Knaflic, 2019; Hyland, 2018; Birkenkrahe, 2014; Pollock; Bono, 2013; Fairbairn, 2004), including seeing lot of works of the fields of decision making, building and climate change (Arnold, 2018; Moezzi; Janda; Rotmann, 2017; Von Mossner, 2016). Furthermore, a lighter and more entertaining process is the base and motivation to write in the storytelling premises (Birkenkrahe, 2014) in academic papers which, as we know well, can be tiresome.

Even being aware of the innovation of bringing storytelling into academic work based on a scientific methodology, its adaptation to the thesis writing process used in this thesis was an enriching experience. As a researcher, it was challenging to write for an audience beyond Academy while maintaining all the basics that a scientific research method requires; as a writer, it was a privilege to write such an intense story full of protagonists and storylines, and; as a reader, I hope it is possible to notice in my thesis the elements necessary to recognize it as a good – scientific – story.

INTRODUCTION

> "Humans are a much more recent species and not born to be farmers or stock-breeders, unlike these ants and termites. They became so after hundreds of millions of years of hominization, that is, biological, technical, and cultural evolution. It was only in the Neolithic era, less than 10,000 years ago, that humans began to cultivate plants and breed animals that they themselves had domesticated. Subsequently, they introduced these plants and animals into all sorts of environments, where they endeavored to propagate them. In this manner, the original natural ecosystems were transformed into cultivated ecosystems, fabricated and exploited by human care and attention. Since then, human agriculture has conquered the world: it has become the principal factor in the transformation of the ecosphere, and its gains in production and productivity have respectively influenced the increase in the number of people and the development of social groups which do not produce their own food." (Mazoyer; Laurence, 2006).

During the last 10,000 years, humankind has developed as a "great geological force" (Crutzen, 2006), moving and modifying everything around it and transforming sedentary communities into complex societies through the Neolithic Revolution. Thousands of years later, the Industrial Revolution transformed the technological and economic environment, modifying land cover and social structure. All these features caused by man have taken the world towards the Anthropocene (Steffen *et al.*, 2015).

For this process to take place, natural resources were used exhaustively, taking the planet to plunge into an environmental crisis never seen before affecting the entire soil-plant-atmosphere system: exacerbated increase in deforestation (Edwards *et al.*, 2019; Vieira; Toledo; Higuchi, 2018) soil degradation (Poesen, 2017; Vanwalleghem *et al.*, 2017), exponential emissions of harmful gases to the atmosphere (Summerhayes; Zalasiewicz, 2018; Previdi *et al.*, 2013; Raupach; Canadell, 2010), extinction of fauna and flora, and loss of biodiversity (He; Silliman, 2019; Turvey; Cress, 2019; Polaina; González-Suárez, 2018). Therefore, we begin to feel the impact of this development, too, on our lives.

With the population development, there was a need for the food system to follow it. In the 1950s, the Green Revolution emerges as a solution aimed to feed this population and end world hunger through some strategies: increase the area of agricultural production with a focus on monocultures (such as soy), use pest-resistant seeds (genetically modified), modernize the field through the use of machinery (replacing human labor) and use chemical inputs (fertilizers and agrochemicals) to protect and leave the crops stronger and more nutritious (Goodman; Sorj; Wilkinson, 2008; Stetter, 1993; Goodman; Redclift, 1991).

In fact, the Green Revolution achieved its goal, which was to produce food at scale, basing on exploitative culture wherever it has been: to produce, it needs more land; to feed the population, it needs to exploit the surrounding environment. So, the legacy left behind was a process of natural resources depletion, which can be observed in the decrease of native vegetation to open pastures, in the degradation of the land due to inadequate management, in the increase of burning to open new agricultural areas, in the increase of global temperature due to greenhouse gas (GHG) emissions, in the land-use change, and the deep-rooted certainty that this is the only way to feed the world (Ramankutty *et al*., 2018; Pellegrini; Fernández, 2018).

In all this complex story, agriculture[2] plays an interesting role. With a path consolidated in the need to produce at any cost, this sector has established itself as an antagonist to the environment, degrading the soil and intensifying climate change. However, this same character also plays as a climate mitigating ally through sustainable land management (IPCC, 2019), creating a new hope that the next Green Revolution will be based on the synergy among environment, food production, and economic development – and Brazil has an important role in this imbroglio.

According to the United Nations (UN, 2019), the global population is expected to reach 8.5 billion in 2030, 9.7 billion in 2050, and 10.9 billion in 2100, which would consequently increase the demand for food. However, there is a limitation in terms of food supply caused by the agricultural area extension. In 2017, USGS (United States Geological Survey) and NASA (National Aeronautics and Space Administration) published a study that showed that the world has 1.8 billion hectares of crops, with the largest areas in India, United States, China, and Russia representing 36% of Earth's cultivated area (USGS, 2017).

Brazil ranks fifth on area extension, followed by Canada, Argentina, Indonesia, Australia, and Mexico. However, agricultural performance is highly variable according to region, due to soil types, climate, technology employed and crop productivity. And this is where Brazil stands out: while most countries use 20% to 30% of their area for agriculture, Brazil uses only 7.6% of its land (USGS, 2017) while it has been increasingly recognized as an agribusiness world power to produce grains, fruits, fibers and agroenergy. In other words, through

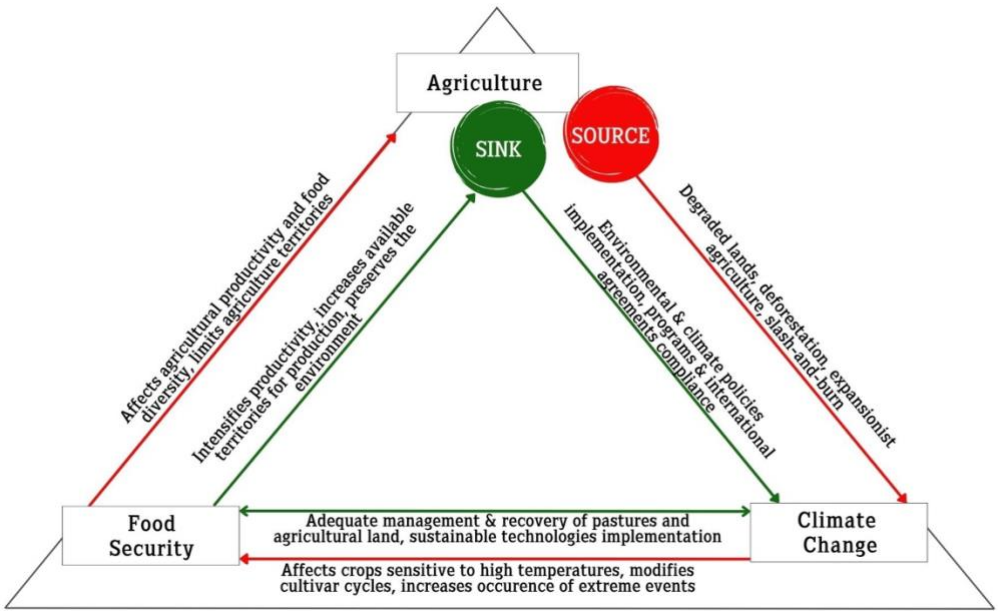
[2] "Agriculture is the most comprehensive word used to denote the many ways in which crop plants and domestic animals sustain the global human population by providing food and other products. (…) the word has come to subsume a very wide spectrum of activities that are integral to agriculture and have their own descriptive terms, such as cultivation, domestication, horticulture, arboriculture, and vegeculture, as well as forms of livestock management such as mixed crop-livestock farming, pastoralism, and transhumance" (Harris; Fuller, 2014, p. 104). To this thesis, it will be used "agriculture" mainly as crop plants and livestock.

intensification and sustainable land management, Brazil can produce more in a smaller space of land.

Therefore, Brazil emerges as a potential world food producer and an expanding supply (USDA, 2022; S&P, 2021; Adami, 2021; Calil; Ribera, 2019). At the turn of the millennium, the country's recent recognition as a leading and highly competitive global agricultural exporter had a significant impact on its position in various international discussions and current issues. Thus, agribusiness came to be seen as a national symbol, and the specific objectives of this sector were reinterpreted as national goals by various Brazilian governments and other policymakers (Søndergaard; De Sá; Barros Platiau, 2023).

Through the agriculture, climate change, and food security interrelationship, the Triad forms in Brazil containing different actors with inclinations that impact their choices and the results of which role agriculture will play, as a sink or as a source of GHG. This role affects the environment and cropland in different ways, as summarized in Figure 2.

Figure 2 - The 21st Century Triad: Agriculture, Climate Change and Food Security



Source: elaborated by the author

In the Triad, it is possible to see how agriculture plays a central role in the climate and food security spheres. Acting as a source, agriculture is characterized as expansionist, which uses deforestation to open up areas for crop and livestock, degrading the soil and abandoning those that have already been used for such purposes. This land use causes a series of effects: the concentration of GHG increases in the atmosphere due to the management system applied, contributing to increasing global warming and consequent climate change. Crops sensitive to

high temperature can be affected, as well as extreme events and their occurrence in unusual regions can increase, impacting food security. As a result, agricultural productivity decreases due to the restriction of areas suitable for certain crops, limiting the diversity of food and access to it – affecting directly the agricultural sector.

On the other hand, the use of agriculture as an important tool in environmental and climate policies or programs and as a protagonist in international agreements, can be a primary factor for the use of the sector as a GHG sink and mitigation actor. The management of agricultural land, the recovery of degraded areas, the monitoring and use of sustainable technologies can help reduce GHG emissions (by applying such techniques, the emission would be considerably lower than if they were not applied, besides also capturing GHG) and achieve food security. Through agricultural intensification the productivity and the territories for farming increase, avoiding the opening of new areas for agriculture and pasture.

Therefore, the main question of this thesis is: how do actors linked to the spheres of the Triad articulate at the domestic level influencing the Brazilian position on the International Climate Change Regime?

The hypothesis is that the convergence and divergence of interests, observed in the articulations among the actors, can answer this question. If the actors have common interests, then there is a greater probability of a Brazilian position favorable to the Triad on the International Climate Change Regime. On the other hand, if the interests are divergent, this articulation will be more difficult and, most likely, the Brazilian position will be favorable to the Triad sphere aligned with the Executive interests.

Hence, the main objective of this thesis is to elucidate the articulations and trade-offs among the Triad and its influence in the Brazilian position on the International Climate Change Regime, through the specific objectives: a) the identification of the actors within each sphere of the Triad, as well as their interests; b) the identification of their domestic political arenas and their behavior in the IRRC through the COP; c) the identification and correlation of convergent and divergent interests articulated in the Triad.

Then, to tell this story the thesis was written over five chapters – in addition to the Preamble, Introduction, and Conclusion – and split into two Parts. Part I contains Chapter 1: A New Hope, with a discussion of land use, deepening its fundamental historical importance for the realization of this thesis; Chapter 2: This is the Way, presenting the methodology and theory used to conduct the research; and Chapter 3: Lights, Camera, Action!, identifying Brazilian

Triad actors. Then, Part II comes into the scene, bringing the convergence and divergence of interests in domestic level and analyzing Brazilian position in Chapters 4 and 5: The Gambit and The Shredding, respectively. The last section of both Chapters will show the results of the variables of the Triad.

PART I

Chapter 1
A NEW HOPE

"You have to know the past to understand the present".
Carl Sagan

Once upon a time, there was a Greek goddess named Gaia, born from Chaos and mother of other divine beings, such as the Sky and the Mountains. James Lovelock personified Earth as Gaia (Lovelock, 1979), a complex entity that involves the atmosphere, the oceans, and the land; a biogeochemistry theory, a metaphor to "living Earth". In the 90s, Gaia has materialized as an Earth protectress in a cartoon named Captain Planet and the Planeteers. She was responsible for gathering five protectors to help her save the world from ecological disasters. From this union, Captain Planet was summoned. On the other hand, everything that harms the environment, such as pollution, deforestation, toxic waste, corruption, when they gather, the Captain Pollution emerges.

Even being an old cartoon, it is possible to observe a few analogies with the current world, mainly the humankind-Earth relation through land use. Then, inspired by such characters, this thesis will call the Captains as Captain Gaia and Captain Degradation.

The Portuguese language allows the Earth (Terra) to be, at the same time, the name of our planet and of the land that sustains us, giving us food, a place to live and protect, a life to build. Perhaps this is not just a curious coincidence. For a long time, the development of humankind walked side by side with the land use, having the Agricultural Revolution as a landmark. Since then, the response to all these changes happened sometimes like Captain Degradation and sometimes like Captain Gaia.

Thus, the main objective of this Chapter is to present the story that made it possible to develop the Earth through the diversity in land use leading to the construction and evolution of the society through an Institutional Continuum. Also, the purpose of this Chapter is to present another option to respond to these changes on Earth, a third Captain.

1.1 The knowledge of the wise man

Since before *Homo* became *sapiens*, he developed an understanding of the environment of which he was a part. This understanding has allowed his physical, social, and emotional

development, creating routines, social bonds and changing the environment around themselves. It's as if Gaia presented humankind with the power of using the land, fire, wind, and water, with humans being the heart in using these powers according to their needs. In a holistic view, all these elements were used to transform the life on Earth: the wind made life on Earth possible, the water allows keeping organisms alive, the land use resulted in the domestication of plants and animals, the fire protected and illuminated the surrounding environment, and the heart allows humankind to use all these elements and build social bonds.

But it wasn't always like this: *Homo* was not born a famer. Backwards, he lived his life for 2.5 million years by gathering plants and hunting animals – as a hunter-gatherer (i.e., Martin-Merino, 2021; Fuller; Stevens, 2019; Harari, 2014; Mazoyer; Roudart, 2006; Weisdorf, 2005; Childe, 1936). This lifestyle started to change in different areas of the planet about the last 12,000 years, when *Homo* began to manipulate a few animal and plant species, using creativity and thinking different ways to set tools to practice agriculture according to crop and farm systems (Mazoyer; Roudart, 2006). The process of tool improvement that *Homo* passed through, allowed the upgrading of the ways to gather food and his emergence on Earth (Childe, 1936). The production of more refined tools such as knives, harpoons, needles, and other cutting instruments, allowed men to hunt new (and bigger) species and to develop other ways of getting food, like fishing and harvesting plants more efficiently (Mazoyer; Roudart, 2006).

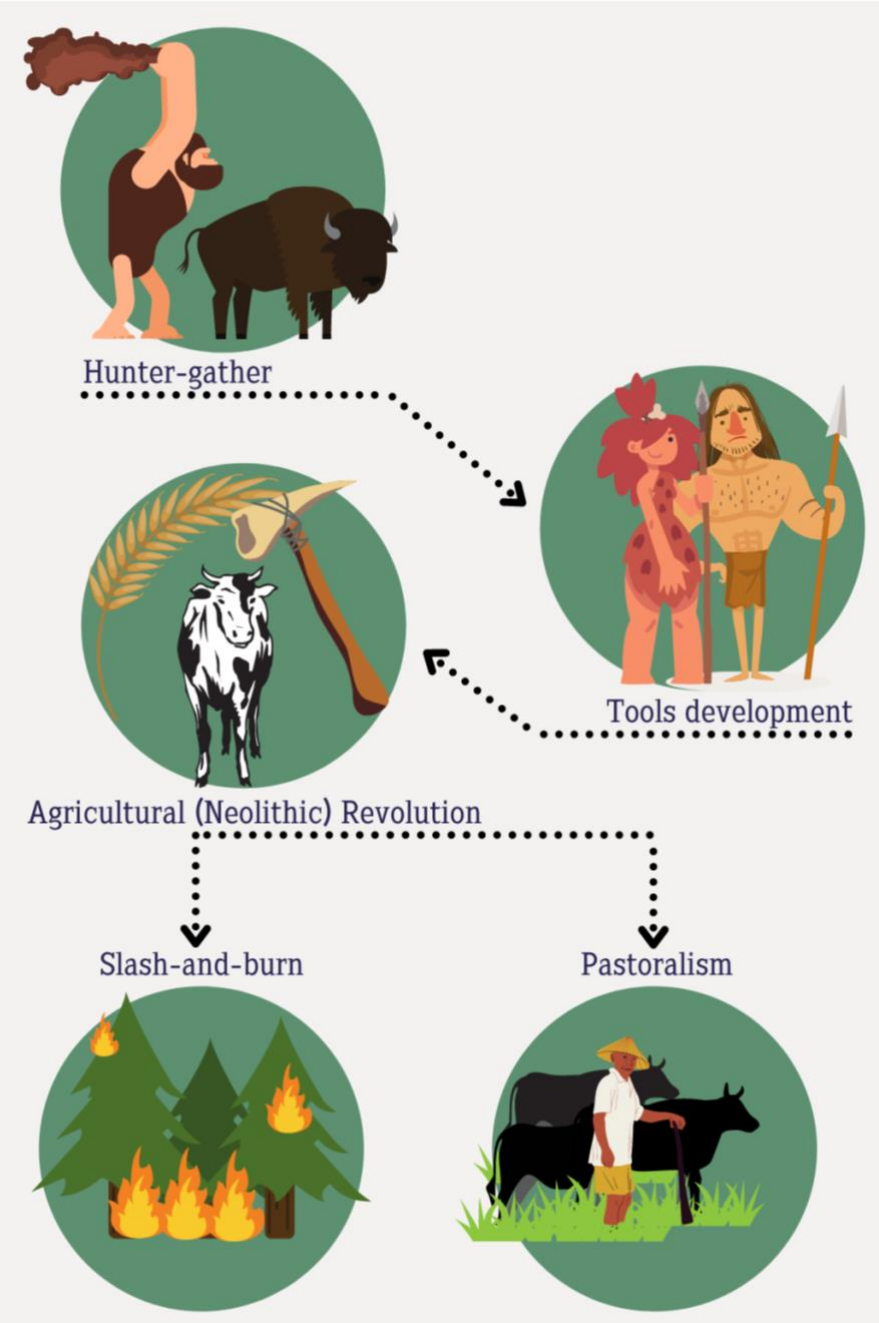
Wisely, *Homo sapiens* began to use and explore more areas than before, although still region-specific (Figure 3) – which permitted them to stay in a place and explore different resources. As result, two things are noticed: Sapiens moved from camp to camp after having exhausted the resources of the surroundings, and the existence of some privileged places where resources were abundant enough allowed groups of people to establish themselves for an entire season. This episode became known as Agricultural Revolution.

Figure 3 - Origins, expansion and approximate dates of the agricultural systems and early farming cultural complexes, attested in the archaeological record

Source: elaborated by the author based on Harari (2014) and Bellwood (2005)

The Agricultural Revolution concept was introduced in 1936, by archeologist Vere Gordon Childe (Childe, 1936) in his book Man Makes Himself as the term Neolithic Revolution. This period, which lasted from 9,000 Before Common Era to approximately 2,000 Common Era, describes an important process of environmental change, when humankind began to modify the surrounding environment by living together in the same place, as a community. The first agricultural and farming systems were certainly practiced near dwellings and alluvial river courses, making it unnecessary to fertilize the land and avoid deforestation – and allowed to focus more on crops than animals. On the other hand, in less fertile landscapes, the focus change to raising livestock. Thus, agriculture has been expanding worldwide through making different uses of the lands in two main ways: pastoralism and slash-and-burn systems (Mazoyer; Roudart, 2006), as shown in Figure 4.

Figure 4 - The Neolithic Revolution



Source: elaborated by the author

1.1.1 The pastoralism

In regions with a dry climate and poorer soil, small groups started to develop a lifestyle based on raising animals, whereas crop growth was hard to happen. These groups became the first pastoralists (TIMEMAPS, 2021). Pastoralism, or pastoral system, can be conceptualized basically as a production system and a way of life. In the first, pastoralism is known as animal husbandry in non-arable areas, such as drylands or highlands. In the second, pastoralism can be

defined as a successful livelihood strategy on less productive lands through livestock herding (FAO, 2001; Mcgahey *et al*., 2014). And, in both, pastoralism can be understood as "the finely-honed symbiotic relationship between local ecology, domesticated livestock and people in resource-scarce, climatically marginal and highly variable conditions" (Nori; Davies, 2007, p.7).

According to variations of the climate, environment, water and other natural resources, and well as geographical areas, the development and status of pastoral systems can be classified in certain parts of the world (FAO, 2001; Dong, 2016) through four essential forms – which can be observed until today: nomadic, transhumant, pastoral farming and agropastoral (Blench, 2001; O'Neil, 2011).

Nomadic pastoralism involves a seasonal migratory pattern, from a used pasture to a fresh one where the animals can graze. Moving livestock to seasonal pastures is a strategy used in various places (i.e. under non-arable climatic conditions) in the world to convert crop residues, and grasses and herbs from areas where crops are not grown, into human food (Dong, 2016; Barfield, 2012; Dyson-Hudson; Dyson-Hudson, 1980). This kind of pastoralism could be used to reduce the livestock's vulnerability to adverse climatic conditions, and manage the impacts of adverse environmental occurrences when they do occur (Zhizhong; Wen, 2008, Morton, 2007) – for example, the impact which the climate change can have in the nomadic pastoralism strategy through the remodeling and changing the familiar environment and even the change of distribution of important climatic variables like precipitation and temperature (Sun *et al.*, 2007).

On the other hand, when pastoralists make regular back-and-forth movements between relatively fixed locations with their livestock, it's known as transhumant pastoralism. This type of pastoralism has occurred throughout the pastoral world (Dong, 2016) and coexists in a symbiotic relationship characterized by this seasonal migration with sedentary groups. However, changes in the environment can have an important influence on this relationship: when situations like droughts and decrease of some resources happened, conflicts for water or land competition are likely to occur between these groups. Thus, under different environmental damage scenarios, the resources may become increasingly scarce and the conflicts may become more and more frequent (McGuirk; Nunn, 2021).

Another way of pastoralism is defined through the term "pastoral farming", used for pastoral mobility with little or no long-distance movement aiming at producing dairy/ beef cattle farming and wool sheep farming instead of growing crops. This kind of pastoralism is

more modern than the nomadic or transhumant pastoralism systems in terms of the level of investment in land and animals. Animals, particularly sheep and cattle, require large amounts of grazing land to feed on, and need to be regularly moved from place to place to find fresh pastures. A pastoral economy, therefore, demands much more land than one based on crop-growing and supports a smaller population.

When occurs a practice that combines pastoralism and crop production (millet, sorghum, maize, vegetables, and pulses), agropastoralism emerges (Dong, 2016) and makes it possible to expand different cultures worldwide. Agropastoralism is an extensive livestock system, which enables the development and management of natural resources in marginal territories, whose agroecological characteristics hinder agricultural intensification (Nori; Ragkos; Farinella, 2016). This system is extremely important and is the most prevalent land use in arid and semiarid environments (Dong, 2016). All countries bordering the Mediterranean, mountain areas or semi-arid lands and many island territories practice agropastoralism, where much of the animal feed is obtained from grazing (Nori; Ragkos; Farinella, 2016). Agropastoralism's impact on vegetation increased progressively (Vella *et al.*, 2019) until current days, and management remains the most important asset in tackling climate change and desertification patterns affecting these marginal territories (Nori; Davies, 2007).

When most of these virgin lands were used and the population density continued to increase, the frequency and intensity of clearings increased too. Thus, a dynamic of deforestation of lands cultivated by slash-and-burn techniques started to happen (Mazoyer; Roudart, 2006).

1.1.2 Slash-and-burn

Little is known about the history of the slash-and-burn agriculture system during the Neolithic, but archaeological works point out that this type of agriculture was not the first to be practiced for a simple and, in a way, even obvious reason: the first forms of agriculture were established in areas that were already deforested and eventually fertilized by domestic waste and close to the homes of the *Homo sapiens*, or on lands that were recently covered by alluvial deposits from river floods. That is, as these privileged areas were naturally limited, they were extended to neighboring environments (i.e. forests and grasslands) when cultivation and animal husbandry activities took on greater importance (Mazoyer; Roudart, 2006).

Any soil cultivated for the first time with a slash-and-burn system has its fertility raised beyond the natural conditions of that environment (derived from climate, geomorphology, soil type, etc.), benefiting both from the ash of the burning, and from the accelerated mineralization of a supplementary humus fraction resulting from the clearing and preparation of the crop area. But the performance (how much is produced per surface area) of the cropland in a slash-and-burn system varies with the management of that area, based mainly on the duration of the rotation and the biomass of the cropland (Mazoyer; Roudart, 2006).

To avoid exhaustion of the use of this type of system, there is a limitation related to the resting time between one slash-and-burn and another, between the population density and the biomass produced there. Thus, for a population with a stable density, the logic of success of this system is very simple: the longer the rotation time (idling time between one clearing and another), the more stable will be the amount of biomass available to the population in the cultivated area. This stability allows the environment to regenerate up to 90% of its original biomass and feed the surrounding population (Mazoyer; Roudart, 2006).

The problem begins to emerge when the population starts to grow. If the population density exceeds this stable level, then the frequency of clearings increases even more, and the duration of idling decreases to a shorter time. Thus, the forest will have little time to rebuild itself and the biomass will fluctuate considerably. The increase in deforestation resulted in deterioration of fertility due to the appearance of erosive processes and a climate change capable of leading even to desertification. Even on current days, forms of slash-and-burn agriculture continue to exist and expand worldwide: deforestation progresses rapidly due to the demographic explosion, but also from the tropical forests' exploration, extensive plantations, and animal husbandry (Mazoyer; Roudart, 2006). Then, other ways of managing the land and solving the question of survival emerge as an urgent issue today.

Both pastoralism and slash-and-burn systems allowed the social organization development in different ways and at different levels, involving multiple actors. For millennia, these systems supported the geographical expansion that occurred in the early Neolithic age and the emergence of the post-forest agrarian societies of this period, causing the population to jump from 5 to 50 million people, approximately (Mazoyer; Roudart, 2006).

Following this, it is possible to observe the feedback between social and agricultural development: agriculture allows humankind to develop social skills, social skills allow humankind to develop agriculture improvements, and agriculture improvements allow increasing food production to feed a growing population. To make this possible, humankind

had to evolve social networks, developing and practicing concepts such as cooperation and security – of food, environmental and personal issues. In the next section, we will understand more about this social evolution.

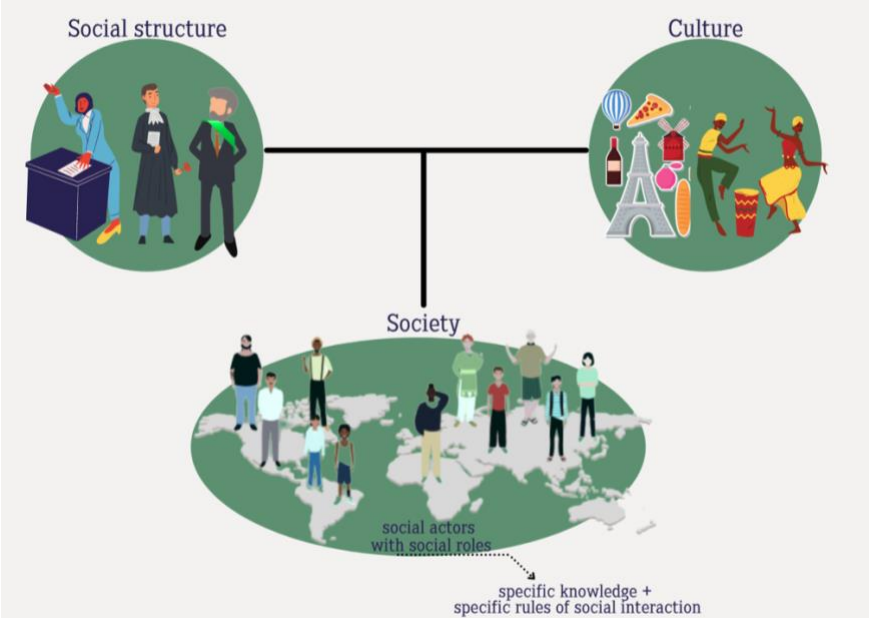
1.2 Do the (R)Evolution

Agriculture allowed not only the development of the way to obtain food but made it possible for humankind to conquer the world through the transformation of the ecosphere, increasing the world population. But also, the transition to agriculture allowed the expansion of social relations among humans (Mazoyer; Roudart, 2006), developing the way people lived their lives and resulting in evolution and complex society that will be described in this section. The development of different agricultural systems through land use allowed humankind to develop themselves as individuals and as part of a common world.

The sociocultural evolution only began about 10,000 years ago, when early hunter-gatherer societies began to change their simple forms of segmentary social differentiation during the Neolithic Revolution (Klüver, 2008), described above. Thus, a society formation can be understood through the social and cultural structures[3] (Figure 5); a web of social roles with the occupants interacting according to the rules and to the knowledge that defines these roles (Giddens, 1997; Klüver, 2008).

[3] For this thesis, we can work with two simple definitions about these words: "culture" as the knowledge (beliefs, worldviews, moral values, customs) that manifest in the interrelationships between individuals or groups, and "social" as the set of rules that govern all social interactions in certain groups – for example, the division of power into legislative, judicative and executive arms in modern democracies is such a rule (Giddens, 1997; Klüver, 2008).

Figure 5 - The Society Formation



Source: elaborated by the author based on Giddens (1997)

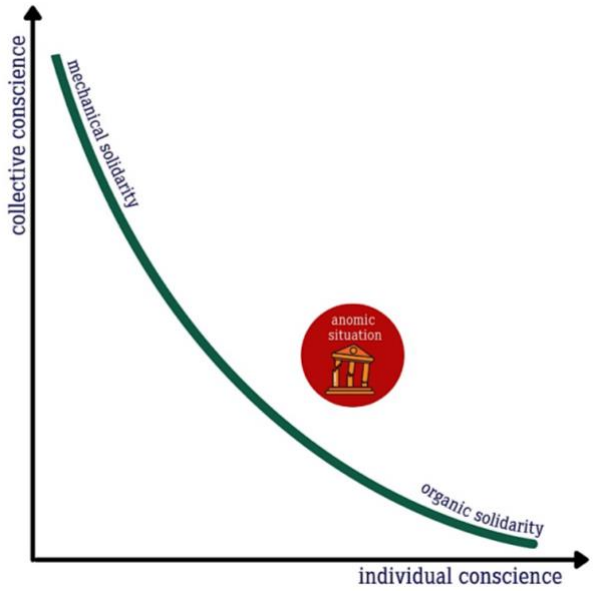
But, for the sociocultural evolution to happen, an important skill had to develop at the societies: heterogeneity. In a simulation shown in "The socio-cultural evolution of our species", Jürgen Klüver presents the influence that social actors have on the evolution of a given society. The more diverse, autonomous, and contrasting the social roles are (which can be divided into "maintenance roles", which maintain traditional norms and values, and "creative roles," related to the arts, research, and innovation), more heterogeneous the society will be and the more likely will occur significant changes in its social structure (Klüver, 2008).

This heterogeneity can be observed in The Division of Labor in Society. David Émile Durkheim approaches in this work the transition from traditional to modern societies through the social system division of labor and how this evolution is linked to the expansion of individualism. Then, talents, skills, and behaviors characterize different groups in societies through professional specialization in labor. Comparing this system to biological principles is similar to the first organisms in the evolutionary scale, which were inserted in a simple structure while following complex organisms that have a more specialized functional structure, in other words: the more specialized are the organism functions, the higher is its position in the evolutionary scale (Durkheim, 1995).

Well, these specialized functions are related to an individual conscience which potentializes the society's evolution. Durkheim (1995) explains that societies were built under two types of conscience: the collective and the individual, and both are linked to each other, being solidary. When external contexts are capable to represent a set of beliefs and common

feelings of individual members in the same society, the collective conscience directs the functions, acts, and structure of society. This kind of society is featured as mechanical solidarity because it links in a dependent way individuals to the society through a common conscience – the individual personality is absorbed by the collective personality. In opposition, when each individual has a self-sphere of action and the individual conscience has progressed to the extent that the other has regressed, society begins to specialize. With more individual movement, the society begins to move too in an organic way – and because of this labor division, this type of society is known as organic solidarity. In both cases, an organization is needed to create the social structure and when the division of labor doesn't produce a solidary (a big and extreme transformation), a state of anomia takes place (Figure 6).

Figure 6 - The division of labor in society



Source: elaborated by the author based on Durkheim (1995)

Changes in social structure are seen since the long period between the emergence of *Homo sapiens* and the Neolithic Revolution – going from a homogeneous to a heterogeneous society: from a little differentiation of social roles to a stratified social hierarchy; from a creative potential that could not unfold to development of creative roles; from a common worldview to a many different individual thinking (Klüver, 2008).

The Neolithic Revolution was the precursor of the urban evolution and open the doors to stratify even more society and individual functions. It marked the transition from self-sufficient communities to a new social structure formation based around a certain settlement (cities) with a relatively growing population which required an expansion of the food supply. So far, Neolithic Revolution is one of the two events in human history that have changed the

relationship of man to nature and to his fellow human beings in a fundamental way (Vatansever, 2013). The other is the Industrial Revolution. And both have brought about a new type of society, with a new type of man that acted, thought, and lived unlike his ancestors (Vatansever, 2013).

While the Neolithic Revolution built an agrarian and handicraft economy, Industrial Revolution change this pattern to one dominated by industry and machine manufacturing. These technological changes introduced new ways of working and living, transforming fundamentally the society – including some points in the agricultural systems.

In the 18th century, Industrial Revolution began in Great Britain. In this period, agriculture's contribution to the British economy was based on the need to feed the growing population and on the fact that landowners dominated British politics and social life (the upper-class model of life was rural). Then, any economic change that affected land would also affect politics. For the owners, the land was not seen simply as a way to make money, but as a way of life. However, a few decades later in the same century, the boom in agricultural prices ended up affecting both the farmers themselves and the farmworkers, forcing a reshaping of customs and life for both based on two main issues that underpinned this transition: the Poor Law and the enclosure. While the former related to the granting of financial assistance to the poor (including the farmworkers) but forced them on their own to look for a job at the wage determined by the market, the latter related to the relocation of once common and open fields to private (and not always cultivated) units (Hobsbawm, 2000).

In the Neolithic Revolution, pastoralism and slash-and-burn used the land as an open field, with communal rotations and grazing. With the Industrial Revolution, enclosed farming emerges as the antithesis of the open field system. The enclosure was essential to set free the process of investment and modernization, which allowed each owner to acquire exclusive control over his property and cultivate without interference from the rest of the community.

In addition, there was an improvement in the land, in the quality of the soil through drained, fertilized, and reseeded pastures (Allen, 2008). On the other hand, enclosure relatively decreased the number of farmers, pushed the villagers out of land ownership, and small farmers were considerably reduced in number. The disintegration of the traditional farm stimulated the multiplication of labor and the decrease of its wages (Hobsbawm, 2000).

But it was only in the 19th century that the Industrial Revolution and science started to affect farming (inserting in the fields drainage systems, fertilizers (as superphosphate), and

mechanization) and farmers occupied no more than a quarter of the population and their national income was even lower than before. Consequently, the life of the rural worker became worse because of the mass rural exodus to railroads, mines, cities, overseas – generating labor shortages and slightly higher wages. When the nobility abandoned agriculture, what was left was a small minority bloc with no political clout. The Industrial Revolution was then not just a mere acceleration of economic growth, but also growth based on the social and political transformation that is strongly characterized by the emergence of new means of production involving the mechanized factory system (Hobsbawm, 2000).

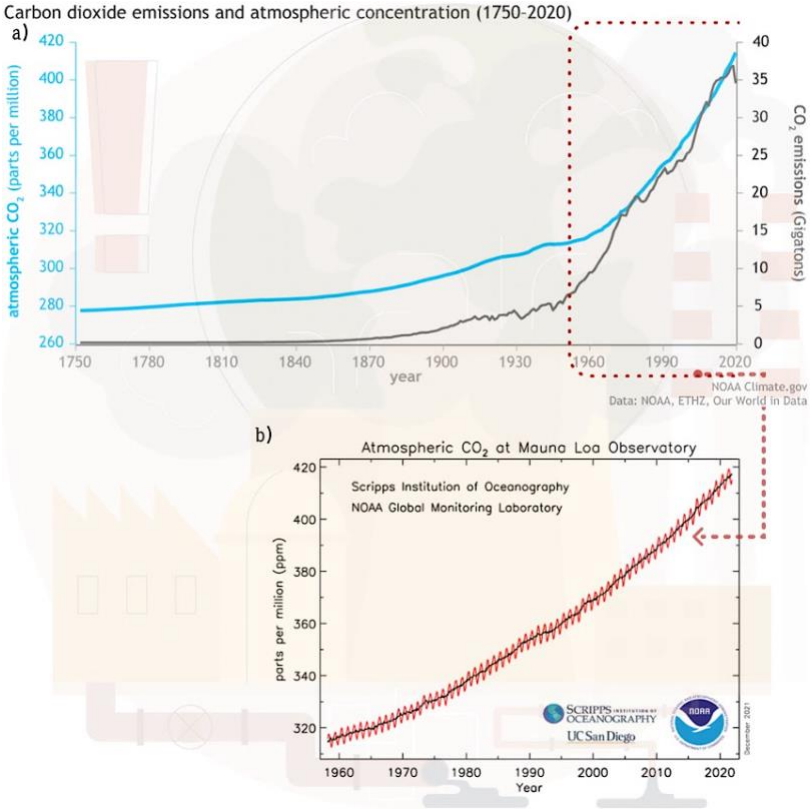
The British Industrial Revolution was the first in history, and so subsequent revolutions were able to use the British experience as an example. However, it is important to note that the Industrial Revolution cannot be explained in the same way in all countries where it developed, since some regions were economically differentiated. While some areas – especially in Europe – were known as areas of potential industrialization because they were relatively urbanized, other regions – usually the American colonies or Eastern trading points – had economies that were dependent on and exported agricultural products or raw materials (Hobsbawm, 2000).

Industrial development plays a major role in society's development. But at the same time, there was a development of the global environmental degradation, where the effects would only be seen - and felt - years later: untreated industrial waste effluents dumped into nearby water bodies; alteration in the natural soil environment by chemicals products, cattle, and pig population, irrigated area and cropland; a decrease of the forest area; a decrease of marine, birds and mammals species; and exhausting of the fossil fuels that were generated over several hundred million years, resulting in large emissions of air pollutants (Ahuti, 2015; Crutzen, 2006; McNeill, 2000) as the greenhouse gases.

All these global environmental degradations have GHG as a key factor in the unfolding of this story. The oxidation of sulfur dioxide (SO_2) to sulfuric acid has led to acidification of precipitation and lakes, causing forest damage and fish death in biologically sensitive regions. The over-application of nitrogen fertilizers in agriculture has led to the microbiological production of nitrous dioxide (N_2O), a greenhouse gas. The anaerobic decomposition of organic compounds in flooded rice produces methane (CH_4), as well as the belching of ruminants such as cattle. Burning fossil fuels, agricultural activities, deforestation, and intensive animal husbandry – especially cattle holding, have emitted carbon dioxide (CO_2) substantially over the past two centuries (Figure 7), changing the global average temperature and the environment around (IPCC, 2019).

Let's think about what happens to a car parked outside in a 40ºC summer? 1) The solar radiation passes through the glass and warms up the interior. 2) Part of the warmth goes out the glass and part is retained inside the car, making it hotter. Now, imagine the car being the Earth. 3) The solar radiation comes to Earth and the atmosphere works as the glasses, keeping the surface heated. This is called the Greenhouse Effect, by having a balanced amount of greenhouse gases that allow keeping the Earth warm - which are essentials for the existence and maintenance of life on our planet. The problem appears when this balance is perturbed: the more GHG is emitted to the atmosphere, the hotter the Earth can get, changing the Earth's climate.

Figure 7 - Graphics of the carbon dioxide emissions and atmospheric concentration



Source: elaborated according to a) NOAA (2021a)[4] and b) NOAA (2021b)[5]

Years and years of global environmental degradation have led to the emergence of an important character in this story, Captain Degradation. A Captain materialized through a superpower of humanity: a "global geophysical force" (Crutzen, 2006), capable of impacting

[4] The amount of carbon dioxide in the atmosphere (blue line) has increased along with human emissions (gray line) since the start of the Industrial Revolution in 1750. Emissions rose slowly to about 5 billion tons per year in the mid-20th century before skyrocketing to more than 35 billion tons per year by the end of the century.

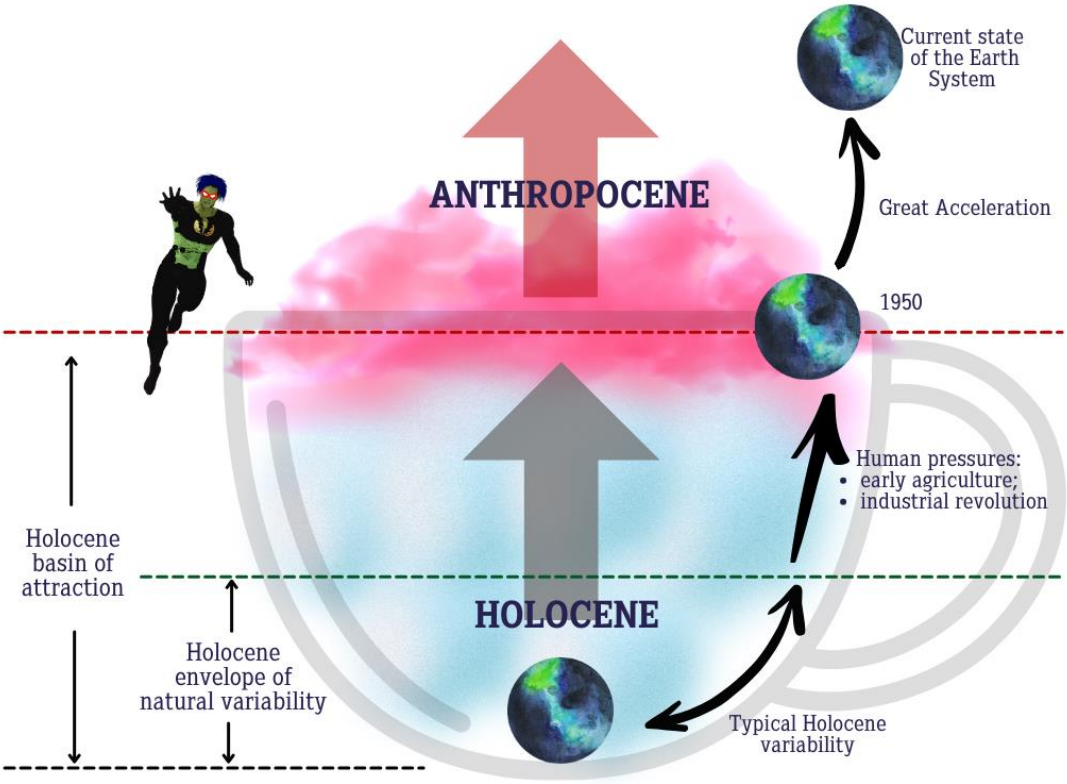
[5] The red lines represent the monthly mean values, centered on the middle of each month. The black lines represent the same, after correction for the average seasonal cycle. The latter is determined as a moving average of seven adjacent seasonal cycles centered on the month to be corrected, except for the first and last three and one-half years of the record, where the seasonal cycle has been averaged over the first and last seven years, respectively.

the balance on Earth. This superpower is nourished by the increase of any human action that can destabilize the Earth system, such as deforestation, overuse of natural resources, use of chemical pollutants, greenhouse gas emissions, and unsustainable economic development. At first, this superpower of humanity was unknown. But the Early Agricultural and Industrial Revolution opened a Pandora's Box of unintentional environmental changes (Jonsson, 2012) capable of discovering it. And when Captain Degradation appears, Gaia is weakened.

1.3 “The power is yours!”

The superpower made *Homo sapiens* take on a new role on Earth: from a species that adapted to changes in your natural environment to a species that changed the natural environment (Steffen; Grinevald; Crutzen., 2011; Zalasiewicz; Williams; Haywood, 2011) Thus, Homo was capable to make the Earth leaving the Holocene towards a new geological era, the Anthropocene. To better understand this transition, a ball-and-cup analogy can help (Figure 8).

Figure 8 - The ball-and-cup model



Source: elaborated by the author based on Steffen *et al.* (2016)

Our planet shifts within the "cup" of the current geological age from natural climatic and biosphere variability (marked by the broken green "Holocene envelope of natural variability" line), for example, the interglacial and glacial era. Perturbations of the Earth System, such as those driven by more intensive human activity of agriculture and industrial revolution, can push the Earth beyond the limits of natural variability while remaining within the Holocene basin of attraction, that is, has still been relatively stable and that the Earth's natural controls (negative feedbacks) have been able to buffer these perturbations.

However, and linked to natural variability, the beginning of the Great Acceleration in the 1950s, marks a strong change in the nature, magnitude, and rate of anthropogenic pressures on the Earth System, driving impacts that push the system beyond the Holocene boundaries into a new geological age, the Anthropocene (Steffen *et al*., 2016; Schellnhuber, 2009). This judgment was mainly based on the fact that the current atmospheric concentration of CO_2 is far higher than at any other time during the last 800,000 years at least (PAGES, 2016).

Beyond the changes in Earth's atmosphere and climate by fossil fuel combustion or the production of industrial chemicals, anthropogenic environmental change was a multidimensional process. The interactions among its many dimensions cause a cascading effect from local to regional and finally to global, potentially leading to unpredictable consequences for the entire Earth system (Ellis, 2018). However, one of the most driving forces that helped the Great Acceleration to Anthropocene is the land-use change.

1.3.1 The Gray of the Green Revolution

There was a Foundation, called Rockefeller, that wished to fight hunger around the world. Then, the seeds of a revolution were planted in early 1941, when a team was sent to survey Mexican agriculture, resulting in the development of the Mexican Agricultural Program, which a young biologist named Norman Borlaug started to work. Norman developed a "miracle wheat" in 1954, which was spread by the Rockefeller and Ford foundations throughout the world, in the 1950s and 1960s (in addition to other crops, such as rice), with the help of the United States government. Well, this is a dominant narrative of the Green Revolution[6] that

[6] The term Green Revolution gives a clue to the political interests involved in the generation of the new agricultural technology. It was purposely coined to contrast with the term 'red revolution', with the objective that developing countries should undergo far-reaching transformations as a result of an agricultural revolution, rather than because of radical political transformation (Harris, 2014).

made Norman Borlaug win the Nobel Peace Prize in 1970. However, today is possible to notice that the Green Revolution was not an unblemished tale; it had some shades of gray.

Norman Borlaug claims that the financial incentives, government investments, improved seeds, and industrial chemicals have led to the destruction of fewer forests than would have been the case without the Green Revolution (Borlaug, 2000). However, data shows another story: about three-quarters of the Earth's land surface has been altered by humans within the last millennium (IPCC, 2019) and, when multiple events of change are summed, the total extent of land change is almost a third of the global land surface, a land area of about twice the size of Germany (720,000 km^2) has changed every year since the 1960s (Winkler; Fuchs; Rounsevell, 2021).

Thus, land-use change (LUC) can be understood as any human activity that modifies the natural environment: approximately 11% of Earth's land is cultivated for crops, 25% is used for pastures and livestock grazing, 1-3% forms urban and other settlements and infrastructures, and 10% of Earth's land is covered by woodlands managed or planted to produce timber, fuel, paper, rubber, and other products (Ellis, 2018). For this change to occur, two major drivers are used, deforestation and bushfires that, besides emitting pollutants to the atmosphere, contribute to variations in the carbon present in vegetation and soil biomass (converting native vegetation to agricultural or pastureland results in emissions of CO_2). As result, LUC can impact land structure, causing considerable degradation.

While agriculture underpinned the development of the civilizations, soils started to deteriorate (Ellis *et al.*, 2013; Steffen, et al., 2005; Ojima; Galvin; Turner, 1994; Turner *et al.*, 1990). In summary, agriculture and clearing of land for food and wood products (called AFOLU - Agriculture, Forestry and Other Land Use) have been the main drivers of land degradation for millennia[7] (IPCC, 2019) – and land degradation means a negative direct or indirect human-induced processes in land condition expressed as long-term reduction or loss of at least one of the following: biological productivity, ecological integrity or value to humans (IPCC, 2019). So, a great example that impacts these three points is food production.

The Green Revolution seems to have food production successfully exceeding population growth: while the global population increased by 110% between 1950 and 1990, global cereal production increased by 174% over the same period (Otero; Pechlaner, 2008). But the

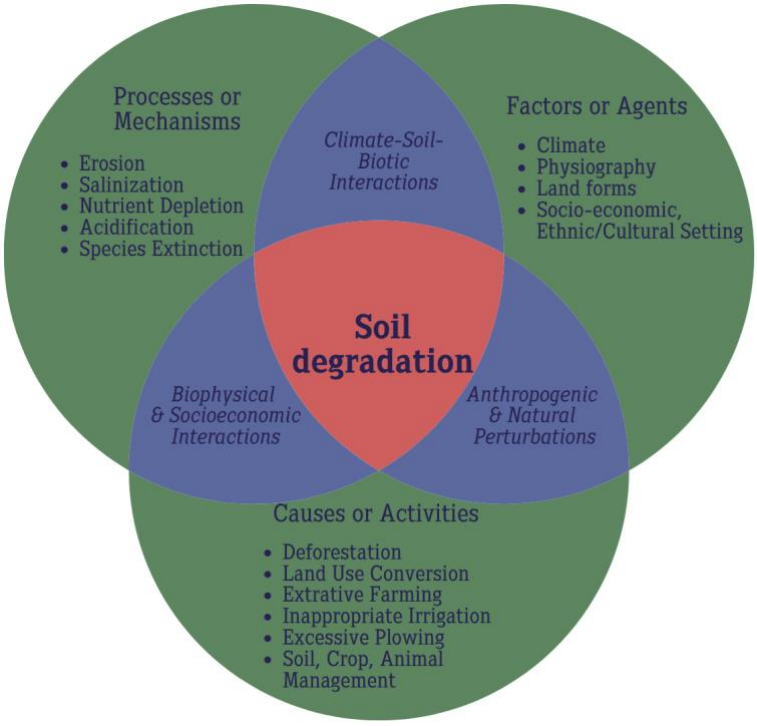
[7] But, this does not mean that agriculture and forestry always cause land degradation; sustainable management is possible but not always practiced (IPCC, 2019). More about this question will be addressed below.

availability of calories wasn't capable to make the world escape from hunger (Vanhaute, 2011). The number of hungry people increased by more than 11% (Rosset; Collins; Lappé, 2000), and current data suggest there more than 2.3 billion people didn't have access to adequate food for the 2020 year, staying in some level of food insecurity (FAO *et al*., 2021).

If the food insecurity is related to hunger, the term "food security" was used to describe when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life (FAO, 1996). In Green Revolution, nutritional gains have been irregular, impacting food security. Although overall calorie consumption has increased, dietary diversity has declined for many poor people, reducing the body's absorptive capacity for micronutrients (Welch; Graham, 2000). In some cases, traditional crops that were important sources of critical micronutrients (i.e. iron, vitamin A, zinc) such as pulses, vegetables, and fruits were displaced for cereal grains which have a lower nutritional value, but a higher market value (Webb, 2009).

The soil degradation process can be exacerbated by the nexus among three drivers (Lal, 2015): process (types), factors (agents of degradation related to natural or anthropogenic drivers), and causes (specific activities which aggravate the adverse effects of process and factors), as showing in Figure 9.

Figure 9 - The process-factor-cause nexus as a driver of soil degradation.



Source: elaborated by the author based on Lal (2015)

The consequences of land use by humans range from GHG emissions to environmental pollution, soil erosion, habitat loss, species extinctions, and species introductions. Burning lands to remove the vegetation emit CO_2, and soils uncovered to lead to erosion and loss of nutrients; disturbance, tillage, and the draining of wetlands cause soil organic matter to decompose, emitting yet more CO_2; rice produce in flooding soils releases large amounts of CH_4[8] and the use of nitrogen-rich fertilizers releases N_2O[9]; agrochemicals and herbicides use harms species both on and off agricultural fields, joining excess nutrients from fertilizers in polluting ponds, lakes, streams, rivers, and coastal areas downstream. In addition, clearing lands is also used to improve vegetation productivity for livestock, while intensive large-scale livestock systems produce CH_4 and other GHG emissions from manures, hazardous than that from cropped fields (Ellis, 2018). The process-factor-cause nexus is strongly impacted by site-specific conditions. Thus, understanding the nexus and the trade-offs among them is critical to restoring soil quality, avoiding and mitigating degradation (Lal, 2015).

But the degradation started to have some consequences beyond the local frontiers, requesting a systemic nexus answer: by influencing the economic and political levels, the process-factor-cause nexus made the International System a game arena. Thus, Captain Degradation begins to harm himself – even if not realizing it at first – by extrapolating the absorption of impacts to the planet, making space for the Captain Gaia emerge to fight against the results of the Great Acceleration.

1.4 Different views in a common world

During the Great Acceleration, the increased attention to environmental issues started to happen due to several reasons, but four major factors were an important kick-off to create Captain Gaia (Figure 10).

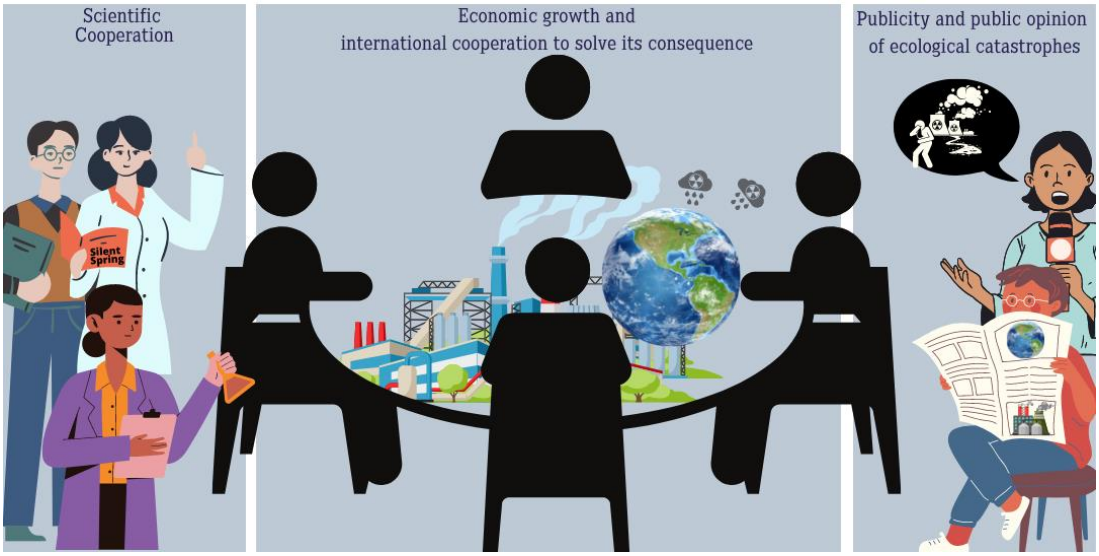
When the negative results of the Great Acceleration began to affect a large part of the population of the richest and developed countries (First and Second World, respectively) – societies that grew uninterruptedly to meet their basic needs in health, housing, education, and food – then they were ready to change their priorities and discuss new ideas and behaviors that

[8] Fun fact: each CH_4 molecule has more than ten times the greenhouse warming potential of CO_2 – though it spends less time in the atmosphere than CO_2 (Ellis, 2018).

[9] Fun fact: N_2O is an even more potent greenhouse gas with more than 100 times the warming potential per molecule of CO_2, and is very stable (Ellis, 2018).

would change and impact their lives (Lago, 2006). Under this historical moment, both the capitalist and socialist models of development marked a strong questioning that allowed, in other words, a part of humanity to change the direction of the superpower: 1) the increase in scientific cooperation in the 1960s, resulting in numerous concerns[10], such as climate change and problems of quantity and quality of available water; 2) the increase in publicity and consequent public opinion of environmental problems caused especially by the occurrence of several ecological catastrophes[11]; 3) the accelerated economic growth that generated a deep transformation of societies and their ways of life without any future precaution of the long-term consequences; 4) numerous other problems, identified in the late 1960s by scientists, that could not be solved otherwise than through international cooperation, such as acid rain, the pollution of the Baltic Sea, the accumulation of heavy metals and agrochemicals that impregnated fish and birds (Le Prestre, 2005).

Figure 10 - The path to Stockholm Conference



Source: elaborated by the author based on Le Prestre (2005)

When the negative results of the Great Acceleration began to affect a large part of the population of the richest and developed countries (First and Second World, respectively)[12] – societies that grew uninterruptedly to meet their basic needs in health, housing, education, and

[10] The repercussion of works such as Silent Spring (1962), by Rachel Carson, and This Endangered Planet (1971), by Richard Falk, or of essays and books essays and books by Garrett Hardin, such as The Tragedy of Commons (1968) and Exploring New Ethics for Survival (1972), had a strong impact on public opinion (Lago, 2006).
[11] Such as the mercury poisoning of fishermen and their families in Minamata, Japan, between the 1950s and the 1970s, or the damage caused to the English and French coasts by the sinking of the oil tanker "Torrey Canyon" in 1967 (Lago, 2006).
[12] In the 1960s, the societies were categorized in First World, related to developed capitalist countries, Second World, related to communist-socialist countries, and Third World, related to all the other countries – basically the mainly underdeveloped agricultural states and nations.

food – then they were ready to change their priorities and discuss new ideas and behaviors that would change and impact their lives (Lago, 2006). Under this historical moment, both the capitalist and socialist models of development marked a strong questioning that allowed, in other words, a part of humanity to change the direction of the superpower.

Therefore, the Stockholm Conference (also known as Stockholm 1972) was the first world conference convened by United Nations (UN) to discuss the human environment, which reunited 113 countries, 19 governmental agencies, and other 400 intragovernmental and non-governmental organizations in 1972 (McCormick, 1992). In his open speech at Stockholm Conference, Maurice Strong says:

> (…) we have determined that we must control and harness the forces, which we have ourselves created. We know that if these forces can be effectively controlled, they will provide everything that life on this planet desires and requires; but if they are permitted to dominate us, they will have an insatiable and unforgiving appetite (Strong, 1972).

Stockholm 1972 can be defined as a time frame: the moment humankind started to understand that we control the force created by ourselves, a superpower that we can move for two main directions – which are chosen according to our interests. Thus, in the Conference context, two scenarios emerge: one, structured the zero growth, defended by the developed countries and based on the report The Limits to Growth[13] (Meadows *et al.*, 1972) commissioned by the Club of Rome; in contrast, some developing countries argued that the environmental crisis wasn't only technical but also socioeconomic and, therefore had the right to grow because environmental problems and underdevelopment were interrelated (Mendes, 2014).

But all these noises built the basis for middle ground at the Conference. In the Report (UN, 1972) resulted from the Conference, a recommendation for Environmental Aspects of Natural Resources Management interests us:

> (…) (d) It should moreover be noted that in addition to the various physical and climatic phenomena which contribute to soil degradation, economic and social factors contribute to it as well; (…) (UN, 1972).

After 1972, the environmental agenda has since been endorsed at the International System through some Multilateral Agreements for the Environment, such as The United Nations Convention on the Law of the Sea – 1982, The Montreal Protocol on Substances that

[13] The Limits to Growth is a report that shows a computer simulation of the consequences of interactions between the Earth and human systems through relations of the exponential economic and population growth in a finite resources supply environment. Was commissioned by the Club of Rome and concluded that, without substantial changes in resource consumption, the most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity (Meadows *et al.*, 1972).

Deplete the Ozone Layer – 1987, and The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention) - 1989.

Also in the 1980s, some changes were observed in national politics. Several green parties entered the political arena in Europe, environmental organizations grew at a rapid rate and several countries have inserted the principles discussed in Stockholm 1972 into their national policies, including Brazilian politics[14].

The discovery of the superpower allowed to lead the world in another direction: the creation of the United Nations Environment Programme (UNEP), headed by Maurice Strong. As in the Conference, Maurice brings the idea of eco-development and open the doors to the construction of the sustainable development concept, used for the first time in the Brundtland Commission (also known as the World Commission on Environment and Development), in the 1980s report Our Common Future. The Commission's final report proposed the concept of sustainable development as the needs of the present without compromising the needs of future generations (Brundtland, 1987). To this, society, environment, culture and economy must be worked in an interrelated way, balanced in the pursuit of improved quality of life. Then, for society to be prosperous it needs a healthy environment to provide food, resources, safe drinking water and quality air for its citizens (UNESCO, 2022). And climate change is a key factor in this point.

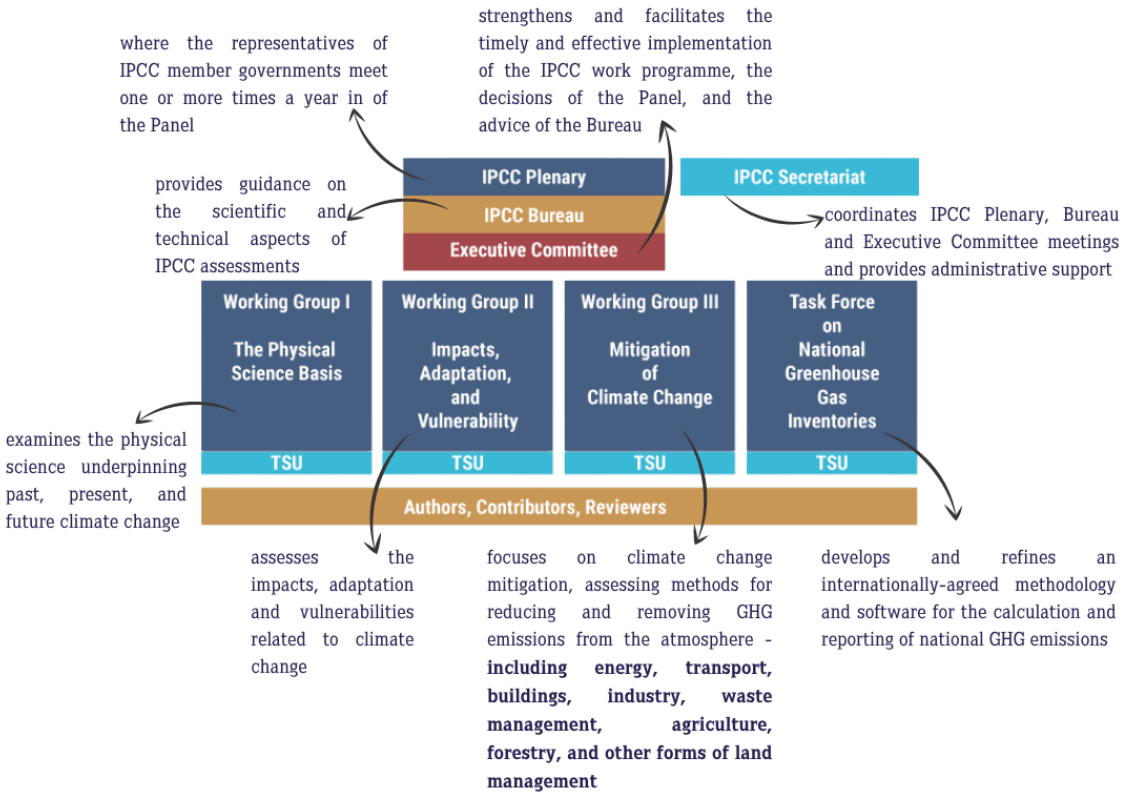
In the late 1980s a window of possibilities opens up for the convergence of environmental issues, observed at an institutional level: the UNEP and the World Meteorological Organization (WMO) established The Intergovernmental Panel on Climate Change (IPCC), in 1988. The IPCC gathers a dataset that allows preparing a comprehensive review and recommendations according to the state of knowledge of the science of climate change, its social and economic impact, and potential response strategies for inclusion in a possible future international convention on climate. Since then, the IPCC has done Assessment Reports to feed international climate policymaking (IPCC, 2022).

But how does it work and what is the importance for us? First of all, the structure of IPCC is organized in such a way that involves most areas and actors (scientifical and

[14] In 1981 Brazil instituted the National Environmental Policy through Law nº 6.938/81 and created the National Environmental System, which paved the way for the entire system of Brazilian public policies for the environment. Later, the twenty-six principles contained in the 1972 Stockholm Declaration were embraced by Art. 225 of the 1988 Federal Constitution, aiming to give effectiveness to an ecologically balanced environment and a healthy quality of human life.

governmental) inside the climate change issue: the sources, the impacts, the mitigation, the sink, the vulnerability, and the potential solutions (Figure 11).

Figure 11 - The IPCC Structure



Source: elaborated by the author based on (IPCC, 2022)

Secondly, the report compiles extensive evaluations that help understanding how to treat this problem in a scientific way, how to reduce uncertain levels about it, what to do to adapt to already present and irreversible impacts, how reduce the source of the problem by mitigation (Mendes, 2014).

The First IPCC Assessment Report underlined the importance of international cooperation since climate change has global consequences and played a decisive role in the preparation of upcoming meetings and the production of a range of Methodology Reports, Special Reports, and Technical Papers on specific scientific and technical matters from governments and international organizations (IPCC, 2022).

In later 1992, Rio de Janeiro received the biggest environmental event until that moment, gathering 172 countries, 108 heads of States or Governments, about 10,000 accredited journalists and representatives of about 1,400 non-governmental organizations (Breitmeier; Rittberger, 2000; Lago, 2006). Captain Gaia has finally materialized to protect the Earth. The humankind superpower used as a geological force to drive the world toward the Anthropocene

has now been used to drive the Earth toward to "(…)elaborate strategies and measures to halt and reverse the effects of environmental degradation in the context of increased national and international efforts to promote sustainable development in all countries(…)" (UN, 1990). This reunion became known as the United Nations Conference on Environment and Development (UNCED, also known as Earth Summit and Rio 92).

Even in an international atmosphere of cooperation and converging interests, the goals of developing and developed countries remained significantly different. But the notion that sustainable development is based on three pillars - economic, social, and environmental - favored the discussions to both the priorities of developed and developing countries (Lago, 2006).

Among the main results of the Earth Summit are Agenda 21, a document with directions for countries and states to include environmental and social issues in their economic development; the creation of the Convention on Biodiversity; and the elaboration of the United Nations Framework Convention on Climate Change (UNFCCC), the international treaty to reduce global warming and cope with the consequences of climate change. Thus, 195 countries have internalized the Convention into their policies adopting an understanding of the cause-effect relationship of climate change, GHG concentration, average temperature increase, and its relationship to anthropogenic activities (Lago, 2006).

Well, the Earth Summit was a kickoff for the creation of the International Climate Change Regime (ICCR). Since then, the world began to gather regularly through the Conference of Parties – the COPs. The COP is part of the International Climate Change Regime, established with the UNFCCC, an association of all the signatories countries (called "Parties"), which began to meet annually since 1995 to assess the situation of climate change on the planet and propose mechanisms to ensure the effectiveness of the Convention (UNFCCC, 2022a). The role of the COPs is, among other things, to review the obligations of the Parties and the institutional mechanisms established; promote and facilitate the sharing of information on measures taken to address climate change and its effects; promote the development and evaluate the methodologies for the preparation of inventories of GHG; and evaluate the effectiveness of measures to limit emissions and increase removals of these gases (UNFCCC, 2022a).

Every year, at the end of each COP meeting, a series of decisions are adopted to guide the activities of its members during the period following the meeting - which is taken by consensus among the Parties, making the negotiations a slow and arduous process, but at the same time, a necessary moment of cooperation. The delegation of each Party can be formed by

actors beyond the government delegates, as businesspeople, stakeholders, lobbyists, non-governmental organizations (NGOs), environmentalists, indigenous organizations and social movements. As only government delegates have the voting power at COPs, the other participant actors (observers) can influence Parties' position in the meeting. In other words, the alignment with the current government can be favorable for some actors, using the superpower to make Captain Gaia or Captain Degradation stronger.

For example, the third COP, that took place in Kyoto in 1997, resulted in the first international treaty to control GHG emissions in the atmosphere[15]. However, when it was adopted, the Kyoto Protocol was signed by only 84 countries, and the United States, one of the biggest emitters of GHG in the world, abandoned the Protocol in 2001 because achieving the established goals would compromise its economic development (BRASIL, 2022). On the other hand, developing countries, such as China, Brazil, and India, have not been given targets and obligations to reduce their emissions, but even so, they have set "voluntary" emission reduction targets. And Brazil began to use its superpower during COP meetings.

Years later, when the Kyoto Protocol was about to expire and its extension needed to be negotiated, the Brazilian government presented an ambitious target to combat climate change, among them the recent approval in Congress of the law that projects the reduction of the country's emissions by 2020 – especially by changes in land use. During the COP 15 in Copenhagen, Denmark, the country presented a set of voluntary actions (NAMAs - Nationally Appropriate Mitigation Actions) established to reduce its GHG emissions between 36.1% and 38.9%, by not emitting about 1 billion tons of CO_2e.

To this end, it proposed the following actions: 1) reduce by 80% the deforestation rate in the Amazon and by 40% in the Cerrado; 2) adopt intensively the recovery of pastures currently degraded in agriculture; actively promote crop-livestock integration; expand the use of the no-tillage system, and the Biological Nitrogen Fixation; and expand energy efficiency, the use of biofuels, the supply of hydroelectric and alternative sources of biomass, wind power, and small hydroelectric centers, as well as expanding the use of charcoal from planted forests in the steel industry (BRASIL, 2012). This set of actions became known as the ABC Plan and involved several actors through the land use management related to agribusiness, food security, family agriculture, environmentalists, industry, and others.

[15] Among the targets, the protocol established a 5.2% reduction, about 1990, in the emission of pollutants, mainly by industrialized countries, in the period between 2008 and 2012. The protocol also stimulated the creation of forms of sustainable development to preserve the environment (BRASIL, 2022).

In COP 20, Brazil reaffirmed its protagonism through the National Determined Contributions (NDC) in Paris Agreement, including the agriculture sector through strengthening the ABC Program as the main strategy for sustainable agriculture development by restoring an additional 15 million hectares of degraded pasturelands by 2030 and enhancing 5 million hectares of integrated cropland-livestock-forestry systems by 2030. Already in COP 26, Brazil's goals weren't readjusted in addition to building a controversial discourse on environmental protection – supporting a tiny fraction of the domestic interests.

Well, it can be seen then that the humanity's superpower observed during the COP is influenced by what happens domestically in each country, that is, the actors influencing the positioning of countries in the international arena. The Great Acceleration led agriculture to play an important role internationally, with actors able to impact in the Brazilian Foreign Policy (Portuguese acronym, PEB[16]) formulation. Over time, other key areas have been going in the arena bringing more actors, such as climate change and food security, shaping a Triad. So, understanding how the actors linked to the Triad spheres articulate at the domestic level influencing the Brazilian position on the COP is an important point to understand these dynamics.

Nietzsche says that if a man has a why to live, then he can support almost any how. Bringing this thought to this thesis, with all the story introduced in this Chapter, it is possible to notice that until now, *Homo sapiens* tried two main directions, through the divergence of interests (why), observed in the articulations among the actors (how): the one that makes Captain Gaia stronger and that one that makes Captain Degradation stronger, as an Institutional Continuum. Land exploration without thinking about the future generations can lead the Earth in the direction of the Captain Degradation in Institutional Continuum. In contrast, the adoption of sustainable choices and the protection and maintenance of the global environment can lead the Earth in the direction of the Captain Gaia in Institutional Continuum. Since Stockholm, the Earth has been sliding between one extreme of the Continuum and the other without, until then, presenting a viable solution for either side. But what if humankind was able to build a third Captain (Figure 12)?

[16] Política Externa Brasileira.

Figure 12 - The Institutional Continuum

Source: elaborated by the author

Maurice Strong says in his Stockholm speech that we have determined that we must control and harness the forces, which we have ourselves created. Well, if we still use these forces for divergence interests, the articulation will be more difficult and, most likely, the foreign policy elaboration will be based on the pressure capacity of the group with greater strength and alignment with the Executive, as seen at COPs - keeping the world in an Institutional Continuum between Captain Gaia or Captain Degradation. But, if the actors use these forces for common interests, then there is a greater probability of an articulation of the Triad and a common proposal presentation for the formulation of foreign policy – a new hope can emerge and a different Captain can be formed, the Captain Triadic. And Brazilian agriculture has an important role in this hypothesis.

Chapter 2

THIS IS THE WAY

"The important thing is not to stop questioning"
Albert Einstein

Knowledge, in general, is related to the accumulation of information acquired over time. However, there are several types of knowledge: the popular, which is based on and limited to the experiences lived by an individual; the philosophical, which is characterized by the questioning of human problems; the religious, which is based on truths and propositions coming from something sacred and supernatural; the artistic, which is based on culture and human creativity; and the scientific, based on facts and builds hypotheses and/or theories. Thus, to unravel the knot narrated in Chapter 1 and understand the use of humankind's superpower, scientific knowledge will support the methodology. Therefore, this section will describe the theoretical research & the data sources which the story takes place through a dance on the Institutional Continuum.

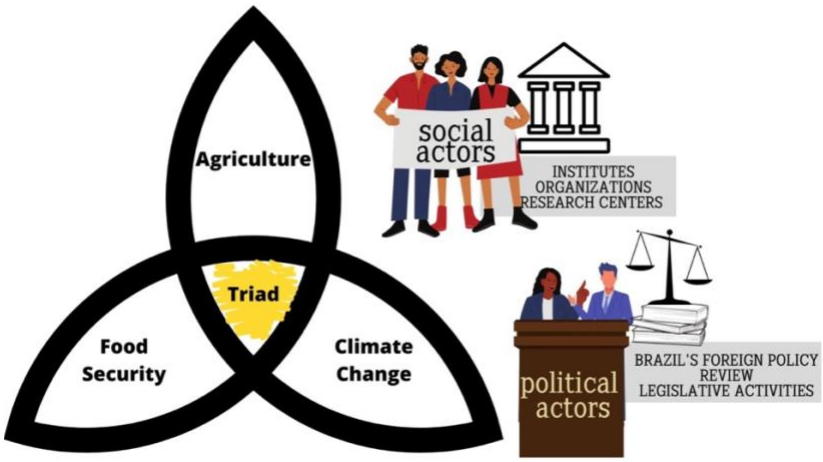
2.1 Actors through the theory

Humankind is growing at the same level as its superpower, and understanding how to use it is essential to lead the world in the Captain Triadic direction. Population projections indicate an accelerated and continuous growth in the coming decades, which should increase the demand for food in general and consequently land use, with a world population exceeding 9.7 billion in 2050 and 10.9 billion in 2100 (UN, 2019).

However, in terms of supply, there is a restriction of agricultural expansion, since about 90% of the land suitable for this purpose is in Latin America and Sub-Saharan Africa (FAO, 2013a). At this point, in 2018, Brazil presents itself as a potential world producer of food and expansion of supply: more than 30% of the national territory used in agricultural production – including livestock and planted, pastures represent more than 20% of the Brazilian territory, agriculture area around 7,8%, and more than 66% of environmental preservation area (EMBRAPA, 2018). A potential protagonist for the 21st Century Triad.

The Triad spheres operate in several arenas at the domestic level, and this interaction influences the systemic level (International System). Then, understanding how government and social actors engage with each other within a dynamic international system and exercising influences over results in the policy decisions can help unravel the political challenge in this global imbroglio. Therefore, to methodologically guide this story, the theoretical background chosen was the perspective of the nested games (Tsebelis, 1998), to analyze the Triad's actors and the trade-offs that occur in domestic policy and influence the behavior of Brazil in ICCR. Then, it was necessary to select and examine the significant role of these actors in the Triad. To do so, the research was based on the selection of political and social actors, showed in Figure 13.

Figure 13 - The Triad Actors



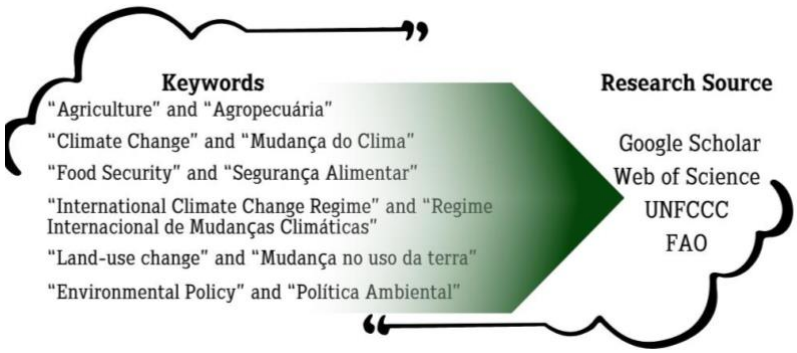
Source: elaborated by the author

To make it happen, Chapter 3 presents the methodological apparatus used to comprehend the domestic and international context. In addition, understanding the stories behind the scenes is important and necessary to be able to suggest politically viable strategies for the Triad spheres in direction to Captain Triadic at the Institutional Continuum. So – and even though the analysis timeline is between 2001 and 2020 –, a section has been written with a brief history of the Triad since the first major international environmental conference, to better understand the Brazilian context within the Triad, as well as its behavior in the ICCR in the coming years.

Then, guided by the social and political actors selected previously, a specialized literature review has been made focusing in contextualize the Triad and the role of Brazil in this scenario. The procedure adopted consisted of a search for academic texts and technical

reports in four main portals that address the Triad spheres. To do so, keywords related with the question of the thesis (in English and Portuguese) were selected, as shown in Figure 14.

Figure 14 - Keywords to explore the Triad context



Source: elaborated by the author

To do so, the documentary research followed five steps: context, author(s), authenticity, key concepts, and documentary analysis (Cellard, 2008). Concerning the context, the analysis made considers the socio-political universe of the documents and to whom it was addressed, making it possible to understand the arguments, refutations, actions and to identify people, social groups, places, and facts to which it alludes - important to identify the interests of the actors (Cellard, 2008).

As for the authors, knowing the identity of the person/entity expressing themselves, their interests, and the motives that led to the drafting of the document may make it possible to elucidate and evaluate the credibility of the text, the interpretation that is given to certain facts, the position that emerges from a decision and the deformations that may have occurred in the reconstitution of an event. Authenticity allows us to ensure the quality and information transmitted, to legitimize documentary information (Cellard, 2008).

The key concepts and the internal logic of the text adequately delimit the meaning of the words and concepts, as well as their importance and meaning according to the context in which they are used, making it possible to analyze the collected content. Finally, the documentary analysis made it possible to interpret and synthesize the information, identifying and categorizing key elements to determine trends and make inferences (Cellard, 2008).

2.3 The key-events

Although the searches were carried out in specific sources, the selected documents led to more references, allowing to explore the various works in the area that contributed to the

discussion and construction of the Triad nationally and internationally. Thus, due to the long time series, it was necessary to choose key-events over time to identify conflicts and convergences of interest in decision-making and the formulation of policies that reflect the thematic agendas of the governments analyzed, shown in Chart 1.

Chart 1 - Key-events

Analysis Level	Key-event	Time series	Government
Domestic level	National Water Agency	Period from 2001 to 2010	Fernando Henrique Cardoso (2º term)
International level	Rio +10		Fernando Henrique Cardoso (2º term)
Domestic level	Fome Zero Program		Luiz Inácio Lula da Silva (1º term)
International level	COP 15		Luiz Inácio Lula da Silva (2º term)
Domestic level	ABC Program		Luiz Inácio Lula da Silva (2º term)
Domestic level	New Forest Code	Period from 2011 to 2020	Dilma Rousseff (1º term)
International level	COP 21		Dilma Rousseff (2º term)
Domestic level	Law nº 13,465		Michel Temer
Domestic & International level	Bolsonaro's actions		Jair Bolsonaro

Source: elaborated by the author

The previously identification of actors in Chapter 3 allowed to divide the time series into two periods, choosing important key-events for each period according to the government's political agenda, which are presented in Chapters 4 (2001 to 2010) and 5 (2011 to 2020).

Due to the time required to conduct the research and a large amount of information in this sector regarding actors, it was decided to aggregate them broadly, searching for web information in institutes, organizations, research centers, and the analysis of the Plenary, Committees, Fronts, and Leaderships. In this way, it was possible to identify the governmental political agendas of each period and understand the alignment with the Executive.

As the key-events brought to identify the actors and trade-offs unfold at the domestic level, so does the influence of domestic policy at the international level. At the domestic level, these leaders are surrounded by members of their parties, parliamentarians, and representatives of influential interest groups, among others. And this interaction at the domestic level encourages leaders to act coherently in both settings. For this thesis, the influence to be observed of these actors in the decision-making process will be analyzed through the claims and preferences of a certain sphere of the Triad included in the positioning of the Brazilian government in the COP.

Bringing up the theory of Tsebelis (1998) again and thinking of each government as a player in a strategic game, one might expect that its goal is to maximize its ability to satisfy domestic demands while minimizing negative consequences from abroad. In other words, domestic positions, and the possibility of entering into agreements are connected.

Currently, Brazilian foreign policy is formulated and conducted in a complex domestic and international environment and is the result of coalitions of interests of domestic and international actors with varied capacity for influence. In their study, Milani and Pinheiro (2013) discuss the diversity of actors and agendas in PEB. This includes non-traditional State actors, such as federal ministries and agencies, as well as non-State actors representing public interests, human rights, education, culture, and also the interests of economic and social groups. This diversity is the result of the existence of political spaces in both the international and domestic order, creating complexity in the PEB decision-making process, challenging the precise identification of the main agent and institutional locus of decision-making (Milani; Pinheiro, 2013).

When it comes to environmental issues, there is greater complexity, as it involves a wide range of actors and decision-making processes. It is therefore essential to describe this diversity accurately, comparing behavior over time and in different decision-making contexts.

By examining their historical involvement in key domestic events in different periods and their participation in international conferences, this step aims to elucidate how these actors have influenced Brazilian foreign policy[17] through the COPs. After this step, the correlations between the variables of the Triad will be analyzed, aiming to discover instances of convergence and divergence of interests among the actors and to explore the alignments and

[17] The author chosen are central to the construction of the thesis, but other authors will be introduced in the course of the research, mainly because it deals with foreign policy decision-making.

conflicts of interests within the Triad. The next sections will address the methods to achieve these objectives. However, to strengthen the results found, a correlation of quantitative data related to the Triad was carried out.

2.3 The correlation

To support the divergent and convergent interests articulated in the Triad, some quantitative variables were selected (Chart 2) to correlate them with each other and with the results found previously. Thus, the chosen approach was the Machine Learning (ML) – that can be defined as the scientific field that gives machines the ability to learn without being strictly programmed (Samuel, 1959).

Chart 2 - Key-events and quantitative data

Analysis Level	Key-event	Time series	Government	Quantitative data
Domestic level	National Water Agency	Period from 2001 to 2010	Fernando Henrique Cardoso (2º term)	Temperature Deforestation area Hotspots area Rice area/productivity/production Corn area/productivity/production Bean area/productivity/production Sugarcane area/productivity/production Soy area/productivity/production Sorghum area/productivity/production Wheat area/productivity/production Manioc area/productivity/production Dairy cattle production/head Beef cattle production/head Gini Index GDP Crop area Pasture area Agriculture & livestock CO2e Emissions Degraded pasture area
International level	Rio +10		Fernando Henrique Cardoso (2º term)	
Domestic level	Fome Zero Program		Luiz Inácio Lula da Silva (1º term)	
International level	COP 15		Luiz Inácio Lula da Silva (2º term)	
Domestic level	ABC Program		Luiz Inácio Lula da Silva (2º term)	
Domestic level	New Forest Code	Period from 2011 to 2020	Dilma Rousseff (1º term)	
International level	COP 21		Dilma Rousseff (2º term)	
Domestic level	Law nº 13,465		Michel Temer	
Domestic & International level	Bolsonaro's actions		Jair Bolsonaro	

Source: elaborated by the author

ML is how to teach a machine to get better at a specific task without telling it exactly how to perform it. Over the years, ML has moved from computer science into more and more diverse fields, such as medicine (Kang *et al.*, 2015; Zhang *et al.*, 2017; Asadi *et al.*, 2014), meteorology (Cranmer *et al.*, 2017; Rhee; Im, 2017), economic sciences (Barboza; Kimura;

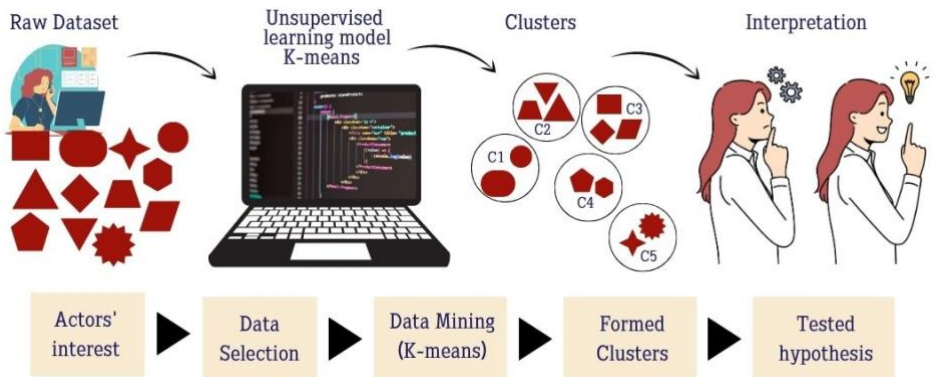
Altman, 2017; Zhao; Li; Yu, 2017), and food security (Maione; Barbosa, 2019). So, in the International Relations field, it wouldn't be any different.

However, even with a previous selection of the quantitative data, it is not possible to categorize them within the hypothesis for two reasons: contextualization (despite the keywords selected previously, it is necessary to understand the context to be able to label the texts within the hypothesis) and the large amount of data obtained. And a massive data is generally available in the unlabeled form. Then, the optimized solution is working with unlabeled data for ML, known as unsupervised learning.

In unsupervised learning, the machine receives a large amount of data that is unlabeled, that is, it has no predefined categories. It's like giving someone a multitude of animal pictures and asking to find similarities among them. The machine can then analyze the patterns in the data and identify groups or similarities on its own. It is useful for tasks like clustering, where we want to find patterns in unlabeled data (Cranmer *et al*., 2017).

Clustering is a method of grouping based on patterns in the data (Jain; Murty; Flynn, 1999), a technique that allows to find clusters of data points with inherent similarity in an unlabeled dataset. Clustering can find the same categories as a supervised classification, but not always. On the one hand, clustering can reveal previously unknown patterns, and on the other hand, it can produce clusters that are difficult to interpret - the researcher being crucial in this interpretation step. In the case of the thesis, the clusters will reaffirm our hypothesis, following the textual analysis carried out earlier (Figure 15).

Figure 15 - Unsupervised learning through clustering



Source: elaborated by the author

Cluster analysis is a technique that aims to help the user identify natural patterns in a data set. When applying cluster analysis, we seek to discover groups of elements that exhibit similar behaviors, based on specific criteria or metrics. This approach is particularly useful for

understanding the structure of data, as it allows the identification of meaningful groupings and important distributions. Thus, it becomes possible to break down the dataset into more comprehensible subsets. Furthermore, the established patterns can be used to segment a population into subgroups, paving the way for further analysis. So, the process of clustering in databases aims to reveal valuable insights and simplify the understanding of the data (Doni, 2004; Halkidi; Batistakis; Vazirgiannis, 2001).

A commonly used example for clustering is K-Means, which is an unsupervised learning algorithm that can help classify the dataset through a number of k-clusters. With the K-Means, each cluster is defined by a centroid that reallocate data points from one cluster to another (Kn; Deka; Gupta, 2021). One of the methods most used to determining a confident number of clusters is the Elbow method, that determines the optimal number of clusters to be chosen based on intra-cluster similarity (Kn; Deka; Gupta, 2021).

The data mining techniques used by K-Means can find many different patterns, but not all of them are valuable or interesting for the proposed research. The goal is to discover useful knowledge that can be understood and used (Doni, 2004). So, to ensure a good interpretation of the clusters, the evaluation and quality of the results was analyzed by matching two techniques: the knowledge analysis and the silhouette score.

The first includes the understandability and the “interestability”. Understandability is about how easy is to understand the result discovered. The “interestability” is a measure of how interesting or surprising the result is. After analyzing the result, if it is not useful or does not meet the proposed goals, we can try again, adjusting the settings or choosing different data, to get better results next time. It is like searching for treasure again, changing the strategy to find something more valuable (Doni, 2004).

The last one, silhouette score, assesses the quality of the clusters. A high average silhouette coefficient indicates that the clusters are well formed, which helps us determine the optimal number of clusters, represented by 'k'. This score can range from +1 to -1, with values close to +1 indicating that the data point belongs to the appropriate cluster. Values close to 0 suggest that the point could be in another cluster, while values close to -1 indicate that the point is in the wrong cluster. Thus, the analysis of the silhouette score helps us assess the quality of the clusters obtained (Shahapure; Nicholas, 2020). The Appendix contains the code and graphics produced.

The cluster analysis was shown in the last section of Chapters 4 and 5 and makes it possible to verify the interpretation of the events that occurred during the period analyzed. With the results, it was possible to understand the correlations of the selected variables (the independent variables, which influence, determine, or affect another variable; the dependent variables, which are explained by the influence of the independent variables).

Chapter 3

LIGHTS, CAMERA, ACTION!

"Daring ideas are like chessmen moved forward; they may be beaten, but they may start a winning game".
Johann Wolfgang Von Goethe.

Homo sapiens turned the Earth into a chessboard. In a given moment the players were pastoralists wanting to feed their cattle, raise animals, or track for arable lands; in another, the players were sitting at a big table deciding the rules of the game between Captain Gaia and Captain Degradation. But the fun fact is that each player has your only game in arenas at the domestic level and what happens there, impact and influence the chessboard.

During the last decades, the evolution of Agriculture, Climate Change, and Food Security occurred through a dynamic interrelationship in several arenas with different actors participating in the processes of public policy formation: individuals, groups, or organizations that exert direct or indirect influence at different moments. Therefore, the actors involved in the formulation and implementation of Brazilian foreign policy are mapped to understand these trade-offs.

3.1 The actors behind the players

Through the lights and cameras of the political arena, the actions and behaviors of government leaders can be influenced behind (sometimes not too much behind) the scenes by several actors. Such actors can be understood as individuals or institutions that influence public policy processes, may be governmental (bureaucrats, judges, politicians, and others) or non-governmental (interest groups, political parties, media, policy recipients, third sector organizations, international organizations, researchers, experts, trade associations, and others) (Secchi, 2013). In addition, their behaviors will depend on their interests, ideologies, resources, and the influence about public policies, acting more emphatically or in a milder way according to their participation in certain stages of the political cycle (Macedo *et al.*, 2016).

Thus, it is necessary to understand how these actors organize themselves to influence the formulation of public policies in the active political games since a considerable part of the political activity of governments aims to satisfy the demands brought by social or political

actors (Rua, 1998) and that some groups with greater power tend to impose their will (Gómez, 2012), such as interest groups.

Because it is a broad term, interest groups can include several types of actors, being diverse in the concepts worked. For Almond & Powell Jr. any group of individuals connected by ties of problems or advantages and who have some awareness of these ties (Almond; Powell Jr., 1972) can be characterized as an interest group - and this is the concept to be worked on in this thesis. According to the authors, the interest group traditionally performs articulating interests, which can be understood as the process by which groups present their demands to policymakers (Almond; Powell Jr., 1972).

The public policy cycle is then expected to consider the demands presented by interest groups. However, policymakers, regardless of their status as political leaders, have their own individual interests and ambitions, that guide their policy choices. And these interests may diverge from the demands presented, affecting the stages of the policy, and shaping its results. Even if the choices are not favorable for society, or for certain interest groups, they are rational when considering the political game.

Regarding rationality, in 1968 Garrett Hardin addressed rational choice in his article published by Science, The tragedy of the commons, stating that some individual choices could lead to tragedy[18] (Hardin, 1968). For instance: an open pasture to all which is to be expected that each pastoralist will try to keep as many cattle as possible on the common lands. Such an arrangement may work reasonably satisfactorily for a while, keeping the numbers of both man and cattle below the carrying capacity of the land. However, as a rational thinking being each pastoralist seeks to maximize his gain, wondering how adding one more animal to the cattle would be useful to him[19]. Rationally, the pastoralist behavior would be adding more and more animals in his cattle – which could impact the land lead to soil degradation. Then, a tragedy of the commons may happen (Hardin, 1968).

On the other hand, another possibility can also occur: the pastoralist may choose not to add more animals to his cattle to the common land - an attitude that can be understood as

[18] Elinor Ostrom (Ostrom, 1990) presents arguments about the sustainable use of natural resources for the common good that counter the paradigm presented by Hardin (1972). However, Ostrom does not ignore it, but inserts it as one of its pillars in the discussion of the common good. According Ostrom, the subjects (those who act on the environment), faced with a situation prone to tragedy (the object) will behave in a way that can be analyzed by game theory or the logic of collective action, where cooperation can make them avoid tragedy.

[19] Therefore, two scenarios are observed: 1) the pastoralist would receive the gains from the sale of the additional animal, so the positive utility would be +1, but 2) the effect of overgrazing by raising one more animal would be shared by all the pastoralists, so this individual decision making would be -1.

suboptimal since it minimizes his gains in that situation. It is through observing this kind of behavior, that George Tsebelis presents the idea of nested games (Tsebelis, 1998), when there is a possibility that some players perform suboptimal moves in the view of outsiders with the prospect of winning in the main game arena, leading to a kind of cooperation among players. In other words, pastoralists may choose not to put more animals in the pasture, aiming at the main game that would maximize their long-term gains more than if they chose the optimal choice in other arenas. According Tsebelis (1998),

> First, option Ai is not optimal because the actor is involved in games in several different arenas, but the observer focuses on only one arena. Let us call the arena that attracts the observer's attention the principal arena. The observer disagrees with the actor's choices because the former sees the implications of the latter's choices only for the principal arena. However, when the implications in other arenas are considered, the actor's choice is optimal. I refer to this case of nested games as games in multiple arenas. In the second case, option Ai is not optimal because the actor "innovates," that is, takes steps to increase the number of available options so that some new option is now better than Ai. Increasing the available options means actually changing the rules of the game that define the options available to each player. In this case, the observer does not see that the actor is involved not only in a game in the principal arena, but also in a game about the rules of the game. I call this case of nested games institutional design (Tsebelis, 1998, p.8).

Certain suboptimal choices means that several games are played at the same time, which may bring additional costs to the choices that would be preferred by the players in a particular arena, making it difficult to choose in another arena. Games in multiple arenas can be conceptualized as games in which the prevailing situation in the other arenas determines the players' payoffs in the main arena or vary according to the moves made by the players in those arenas (Tsebelis, 1998).

In the political arena, these simultaneous games can be observed in parliamentary games, electoral games, bargaining games, in international politics and domestic politics (for national leaders), and in the interaction between economics and politics. To explain the behavior and understand the motivations of these players to make such a choice, it is necessary to study the network of games in which they are involved and their priority arenas, assuming that all human activities are goal-driven through the Rational Choice Theory.

> In game theory, the players face a series of options (strategies); when each selects one strategy, the players jointly determine the outcome of the game, receiving the payoffs associated with that outcome. In order to find the solution to a problem, game theory assumes that the rules of the game (which determine the available strategies) and the payoffs of the players are fixed. Once the rules and payoffs are fixed, the actors choose mutually optimal strategies; each player selects a strategy that maximizes his payoff, given what the other players do. This account specifies that game theory does not leave room for suboptimal action (Tsebelis, 1998, p.6).

In these arenas structured on nested games, the pay-off in each arena is influenced by the decisions made in another. Then, it is possible to understand how each player positions himself and which arena is the one where he can gain the most benefits and from which he coordinates his actions. Only after understanding which arena is the priority of a governments, it is possible to insert rationality into its choices in the domestic and international behavior.

Rationality would then be an optimal correspondence between means and ends. Here, Tsebelis (1998) presents four examples of one-shot two-by-two games in which variation in payoffs occurs: the Prisoners' dilemma, the Assurance, the Chicken, and the Deadlock game. However, such variations in payoffs affect the behavior of players in the priority arena and the consequences for balance in different games. Each player has a choice between two strategies, which can be chosen in all four games: cooperation or defection (non-cooperation).

The occurrence of cooperation is important to several fields such as political philosophy, international politics, and political economy. But in some games, it is observed that defection is the dominant (most advantageous) strategy when there is a lack of communication between players, causing both to defect - regardless of whether the outcome for this choice is optimal (Deadlock game) or suboptimal (Prisoner's Dilemma). On the other hand, in games where mutual defection is known as the worst payoff - Chicken Game - or cooperation is the preferred outcome - Assurance game - cooperation is the actors' choice. About the latter game, one of its characteristics is that it does not have a dominant strategy, with cooperation being the strategy with the best payoffs in the game (Tsebelis, 1998).

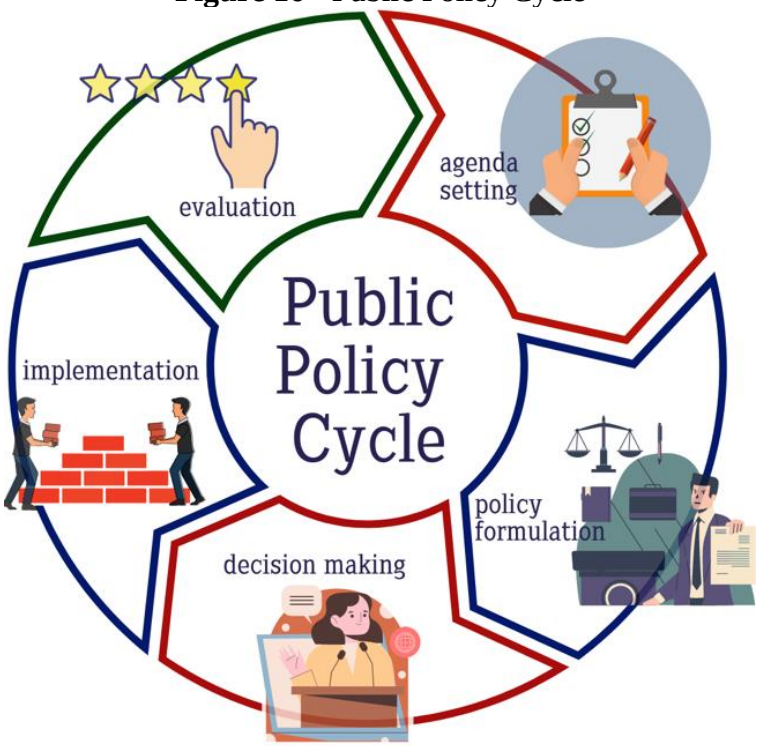
Besides all this complex theory involving strategies, payoffs, and players, in practice the theory of games can be used to predict how people behave, following their own interests and conflicts, as well as each other when anticipating the opponent's decisions (Madani, 2010). And to understand the behavior of these players, it is necessary to understand their interests and the arenas in which they play their games. And it is in the political arena that this dynamic can be better observed - not least because, according to Tsebelis (1998), an increase in rewards for cooperation makes this strategy more attractive.

A way to analyze the political arena is through the formulation of public policies. Among the various concepts of public policy, that of Lowi and Ginsberg (1996) stands out for bringing similar terms to those cited in the game theory, of reward and penalty: "an officially expressed intention backed by a sanction, which can be a reward or a punishment". In other

words, a public policy can materialize through laws, rules, statutes, regulations, edicts, or orders (Lowi; Ginsburg, 1996).

This materialization of public policy can be built through the following path: a problem is identified that needs a public initiative to be solved and some solutions are proposed. The solutions are evaluated and the most promising proposal (and one that has a public initiative) is specified, defended, and public support is sought. The proposal is then presented to the Legislative or Executive Branch of government and enacted with or without modification. Finally, implementation of the proposal occurs, and then feedback. The cycle begins again with suggestions for improvement, replacement, or abandonment of that policy (McCain, 2009). Briefly, Lasswell (1956) presents this path in five stages: agenda setting, policy formulation, decision making, implementation, and evaluation (Figure 16).

Figure 16 - Public Policy Cycle



Source: elaborated by the author based on Lasswell (1956)

The point is that several problems can be observed in a country, according to its specificities: food insecurity, access to health, employment opportunities, access to education, housing for citizens, and quality education, among countless others - and this is known as the public or constitutional agenda of a country. But despite the recognition of these problems, not all of them are analyzed and solved with the same weight for various reasons, such as institutional breakdown, scarcity of financial resources, and political interest in certain issues. This last point deals precisely with the path that a certain problem takes from its identification

to its insertion in the cycle of public policies: it is not linear and depends mainly on the interests and focus of the current government, that is, its governmental agenda (Villanueva, 1993).

A government agenda follows a process formed by three main stages: 1) the emergence/recognition of a problem; 2) the existence of alternatives to solve the problem - coming from specialists, researchers, politicians, etc.; 3) how favorable are the political, administrative and legislative contexts for the development of the action (Capella, 2007). And it is during the agenda formation, in which a large number of actors is inserted, that the convergence of interests can occur during the convergence of problems (Howlett; Ramesh; Perl, 2013; Gómez, 2012). However, the choice of a problem to be part of a government agenda is not chosen only by its ability to affect the collectivity but happens mainly through the strength of ideologies, interests, and needs of the actors involved that influence political processes and relations (Villanueva, 1993) – after all, different values or interests may consider certain proposals better than others (McCain, 2009).

Then, a dynamic of cooperation & competition can be observed in the political arena, through the relationships among the actors which can form a wide network of articulation from local movements to national organizations to achieve political leaders or even international organizations (Cesário, 2016). According to some authors, the network between interest groups and governmental officials works as an influence resource trading structure, which can be translated into technical knowledge, information monitoring, public support from interest groups, and control over policy decisions by government agents (Pappi; Henning, 1998, 1999; Henning, 2009).

Besides, foreign policy could be understood as a dimension that oscillated between the field of Public Policy and that of International Relations, making it possible to understand the relations between state and non-state actors in the international system and the role that they have within the overall distinctive process of decision-makers and the outcomes of these decisions (Alden; Aran, 2017).

Then, assuming that foreign policy is a public policy in this thesis, with the State and the government acting internationally, it is recognized that its formulation and implementation are part of the dynamics of government choices which, resulting in coalitions, bargaining, disputes, and agreements between representatives of different interests, which express the very dynamics of politics. Foreign policy thus incorporates a condition of extreme singularity in relation to the government's other public policies (Millani; Pinheiro, 2013).

This means recognizing the government as the key-institution in the production of public policies, although the contribution of the Legislative Branch and the Judiciary – which are integral parts of the State –, must be taken into account (SOUZA, 2006). Traditionally, foreign policy analysis has focused on the domestic decision-making process as an explanation for states' international behavior. However, later works, such as Rosenau's "Domestic Sources of Foreign Policy" (1967), highlighted the importance of domestic actors and factors in the formulation of foreign policy, such as confederations, companies, non-governmental organizations and social movements, playing relevant roles in the production of these policies and being able to influence their content (Millani; Pinheiro, 2013).

Another aspect of the prominent presence of the business sector on the international board, which has been acquiring global reach and increasing its international involvement. Although they act in parallel, there is a significant dialog between Brazilian business and government actions on the foreign scene (Hirst; Lima; Pinheiro, 2010).

In addition, Milner (1997) says that the ratification of an international agreement directly affects the size of the rewards that each interest group in the country can obtain. Those who stand to lose from the agreement will try to block or change it, while those who stand to benefit from the agreement will push for its ratification. Thus, we can imagine this political game as a dispute in which each player seeks to maximize their own advantages and minimize their losses. Those who have more domestic wins have more cards to play in international negotiations, while interest groups that would be disadvantaged by the agreement try to turn the game in their favor. This complex dynamic shows how relations between governments and international agreements are intrinsically linked to the domestic demands and interests of each country.

Interests influence attitudes, thus being the basis of a political agenda structure. When offering a theory of the interaction between domestic and international politics, Helen Milner argues that political and social actors have independent interests, interacting strategically. Then, most domestic policies can be found in an environment where the sharing of decision-making occurs unevenly, with the policy being driven by a search for commitment and internal interest. Such policy can be defined by the following factors: the political preferences of domestic actors, the division of power between institutions, and the distribution of information power. Thus, there would be no power in which a single actor or group of people decides, but actors with different preferences that influence the decision-making process (Milner, 1997).

This choice has an explanation: foreign policy analysis focuses on how foreign decisions are made according to a State's institutional structure and the role of interest groups directly involved in foreign policymaking (Ferreira, 2020). Since the State is defined by its decision-making units and not as an unitary actor, foreign policy as a public policy is formulated and implemented in the dynamics of government choices, through the results of coalitions, bargains, disputes, and agreements made at a given moment (Lima, 2013). In other words, foreign policy seeks to explain the behavior of States, their objectives, and the ways to implement them at the external level.

Furthermore, this political network could be designed in such a way that each interest group was a knot and the links among them were established by the action in the same public policy. So, the relationship would be through the interest groups that sought influence in the same public policy (Cesário, 2016).

3.2 A few decades before

Walking a parallel path to the main international environmental events, the proposed Triad on this thesis was developed in such way that its movements on the international board were influenced by the moves that happened in domestic level. The domestic and international context have developed in different ways on the 21st century, influencing the construction of the public policy. However, to understand the Brazilian games on this board inserted in the Institutional Continuum – which sometimes is getting closer to Captain Gaia and other times to Captain Degradation –, is needed recap not just the context of the analyzed periods, but also of the previous ones.

It is not within the scope of this thesis to tell the whole story of the development of the Triad since the colonization of Brazil. The interest is to analyze the trade-offs among the Triad since the beginning of the 21st century and its influence on Brazilian foreign policy formulation. Hence, linking foreign policy and the environmental topic, the synthesis below starts at the first major international environmental conference, aiming to understand Brazil's behavior and the main events at the domestic level, from 1970 to the beginning of the 21st Century – the interest of this research.

While the world changed its power structure from East-West to North-South, the environmental problems follow this restructuration. Such perception was evidenced during the

United Nations Conference on the Human Environment (Stockholm 1972), held in Stockholm on 1972, in which the North countries put the environmental consequences of their uncontrolled economic development on the shoulders of the South countries (Lago, 2006).

At this time, Brazil was plunged into a military dictatorship that impacted its environmental agenda almost null and its movements on this board. Then, when was suggest that the global South break its economic development by the maintenance of the natural resources, Brazil led the South positioning arguing that "the economic and populational growth of the developing countries couldn't be sacrificed and that the developed countries should pay by the efforts to avoid environmental pollution[20]" (Moura, 2016). However, to the international opinion, this movement headed by Brazil was illogical and reflected what was happenning internally in the country.

In fact, even after such criticism, Brazil took some years to consolidate the environmental institutions since Stockholm 1972 (Lago, 2006). From 1930 to 1960 there was not a specific environmental policy in Brazil or an institution with an environmental theme, but policies that touched on environmental issues related to the exploitation of natural resources and its economic use, such as: the creation of some National Parks and the Brazilian Institute of Forest Development, linked to the Ministry of Agriculture; the Water Code (Decree nº 24643/1934) linked to the Ministry of Mines and Energy and with interest in the country's water use; the Forest Code (Decree nº 23793/1934) linked to the Ministry of Agriculture with interest in protecting soils for agricultural use; and the Wildlife Protection Law (Law nº 5197/1967). In the late 1960s and early 1970s, the theme gained stage when some environmental demands began to emerge and take space in public opinion (Moura, 2016).

Only in the 1980s that there was greater attention to environmental issues at the national level, such as: the establishment of the National Environmental Policy (Law nº 6.938/81) which opened space to the Environmental National System (Portuguese acronym, SISNAMA[21]) emergence and "established the principles, guidelines, instruments and attributions for the different entities of the Federation that act in the national environmental policy[22]" (Moura, 2016, p.16); the creation of the Ministry of the Urban Develeopment and Environment, aiming

[20] Free translation of "o crescimento econômico e populacional dos países em desenvolvimento não deveria ser sacrificado e que os países desenvolvidos deveriam pagar pelos esforços para evitar a poluição Ambiental" (Moura, 2016, p.15).
[21] Sistema Nacional de Meio Ambiente
[22] Free translation of: "estabeleceu os princípios, as diretrizes, os instrumentos e atribuições para os diversos entes da Federação que atuam na política ambiental nacional" (Moura, 2016, p.16).

to define policies and to coordenate environmental government activities; and approval of the Resolutions nº001/1986 and nº009/1987 about environmental licensing by the National Council of the Environment (Portuguese acronym, CONAMA[23]).

At the end of the military dictatorship, the New Republic was established in 1985 through the government of José Sarney. Actions such as the revocation of the measures that limited the right to vote and political organization, as well as the elaboration of the new Constitution in 1988, materialized the return to democracy. The main challenge of this transitional government was to deal with the economic and social crises that the country was facing, such as the intense disputes of actors advocating reforms in the economic and political fields, including non-governmental organizations and social movements (Prado; Miyamoto, 2010).

In the 1980s, international criticism emphasized the need for efficient public policies directed at the preservation of the Amazon (ranging from rivers contaminated with mercury to the irrecoverable fires that devastated the Brazilian fauna and flora) and to avoid the predatory exploitation of resources and the destruction of the environment. Coupled with this, the UN report coordinated by Gro Harlem Brundtland (Brundtland, 1987) led the Brazilian government to adopt defensive policies, as it argued that natural resources that concern the interests of all humankind should be managed internationally - creating the idea of shared or restricted sovereignty.

The Sarney government was thus guided by a nationalist speech about who should take care of the great forests (BRASIL, 1990), reverberating in the world media and increasing international pressures when the Constituent Assembly was convened in 1988 (Prado; Miyamoto, 2010). It was with the death of Chico Mendes[24] in December 1988, that the Sarney government begins to incorporate environmental issues into its agenda with more attention than it would probably prefer. However, even with initiatives that were framed within the environmental issue, the concern to occupy the Amazonian space in the best possible way was

[23] Conselho Nacional do Meio Ambiente

[24] Chico Mendes was a Brazilian environmental leader with a life trajectory focused on the defense of the Amazon and its populations, with a struggle widely recognized and studied by academics and researchers from various fields of knowledge. Such studies demonstrate the relevance of the legacy left by Chico Mendes, in which the actuality of his struggle for forest preservation and protection of the rights of indigenous peoples and traditional communities are increasingly relevant themes. His assassination in 1988 had national and international repercussions, as his struggle raised awareness that it was possible to reconcile progress with preservation (Ventura, 2003).

always under a strategic-military prism, such as the Our Nature Program (Programa Nossa Natureza) (Prado; Miyamoto, 2010).

In 1990, Fernando Collor de Mello was elected with the promise of changing the country - especially on the environmental issue. While Sarney was more aligned with a traditional and extractivist development vision, Collor's speech adopted a more environmentally conscious stance, advocating the need for public policies to promote sustainable development (Figueiredo; Silva Schneider, 2016). This was shown clearly when the environmental agenda was used as a strategic move to show the world Brazil's new positioning by hosting in Rio de Janeiro, in 1992, the UNCED an important landmark for Brazilian environmental protagonism.

After the Conference, the Brazilian government intensified its efforts to implement public policies that promote sustainable development, especially in the areas of energy and water (Figueiredo; Silva Schneider, 2016). Programs to encourage energy efficiency and integrated water resource management were created to reduce environmental impact and promote sustainability (Pegui, 2020), such as the National Program for Energy Conservation, the National Water Program, and the National Fund for Scientific and Technological Development.

Collor's foreign policy also helped to strengthen Brazil's prominence in the environment. Brazilian diplomacy consecrated three successes in this period (Cervo; Bueno, 2008): 1) holding the UN Conference in Rio de Janeiro in 1992, 2) the insertion of the development issue in the environmental debate, and 3) the overcoming of the North-South dichotomy in the international arena with the establishment of a climate of cooperation. As a result of this change in focus, we have the UNFCCC, the Convention on Biological Diversity, and Agenda 21. Even with positive points for the environment, Collor’s government was impacted by the economic measures adopted causing his impeachment, and his vice-president, Itamar Franco, assumed power until the next election.

Following a path that led him to the Brazilian presidency, Fernando Henrique Cardoso (FHC) participated in the strengthening of the federal government in the political, social, and economic dimensions of that period: a successful renegotiation of the foreign debt; the improvement of the conditions of the federal public accounts; the impeachment of President Fernando Collor de Mello and the possibility of Luiz Inácio Lula da Silva victory in 1994; the consolidation of an ideological change in Brazilian society; the strengthening of constitutional

reforms supported by opinion makers, the middle class, the media and business sectors; and, above all, monetary stabilization through the initial success of the Real Plan (Abrucio, 2005).

With a governmental agenda built around economic recovery, the first Fernando Henrique Cardoso administration (1995-1998) was marked by the intertwining of two main agendas: monetary stabilization and constitutional reforms. The "Real Era" promoted an important change in the position of political and social actors concerning their interests and influence in the Executive (Pierson, 2000) and, consequently, impacted the construction of the governmental agenda (Couto; Abrucio, 2003). However, some events were held on the Triad topics during the first administration of FHC which, since they are not part of the analyzed time frame, will not be deepened (showed in Chart 3).

Chart 3 - Summary of Triad moments that highlighted FHC's first term as President

Event	Description
Provisional Measure nº1.511/1996 	One of the government's responses to the increase in the deforested area between 1994 and 1995 was Provisional Measure 1511/1996, which increased from 50% to 80% the legal reserve requirements for the total area of rural properties in the Amazon, so that no rural property in the region had more than 20% of its area deforested.
Program for the Prevention and Control of Burning and Forest Fires in the Arc of Deforestation (PROARCO) 	The extensive fires that occurred between 1997 and 1998 in Roraima led the Ministry of the Environment to launch the Program for the Prevention and Control of Burning and Forest Fires in the Deforestation Arch (PROARCO). The objective was to reduce the practice of burning in the regions of agricultural frontier expansion in contact with the Amazon biome with high incidence of deforestation, by implementing a satellite monitoring system.
Environmental Crimes Law nº 9.605/1998 	The Environmental Crimes Law established penal and administrative sanctions, also for legal entities, in case of conducts and activities that harm the environment, making the public power an effective instrument to punish damages caused to the environment.
Kyoto Protocol 	Internationally, Brazil had an active participation in the construction of the Kyoto Protocol. This agreement defined goals for the reduction of greenhouse gas emissions applicable exclusively to developed countries, which also committed to finance the adoption of clean technologies by developing countries. The Brazilian delegation had a prominent role in the creation of the Clean Development Mechanism, the basis for the creation of a global carbon market with the objective of stimulating the financing of greenhouse gas emission reduction projects.

Source: Elaborated by the author according to INPE (2023) and Fundação FHC (2023)

Even though Brazil has the largest freshwater reserve in the world, it still faces many challenges in managing this vital resource. In the 1990s, few cities had no water supply services.

However, the situation was quite different regarding sanitary sewage: more than half of the Brazilian cities had no sanitary sewage at all, with the North, Midwest & Northeast being the most affected regions (IBGE, 2000). It was in this scenario that the first government of Fernando Henrique Cardoso began to draw up a new policy, the water policy. The goal was to improve the management of water resources in Brazil and to create an administration model that considered water as both a public good and an economic asset. And so, measures were adopted to favor and stimulate the adequate water management in the country, which were developed more densely in his second term (Scantimburgo, 2013).

The water resources policies of the Cardoso government were the subject of heated debates involving diverse actors with distinct interests. Thus, the management of water resources could not be analyzed in isolation. It was necessary to consider the complex relationship between water regulation and the environmental crisis, especially in a context involving market interests (Santos; Medeiros, 2009). The government's actions were guided by several forces, including pressure from environmental movements, the need to meet society's interests in improving the water supply and sewage system, and also to meet the economic recommendations of multilateral agencies such as the World Bank and the IMF, which were interested in partnerships with private enterprise (Scantimburgo, 2013).

At the beginning of his mandate, the government took two significant actions that signaled his intention to prioritize the water sector. The first was the creation of the Water Resources Secretary, and the second was the Concessions Law (Law nº 8987). This law opened the possibility for private companies to participate more directly in water services, which could be interpreted as a step towards privatization. At the same time, the discussion about the National Water Resources Policy (Portuguese acronym, PNRH[25]) was going on in the National Congress, but no specific regulations were yet available. The debate involved mainly three topics: the universalization of access to water services, hydroelectric power generation, and the sustainable use of water (Scantimburgo, 2013).

Such topics have always been historically conflictive, consisting of different groups, such as domestic users, farmers, and the electricity sector. The construction of hydroelectric power plants, such as Itaipu and Tucuruí, for instance, has caused significant socio-environmental impacts. It was expected that water management would be disconnected from the electricity sector to avoid favoring this sector to the detriment of the others. However, reality

[25] Política Nacional de Recursos Hídricos.

showed that this did not happen, and the hydroelectric sector continued to have advantages concerning water use (Scantimburgo, 2013). Moreover, the issue of basic sanitation, including water pollution and the proliferation of diseases due to lack of sewage, has not been resolved.

There were two possible reasons to explain the scenario that unfolded. First, there was no legal and institutional apparatus to guide the management of water resources before the privatizations began. Second, the international consulting firm hired to evaluate the restructuring did not consider the Brazilian reality in relation to the use of water resources and their socio-environmental impacts, such as flood control, irrigation, drinking water supply and basic sanitation – important issues that were also not adequately addressed in the Concessions Law (Scantimburgo, 2013). It was only in 1997 that the Water Law was approved in Congress, instituting the PNRH, and the control and rights over water started to have specific legislation.

Law 9433/97 brought significant changes to water resource management in Brazil. The law recognized that water is a finite and valuable resource that requires collective planning and monitoring by the government, civil society, and citizen. It incorporated many of the instruments advocated by the World Bank, such as rationalized, decentralized, and environmentally sustainable management. The law created State Councils for Hydric Resources and Hydrographic Basin Committees to achieve these objectives (Fundação FHC, 2023; Jacobi; Monteiro, 2009). However, the law was not without controversy. President Fernando Henrique Cardoso vetoed thirteen specific points, mainly concerning the forms of charging for water use and citizen participation in policy implementation. The electricity sector, undergoing privatization at the time, was also a sensitive topic. Any obstacle could have hindered the interest of companies in acquiring service concessions (Caubet, 2006; Scantimburgo, 2013).

Brazil has a history marked by different periods that have shaped its relationship with the Triad. Because of this, the time series analyzed in this thesis it will be split into the following two chapters. Chapter 4 describes the period from 2001 to 2010. At the beginning of the 21st century, Brazil faced high levels of deforestation, especially in the Amazon, which guided some decision-making during this period. With this motivation, the country was also involved with significant international initiatives, such as the UNFCCC, but had not yet taken concrete action at the national level. Some of the issues addressed at that time were the National Water Agency and the Rio+10 conference.

Between 2003 and 2010, a new era began to unfold. During the two terms of President Lula da Silva, there was a significant increase in public and political attention focused on

environmental conservation and climate change mitigation. Economic and political stability allowed Brazil to dramatically reduce deforestation rates and incorporate forest preservation and land conservation practices into agribusiness sector. In addition, Brazil's foreign policy has strengthened, adopting a more cooperative stance in international climate negotiations. Finally, a cluster analysis will be conducted in the last section, proposing observed paths and insights about the period.

Chapter 5 will show a break from the previous period, mainly in the observed policy agenda. Between 2011 and 2018, during the terms of Dilma Rousseff and the subsequent presidency of Michel Temer after Dilma's impeachment, the country faced economic challenges and political and social instability. Anti-environmentalist forces, especially those linked to agribusiness, gained prominence, leading to public and political neglect of the environment. Deforestation returned, and Brazil lost its leadership role in global climate governance.

Additionally, the first two years of the Bolsonaro government, between 2019 and 2020, were marked by an abrupt shift in Brazil's environmental and climate policy. The country began to reject and second-guess issues related to climate change and sustainable development, both nationally and internationally. With this background, cluster analysis will be conducted in the last section of the chapter to analyze the observed period.

This history shows us the different chapters of Brazil's relationship with the environment, from periods of significant advances to moments of challenges and setbacks. It is now up to this thesis to understand the trade-offs occurring in this trajectory so that it is possible to propose paths in the Institutional Continuum toward the Triadic Captain.

PART II

Chapter 4
THE GAMBIT

"Man is by nature a political animal".
Aristotle

"Politics is not a matter of discussion". Under this phrase, several Brazilians and I grew up and learned how to deal with politics: by not talking about it.

However, in recent years, the discussion about politics in Brazil has intensified while significant changes have been observed in the Institutional Continuum - especially when it comes to the Triad. And so, we have learned that not discussing politics is to consent and conform to decisions that influence our lives from waking up to falling asleep; it is to allow the maintenance of a status quo that is often not beneficial to us or our environment, but that ends up being comfortable because it is the only form of politics we know. After all, politics is not discussed, and such behavior can lead to a walk down the Institutional Continuum in the stride toward Captain Degradation.

Discussing politics, analyzing and understanding the trajectory of certain events allows us to understand the decision-making processes and the articulations that took place. To this end, this chapter aims to unravel the chessboard of Brazilian politics, correlating governmental actors and agendas with the exploration of time series data using machine learning.

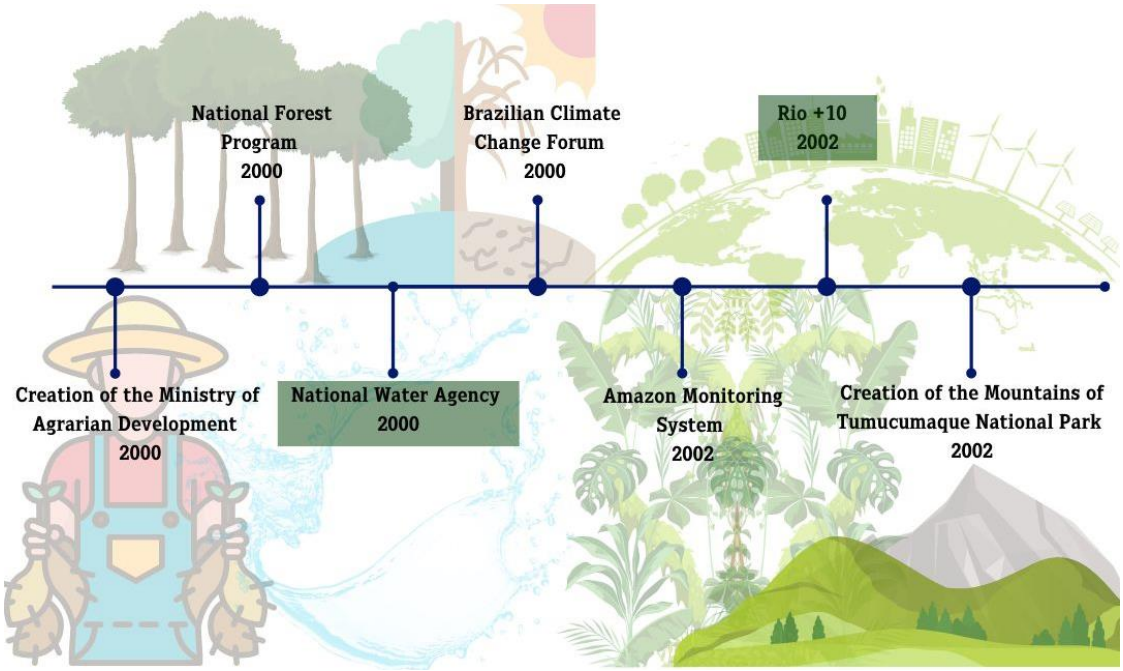
4.1 A slow movement

President Cardoso's (Brazilian Social Democracy Party, Portuguese acronym PSDB[26]) first term was a milestone in the search for significant changes that would elevate Brazil's role in the world, opening the way for some actions related to the Triad – such as environment and social justice – to be carried out in his second term. Among the topics on the government agenda, the use of water as a vital and economic good was a protagonist in this period, being widely debated in Congressional hearings and Brazil's positioning in the international arena. To analyze this period from the point of view of Tsebelis' nested, two topics will be highlighted: the creation of the National Water Agency (Portuguese acronym, ANA[27]) and the Brazilian

[26] Partido da Social Democracia Brasileira.
[27] Agência Nacional de Águas.

position in the Rio+10, the tenth anniversary of the World Summit on Sustainable Development (Figure 17).

Figure 17 - Events during the last years of the FHC government and the key-events chosen



Source: Elaborated by the author according to Fundação FHC (2023)

The Water Law received a positive response from society and environmental groups due to its provision for citizen participation and was also welcomed by social movements (Jacobi; Monteiro, 2009). However, a regulatory agency capable of implementing the law was only created in FHC's second term as president of Brazil, when the time series analyzed in this thesis begins.

It was in 1999 when the destiny of the ANA began to be traced. In a seminary, promoted by the presidency and the Ministry of the Environment through the Secretariat of Water Resources, the first seeds of the Agency were planted. Despite the importance of popular participation in management, civil society did not have a strong presence at that event and the seminary was dominated by members of the public power, both federal and state, technical consultants, and representatives of the influential World Bank. FHC, at the time, envisaged in the regulatory agencies, such as ANA, a bridge between consumers, the population, clients, private investors, and public administration. Their purpose would be to regulate, grant, and sanction to ensure the common good (Cardoso, 2001).

The ANA was submitted to the Ministry of Environment and many people wondered why this decision was taken and how it would affect the socio-environmental importance of

water use. Curiously, Fernando Henrique Cardoso justified this decision as something neutral that would not serve specific interests, since the management of water resources would face pressures in other aspects (Cardoso, 2001).

This view was shared by the then Minister of the Environment, José Sarney Filho (Liberal Front Party, Portuguese acronym PFL[28]), when he presented the draft bill for the creation of the ANA at the seminar, highlighting that the agency would be an important contribution to the ongoing discussion in the National Congress. And, more than that, the draft bill incorporated the basic premises of Law nº9433/1997, recognizing water as an asset of economic value, defending the decentralization of the management of water resources, and promoting the participation of society in decision-making processes, always with the objective of using water rationally.

In the Chamber of Deputies, a Law Project for the creation of the ANA was presented with urgency. In two sessions, the responsible commissions - Consumer Defense, Environment & Minorities, Mines & Energy, and Administration, Labor & Public Service - analyzed, evaluated, and made proposals for changes (Soares, 2005). Although the proceedings were accelerated, ANA only began to operate as an autarchy in 2001, with administrative and financial autonomy, and was linked to the Ministry of Environment.

In its first report, ANA was faced with crucial challenges: "to discipline the use of rivers to avoid pollution and waste, to guarantee water of good quality and in sufficient quantity, including for future generations, and to ensure the multiple uses of water resources"[29] (ANA, 2002, p.8). Additionally, it was important to ensure the multiple uses of water resources. The ANA decided to act immediately and focused its attention on the economic issue. To this end, it encouraged the creation and consolidation of watershed committees in strategic regions of the country, where pollution rates were alarming and water conflicts frequent. These measures aimed to protect the environment and promote a more efficient management of water resources.

The harmony between the management model adopted by ANA and the recommendations of the World Bank has created a strong link between the two entities. The World Bank played a significant role in several water projects developed by ANA, encouraging the implementation of charging for water use. This measure was justified to generate financial

[28] Partido da Frente Liberal.

[29] Free translate of "disciplinar a utilização dos rios, de forma a evitar a poluição e o desperdício, para garantir água de boa qualidade e em quantidade suficiente, inclusive às gerações futuras, e assegurar os usos múltiplos dos recursos hídricos" (ANA, 2002, p.8).

resources for the recovery and preservation of water sources, as well as for the advancement of basic sanitation. However, despite these noble intentions, the resources obtained were not always properly directed to these purposes. However, it is important to emphasize that this thesis does not explore the inconsistencies involved in this issue (Scantimburgo, 2013).

This brief analysis of the ANA allowed us to analyze the actors involved, as well as the trade-offs regarding the topic analyzed. Water management during the FHC government, more visibly during the second mandate, reflected the political and economic context that guided Brazil during this period. The participation of the World Bank in the development of the Water Law and in the creation of the ANA favored mainly the private sector and some economic sectors in the first years, such as Agriculture & Aquaculture, which were charged minimum amounts for water use (IBGE, 2000). However, despite the propaganda, civil society and social and environmental movements were not taken into consideration either during the creation period of the ANA or during its implementation.

In contrast to the creation of the ANA, civil society participation gained significant momentum after the historic UNCED in 1992. During the following ten years, there were remarkable advances in the strengthening of environmental laws in different countries, as well as undeniable progress in the scientific and technological fields and the private sector. These advances culminated in the World Summit on Sustainable Development in Johannesburg, in 2002. However, despite the expectations raised, UN Secretary-General Kofi Annan admitted beforehand that this meeting represented slow progress and a deepening environmental crisis.

In the decade between the two environmental conferences, three economic & political obstacles emerged that cast a shadow over global action. The first was the phenomenon of globalization, driven by economic growth in many parts of the world. However, this expansion did not follow the principles of sustainable development, which seeks a balance between the economic, social, and environmental pillars. Instead, negotiations were conducted by institutions such as the International Monetary Fund (IMF), the World Bank, and the Word Trade Organization (WTO), whose priorities did not always align with those of the UN (Lago, 2006).

Second, the United States played a key role in not putting the issue of global warming on its domestic agenda. Without a clear commitment from the world's most influential country, the ratification of previous agreements became a difficult challenge to overcome. The absence of this protagonism significantly impacted the negotiations (Lago, 2006).

The third obstacle arose after the tragic events of September 11, 2001, when the international political agenda underwent a drastic change. The debate over sustainable development took a back seat to issues related to security and counterterrorism. This shift in priorities further diminished the momentum for action in the environmental field (Lago, 2006). While each of these points can be analyzed in greater depth, the objective of this thesis is to understand Brazil's behavior during this challenging period.

In developed countries, where comfort and services supplied the population's basic needs, the motivation to change consumption patterns was scarce. However, in developing countries with social progress, an environmental awareness fuelled by the ideals of sustainable development was emerging. In Brazil, a country of continental dimensions, it was possible to witness environmental contrasts since 1992: while half of the deforestation in the Amazon was linked to land reform, sustainable forest management projects were emerging; despite advances in biotechnology, only 7% of the Atlantic Rainforest remained preserved, and 7% of the Cerrado escaped intensive exploitation; while the environmental leader Chico Mendes was murdered by landowners in Acre, less than fifteen years later his closest associates would assume prominent political positions, such as the Ministry of Environment, the Senate and the Acre Government (Bezerra; Facchina; Gutierrez, 2002; Ventura, 2003).

Despite the observed dichotomy, Brazil has advanced considerably in the environmental area, achieving a remarkable change in its international posture towards the environment when it arrived in Johannesburg. Compared to the last three major UN conferences, the country demonstrated significant progress. In 2001, the Interministerial Commission for the Preparation of Brazil's Participation in the Summit on Sustainable Development was created. This commission included representatives from civil society, the academic and scientific communities, trade unions, and business entities. These diverse sectors worked together and offered practical and precise guidance for the necessary changes toward sustainable development (Lago, 2006). According to Lago,

> Due to the growing internal awareness of the scientific complexity and the economic and social implications of the environmental issue, a specific dynamic has been created, in which the Federal Government interacts with numerous other actors: the greatest demonstration of this was the careful elaboration of the Brazilian Agenda 21, presented in Johannesburg, the result of five years of work and consultations with more than forty thousand people[30] (Lago, 2006, p.136, free translation).

[30] Free translation of "Graças à crescente conscientização interna da complexidade científica e das implicações econômicas e sociais da questão ambiental, criou-se uma dinâmica própria, na qual o Governo Federal interage com inúmeros outros atores: a maior demonstração disso foi a cuidadosa elaboração da Agenda 21 brasileira,

The Commission's meetings resulted in the Latin American and Caribbean Initiative for Sustainable Development (known as ILAC), to be presented at the Summit, which incorporated a goal for an energy matrix with at least 10% renewable energy by 2010. To reaffirm the leadership, in 2002 the International Seminar Rio+10 was held with the presence of several political personalities, especially President Fernando Henrique Cardoso, President Thabo Mbeki of South Africa, and the Prime Minister of Sweden, Göran Persson, seeking to convey to the world public opinion the commitment of the three "host countries" of the United Nations environmental conferences with sustainable development.

The ILAC Proposal brought with it a series of guiding goals, covering vital areas such as biological diversity, the development of sustainable cities, social issues, economic and institutional aspects, as well as the efficient management of water resources (BRASIL, 2002a) – this last topic gained prominence during the second term of the FHC government and was analyzed in this thesis through ANA.

In the document, the topic explored the importance of water supply and presented several measures to deal with this challenge. One of them is the improvement of technology to increase the efficiency of water use in industry, agriculture, and domestic consumption. In addition, the introduction of modern seawater desalination technologies and the integration of coastal aquifer management to prevent saline intrusion are also proposed (BRASIL, 2002a).

Another aspect addressed is watershed management. The aim is to improve and strengthen the institutions responsible for the integrated management of watersheds and aquifers, through the establishment of watershed committees. These committees would count on the participation of representatives from all the subnational levels of government, civil society, the private sector, and other stakeholders (BRASIL, 2002a).

For the management of marine and coastal areas, action plans are proposed for the integrated management of coastal resources and ecosystems, with a special focus on Small Island Developing States. In addition, a comprehensive and integrated approach is sought for the management of the Caribbean Sea, through the development of a comprehensive strategy for its protection and management. Finally, the document highlights the need to improve the

apresentada em Joanesburgo, resultado de cinco anos de trabalho e consultas a mais de quarenta mil pessoas" (Lago, 2006, p.136).

quality of terrestrial waters. This includes improving effluent quality and reducing the discharge of pollutants into surface and groundwater bodies and the coastal zone (BRASIL, 2002a).

At the Summit, President Fernando Henrique Cardoso's speech in the Plenary reiterated the Brazilian priorities, mentioning the 10% goal of the Brazilian Energy Proposal, the creation of the largest tropical forest protection area in the world, the Tumucumaque National Park, and the Brazilian commitment to stop the global warming process and to avoid watching "passively the destruction of the Earth ecosystems (BRASIL, 2002b, p.105). According to FHC,

> We need to exploit natural resources rationally (...) It is essential to find a balance between economic prosperity, environmental protection, and social justice. There is only one possible answer: a new development paradigm. A paradigm that is based on the principle of common but differentiated responsibilities[31] (BRASIL, 2002b, p.105, free translation).

The Brazilian delegation played a crucial role in the inclusion of ILAC in the Implementation Plan. The discussion on renewable energy, amidst changing consumption and production patterns, generated divisions between developed countries and the Group of 77 and China. Despite this, the final text included paragraphs highlighting the importance of necessary changes in the global energy mix for the benefit of the environment. This inclusion was considered one of the most significant advances over Rio, given the complexity of the negotiations on this challenging issue. In addition, the text included other notable outcomes, such as targets for poverty eradication and the creation of a global solidarity fund for this purpose. Targets related to water, sanitation, health, hazardous chemicals, fisheries, and biodiversity were also established. Furthermore, the concept of partnerships between different social actors was reinforced to implement projects (Lago, 2006).

As for the actors, the participation of the productive sector in international discussions about sustainable development has been strengthened - a sector that has always had a protagonist role in the decisions of countries regarding their internal environmental policies. At the same time, NGOs strengthened and legitimized their role during the conference in Johannesburg. Not only were they integrated into the discussions within their organizations, but they also became members of several delegations. This inclusion allowed NGOs to be

[31] Free translation of “Precisamos explorar os recursos naturais com racionalidade. (...)É imprescindível encontrar o equilíbrio entre prosperidade econômica, proteção do meio ambiente e justiça social. Só há uma resposta possível: um novo paradigma de desenvolvimento. Um paradigma que esteja baseado no princípio das responsabilidades comuns mas diferenciadas” (BRASIL, 2002b, p.105).

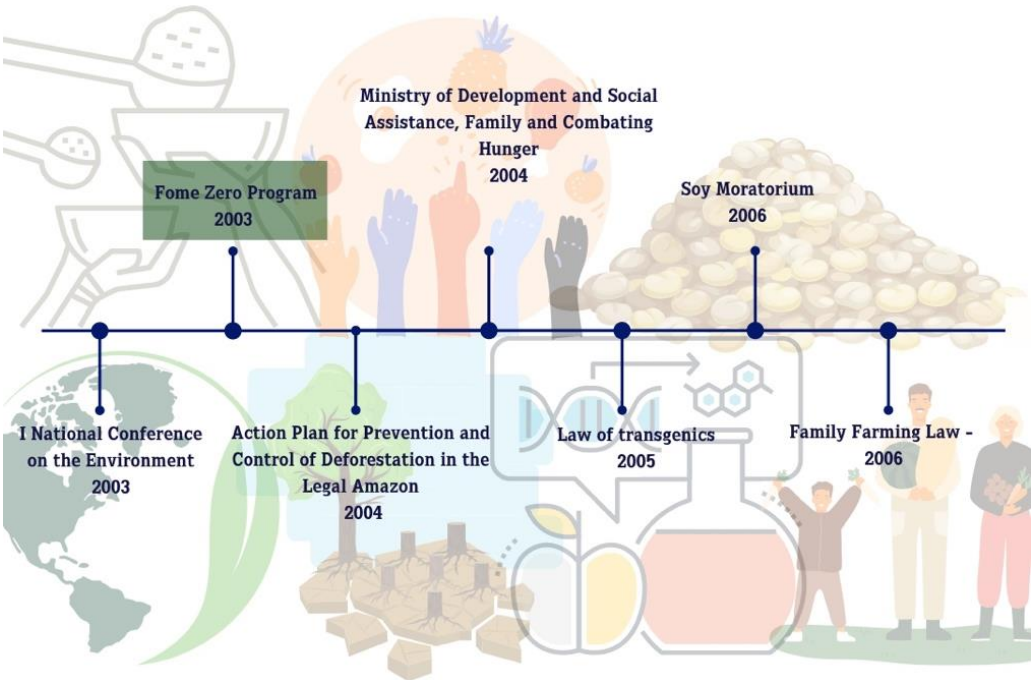
inserted into a more political dimension of the environmental issue, consolidating themselves in other ways (Lago, 2006).

Despite the notable advances in the dialogue between developing and developed countries that began at the Rio Conference, the transition from universal acceptance of the concept of sustainable development to the implementation of concrete actions did not occur at the same pace as the transition to a globalized world (Speth, 2003).

4.2 The Breakthrough

Between 2003 and 2006, Luiz Inácio Lula da Silva (Workers' Party, Portuguese acronym PT[32]) built a political agenda based on several initiatives and public policies aiming to reduce social inequality in the country (Figure 18). Thus, his first mandate placed considerable focus on food access for the population, strengthening food security. To explore this topic further, the Fome Zero Program was chosen to be analyzed in the scope of this thesis.

Figure 18 - Events during Lula's 1st term and the key-events chosen



Source: Elaborated by the author according to Fundação FHC (2023)

In 2003, then-President Lula gave an inaugural speech to the National Congress, saying: "If, at the end of my term, all Brazilians have the possibility of having breakfast, lunch and

[32] Partido dos Trabalhadores.

dinner, I will have fulfilled the mission of my life" (BRASIL, 2003a). This mission became the foundation for the conception and implementation of public policies by the Federal Government, which were based on four crucial aspects.

The first aspect was the tireless battle against hunger and poverty, a fight that became the top priority in the first years of the government. Therefore, the second aspect concerns the orientation that this battle had on macroeconomic policy, ensuring that the eradication of hunger was at the center of all decisions (Del Grossi *et al.*, 2019).

In addition, the third aspect relates to the development of a comprehensive food and nutrition security system, which aimed not only to provide meals but also to ensure that every citizen had access to nutritious and healthy food (Del Grossi *et al.*, 2019).

However, such a grand mission couldn't be accomplished in isolation. Thus, the fourth aspect concerns the mobilization of civil society around this cause. Lula's government strategy involved a set of structural actions involving four types of policies: 1) specific, giving citizens the power to buy food, food baskets and expanding school meals; 2) structural, including the generation of employment and income, incentives to family agriculture and scholarship programs; 3) family-based and community food security, encouraging rural communities to cultivate and trade food, and; 4) national, implementing the Fome Zero Program (Zero Hunger Program) still in 2003 (Del Grossi *et al.*, 2019).

The Fome Zero Program emerged as a key initiative of Lula's first government, with the intention of realizing his political agenda and based on the recognition of the human right to food as something universal and indispensable. To achieve this goal, the Lula government developed a comprehensive approach, combining social policies with structural economic changes, in collaboration with state and municipal governments. The core of the Fome Zero Program was built around five main points, which were designed to address the challenges of food security in Brazil. These points included: the intensification of agrarian reform, the strengthening of family farming, an emergency project aimed at living in the semi-arid region, a program against illiteracy, and an employment generation program (Takagi, 2010).

The intensification of agrarian reform, with the goal of redistributing and promoting access to land for more vulnerable farmers, aimed to strengthen family farming, a crucial sector for food security and sustainable rural development. Another important initiative was the project focused on the Semi-Arid, a region known for its adverse climatic conditions, which pose significant challenges to agricultural production. The Fome Zero Program had specific

strategies to address these adversities, such as access to water, soil conservation actions, and adapted agricultural practices (Takagi, 2010).

In addition, the Fome Zero Program also recognized the importance of education in the fight against hunger, dedicating a program to combat illiteracy and train farmers. Finally, the program included an employment generation initiative, which aimed to provide decent work opportunities and promote social inclusion by providing income generation in rural communities (Takagi, 2010).

At the end of Fernando Henrique Cardoso's first administration, the Ministry of Agrarian Development (Portuguese acronym, MDA[33]) was created, with the objective of dealing with issues related to family farming and agrarian reform, while the Ministry of Agriculture, Livestock and Supply (Portuguese acronym, MAPA[34]) was left in charge of corporate farming activities, that is, agribusiness. The constitution of these two ministries expressed "the Brazilian State's tense and conflictive recognition of the existence of these two types of agriculture that, although not independent in their dynamics, are carriers of antagonistic proposals for rural development"[35] (Leite *et al*., 2007, p.15).

It was during Lula's first government that the MDA underwent significant changes. Staff linked to social movements and unions became part of the ministry's management, which allowed for a greater influence of these organizations in the formulation and execution of public policies aimed at family agriculture. With the strengthening of the MDA, the II National Plan for Agrarian Reform (Portuguese acronym, PNRA[36]) was elaborated, which included an emergency settlement plan for 60 thousand families in camps, besides the recovery of settlements in precarious conditions, benefiting around 40 thousand families (Picolotto, 2014). However, it is important to point out that not everyone saw these changes in a positive way. Interest groups opposed to these policies did not support the strengthening of the MDA and the implementation of the PNRA.

If on the one hand, rural workers had greater visibility in public policies, on the other hand, ruralists viewed some of Lula's measures in an antagonistic way. Throughout Brazilian history, ruralism has remained an influential group both socially and politically. Private

[33] Ministério do Desenvolvimento Agrário.
[34] Ministério da Agricultura, Pecuária e Abastecimento.
[35] Free translate of "o reconhecimento tenso e conflitivo pelo Estado brasileiro da existência desses dois tipos de agricultura que, embora não sejam independentes em sua dinâmica, são portadores de propostas antagônicas de desenvolvimento rural" (Leite et al., 2007, p. 15).
[36] Plano Nacional de Reforma Agrária.

ownership of the land, as a value, became a guarantee of access to resources and representations of a rural elite in the political sphere, differentiating them from rural workers (Lima, 2016). However, it is not an equal representation, when we analyze the numbers: in 2001 in Brazil, there were more than six million landless farmers, or family farmers, compared to a total of 22 thousand large landowners (Del Grossi *et al.*, 2001) – and the average number of congress members linked to each social group corresponded to 10 and 93 respectively, in the period from 1995 to 2006 (Vigna, 2001; 2007).

During Lula's government, a political coalition of support was formed, including the ruralists, who are congressmen that represent the interests of the large landowners. However, even as part of this coalition, the ruralists organized themselves in the National Congress to investigate the activities of the social movements fighting for agrarian reform. This action gained prominence and became known as the Ruralist Front (Albuquerque, 2006; Lima, 2016; 2018).

The Ruralist Front is a political group that transcends parties, acting in favor of its sectoral interests. When a legislative proposal threatens these interests, the Parliamentary Front for Agriculture (Portuguese acronym, FPA[37]), the official organization representing the Ruralist Front, can hold a joint vote in Congress (Vigna, 2001; 2007, Lima, 2018). This political dynamic reveals the influence of the Ruralist Front and its ability to articulate forces within the government, even when they are part of a coalition. Their actions have a direct impact on the formulation of policies related to land and rural areas, which can generate conflicts with social movements involved in the struggle for agrarian reform.

One of the characteristics that support the persuasion of the Rural Front is its power to mobilize other political bases, allowing the articulation of alliances with other political actors, even if they are not directly interested in rural issues (Lima, 2018). At times of formal referrals in the formulation of laws, decisions in committees, or even votes in the plenary, ruralist parliamentarians use both lobbying and the exchange of favors and benefits, through a network of interests among elites in the National Congress (Barcelos; Berriel, 2009). According to Barcelos & Berriel (2009),

> (...) its ties of cooperation and reciprocity with other political parties sustain its vitality and institutional confidence. Its high political capillarity does not come from the absolute number of its members but from the ability to build new alliances, new institutional relations, and new codes of conduct and loyalty to other political parties or interest groups. Its approach to different parties is not the absence of ideology, but a political differential, a strategy of persuasion

[37] Frente Parlamentar da Agropecuária.

> and sympathy, a way to illustrate its "sensitivity" to the various issues of its interest[38] (Barcelos; Berriel, 2009, p. 17).

President Lula's public proximity to the Landless Workers' Movement (Portuguese acronym, MST[39]) led the Rural Front to mobilize an investigation, with the support of congressmen considered opponents of the Lula government, through a Mixed Parliamentary Inquiry Commission (Portuguese acronym, CPMI[40]), composed of members of the Federal Senate and House of Representatives to investigate important facts and in the public interest. Thus, between 2003 and 2005, the Land CPMI was installed, aiming to

> carry out a wide diagnosis on the Brazilian land ownership structure, the agrarian and urban reform processes, the workers' social movements (which have been promoting occupations of private and public lands, areas, and buildings, sometimes violently), as well as the landowners' movements (which, it is said, have been organizing themselves to prevent the occupations, sometimes violently)[41] (BRASIL, 2003b)

Several actors were mobilized in this chessboard (Figure 19) and their interests influenced the moves made during the Land CPMI.

[38] Free translaton of "seus laços de cooperação e reciprocidade a outras bancadas políticas sustentam sua vitalidade e confiança institucional. Sua alta capilaridade política, não se faz pelo número absoluto de seus parlamentares, mas na habilidade de construir novas alianças, novas relações institucionais e novos códigos de conduta e fidelidade a outras bancadas ou grupos de interesse. Sua aproximação com diferentes partidos não é a ausência de ideologia, mas um diferencial político, uma estratégia de convencimento e simpatia, uma forma de ilustrar sua "sensibilidade" frente às diversas questões de seu interesse" (Barcelos; Berriel, 2009, p.17).

[39] Movimento dos Trabalhadores sem Terra.

[40] Comissão Mista de Inquérito.

[41] Free translation of "realizar amplo diagnóstico sobre a estrutura fundiária brasileira, os processos de reforma agrária e urbana, os movimentos sociais de trabalhadores (que têm promovido ocupações de terras, áreas e edifícios privados e públicos, por vezes com violência), assim como os movimentos de proprietários de terras (que, segundo se divulga, têm se organizado para impedir as ocupações por vezes com violência)" (BRASIL, 2003b).

Figure 19 - Actors of the Land CPMI

Source: elaborated by the author according to BRASIL (2005), Lima (2016) and Gonçalves (2022)

Throughout forty-three meetings during its two years of operation, the Land CPMI was faced with at least three situations of national and international repercussion, involving some type of agrarian issue: the murder of the labor inspectors in Unaí[42]; the Felisburgo massacre[43], and the death of the missionary sister Dorothy Stang[44], who participated in the CPMI hearings in the state of Pará a year before her murder, in 2005.

In response to these events, the Land CPMI produced two reports, each bringing a different perspective. The first report, written by former federal deputy João Alfredo (Party of Socialism and Freedom, Portuguese acronym PSOL[45]), traced an overview of the struggles of social movements, addressing issues such as land ownership concentration, the monopoly of property that contributed to the rural exodus, poverty in the countryside, and the need for state

[42] In 2004, three labor inspectors and their driver were shot in the head with gunshots. The victims were employees of the Ministry of Labor and Employment and were inspecting the working and living conditions of bean harvesters in Unaí, in the state of Minas Gerais.
[43] Also in 2004, in the city of Felisburgo in Minas Gerais, five rural workers were murdered on orders of a farmer who hired 16 gunmen to attack the 230 families of the Terra Prometida camp, organized by the LWM, at the Nova Alegria farm.
[44] In 2005, the American missionary Dorothy Stang was shot dead by gunmen inside the Esperança Sustainable Development Project in Anapú, in the state of Pará.
[45] Partido Socialismo e Liberdade.

intervention. Moreover, the report highlighted violence as an illegal and illegitimate response to agrarian conflicts (Lima, 2018).

The second report, written by the deputy representing the Ruralist Front, Adalberto Lupion (from PFL), was structured around three main themes. First, it defended the recognition of the representativeness of social movements as legitimate actors in the democratic rule of law, as long as they had legal representation. On the other hand, it argued that the MST was illegal for not having such representation. Finally, it stressed the legal consequences of this illegality. The ruralist deputy's report was accepted by 12 votes to 1, ignoring the debate on Agrarian Reform and other issues directly related to the Brazilian land system (Lima, 2018). Despite the strong antagonism of Congress towards agrarian reform policies, as seen with the conclusion of the Land CPMI, the Fome Zero Program continued to strengthen through several actions launched in its scope, which will be detailed below.

One of the strategies adopted by Fome Zero to support family farming was the expansion of resources of the National Program for the Strengthening of Family Farming (Portuguese acronym, PRONAF[46]) nationwide, emphasing the Northeast of Brazil. During this period, the credit system was simplified, amounts were increased, and special credit facilities were created for young people, women, agribusiness, agroecology, agrarian reform settlers, and poor farmers. In addition, the government established the National System of Food and Nutritional Security (Portuguese acronym, SISAN[47]) through Law nº11.346/2006. Family farming was also legally recognized by Law nº11.326/2006, which defined the concepts, principles, and instruments for the formulation of public policies aimed at family farming and rural family enterprises (Del Grossi *et al.*, 2019).

Another important measure was the increased encouragement of income generation for poor farmers and the use of food surpluses, through Law nº10.696/2003, which established the Food Acquisition Program (Portuguese acronym, PAA). This program integrated economic and social policies, giving priority to the purchase of regional and community foods, as well as the local production of residents. PAA purchased food from farmers at fair market prices and distributed it to food-insecure urban families. This approach was effective in breaking two vicious cycles: unemployment in rural areas and hunger in urban (Del Grossi *et al.*, 2019). In addition, it has had a structural impact by creating new markets for family farmers (Sparovek *et al.*, 2007), increasing farm productivity (Chmielewska; Souza; Lourete, 2010), promoting

[46] Programa Nacional de Fortalecimento da Agricultura Familiar.
[47] Sistema Nacional de Segurança Alimentar e Nutricional.

collaboration with farmer associations and cooperatives (Mielitz, 2014) and boosting organic and agroecological food production (Galindo; Sambuichi; Oliveira, 2014).

In 2004, a merger of cash transfer programs targeting needy families occurred, resulting in the creation of Bolsa Família[48]. After the implementation of the program, it was found that about 93% of children and 82% of adult beneficiaries had access to at least three meals a day, thus ensuring a significant improvement in their nutrition and well-being. Moreover, this action contributed modestly to the reduction of income inequality and poverty (Soares; Sátyro, 2009). This initiative also had a positive impact on the transfer of income to women, as mentioned by Jannuzzi and Pinto (2013), and on the increase of prenatal care for beneficiary pregnant women compared to non-beneficiary women (Magalhães Júnior; Jaime; Lima, 2013).

Over the years, Fome Zero has proven its worth, bringing about surprising statistical changes that have echoed throughout the country. Among these changes, we can highlight a significant drop in the poverty rate. In 2003, about 35% of the Brazilian population lived in poverty, struggling to meet their basic needs. However, thanks to the work of Fome Zero, this number was reduced to less than 20% in 2010. Fome Zero has also been responsible for uplifting the lives of millions of Brazilians. More than 28 million people were able to leave the harsh reality of poverty and achieve a better life, and an additional 36 million Brazilians had the opportunity to rise into the middle class, enjoying greater economic and social stability (BRASIL, 2010a).

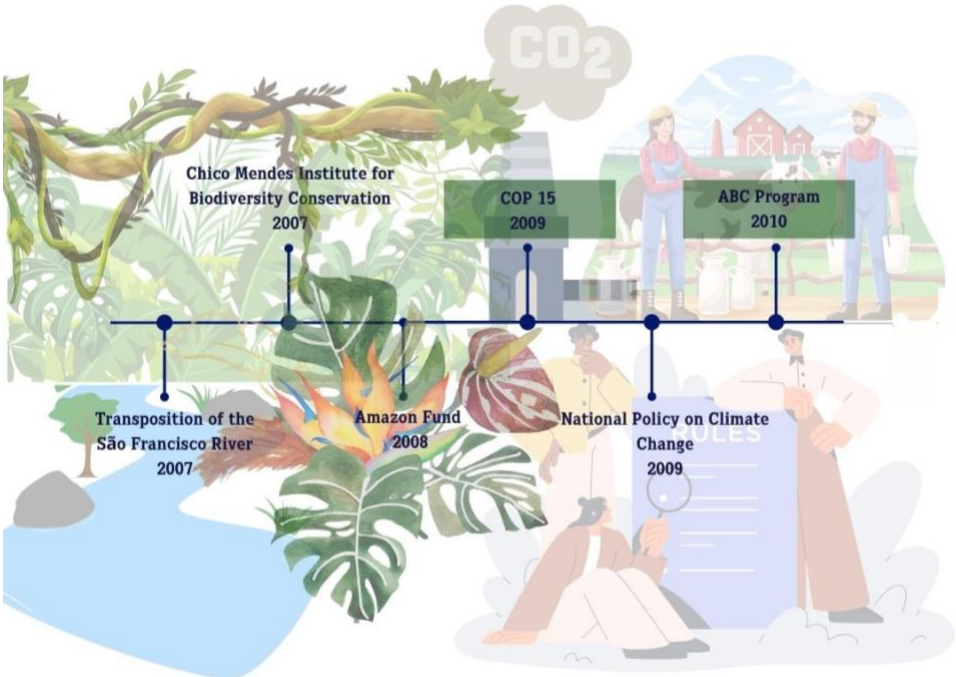
In addition to addressing poverty, Fome Zero also focused its efforts on food and nutritional security. And its actions have been recognized internationally. The indicators of the Food and Agriculture Organization of the United Nations (FAO), the International Fund for Agricultural Development (IFAD) and the World Food Programme (WFP) point to a reduction in the number of undernourished people in Brazil. This achievement was so significant that, in 2014, Brazil managed to remove its name from FAO's Hunger Map, showing the world that it is possible to win this battle (FAO *et al*. 2014).

[48] Bolsa Família is a program that guarantees basic income for families in poverty. The Program seeks to integrate public policies, strengthening families' access to basic rights such as health, education and social assistance. In addition, it seeks to act in complementary actions through articulation with other policies, such as social assistance, sport, science and labor (BRASIL, 2023b).

4.3 The ABC

In mid-2003, food security emerged as a central concern in Lula's government. However, starting in 2004, a new theme gained space on both the national and international agenda: climate and environmental issues, especially the alarming problem of deforestation. This theme gained such importance that it became the main foreign policy agenda of the government during its second mandate, evidencing a favorable stance towards the Triad. Now, let's take a closer look at Brazil's behavior in two crucial moments: COP 15 and the implementation of the ABC Plan. These initiatives cover both the climate issue and agricultural production, illustrating the comprehensive approach adopted by the Lula government (Figure 20).

Figure 20 - Events during Lula's 2nd term and the key-events chosen



Source: elaborated by the author according to Fundação FHC (2023)

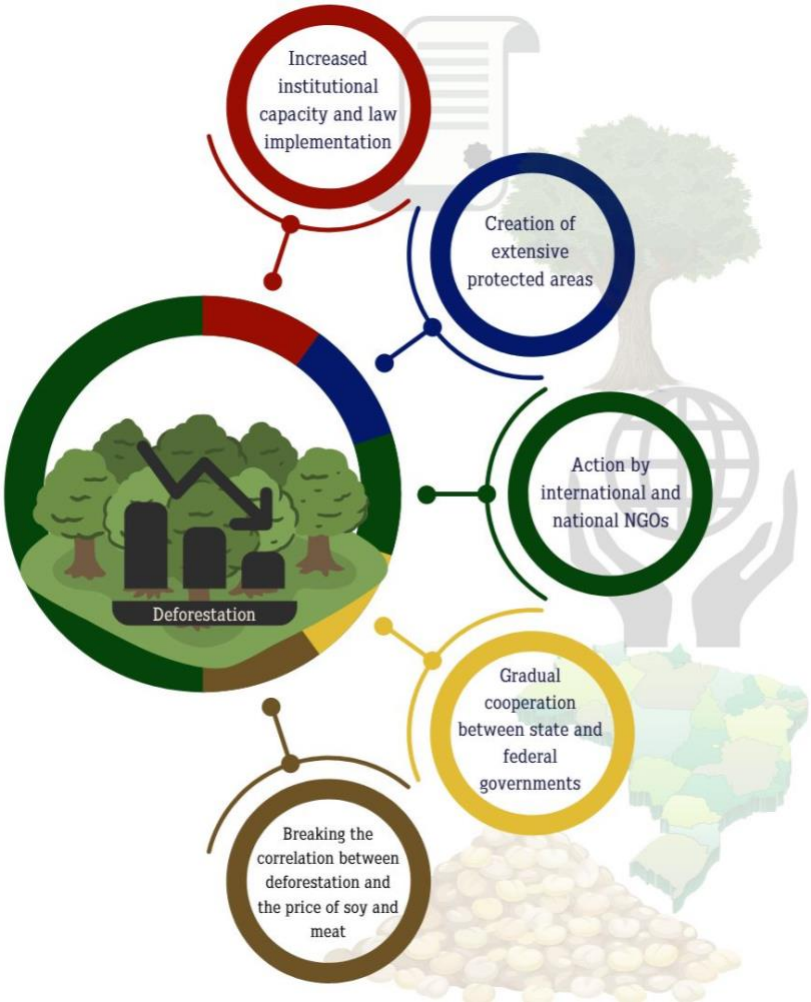
In recent decades, the use and management of natural resources as drivers of economic growth have been increasingly debated in both academic and political circles. An emblematic example of this debate can be observed in the Brazilian Amazon. In this region, throughout history, development has been strongly based on the extractivism of natural resources, such as rubber (*Hevea brasiliensis),* Brazil nut (*Bertholletia excelsa*), timber, ore, and the increased conversion of forests for agricultural and livestock use (Costa, 2012; Loureiro, 2015; Almeida, 2015; 2017; Silva *et al*., 2016; Castro; Andrade, 2016; Cruz, 2019; Cordani; Juliani, 2019; Fearnside, 2022).

With this, the Brazilian Amazon, with its rich biodiversity and the impressive extent of primary forest, which represents 35% of the world's total (FAO *et al*., 2014), constantly arouses the attention of researchers and government authorities. Deforestation in this region has been an object of concern, leading to the search for measures and policies that address both its monitoring and its control. In addition, Amazon deforestation has been widely discussed in relation to its causes and consequences of global climate change. This is because most of the greenhouse gas emissions in Brazil are related to the release of carbon dioxide (CO_2) from land use change and deforestation[49] (BRASIL, 2016c).

Throughout the 1990s, annual deforestation rates kept at a fast pace, averaging about 17 thousand km^2 per year, reaching 27 thousand km^2 in 2004 (Soares-Filho *et al.*, 2009). However, in the period from 2005 to 2009, this average decreased to approximately 12 thousand km^2. This significant decline had a notable impact on the reduction of GHG emissions in Brazil, since uncontrolled deforestation is the main source of emissions in the country, representing about 25% of the total (Moutinho, 2009). But in the Brazilian case, the reduction in deforestation occurred due to the conjunction of some specific factors (Figure 21).

[49] Understood as the conversion of forests into areas for other purposes, such as pasture, agriculture, or another form of land use.

Figure 21 - The five topics that decrease deforestation



Source: elaborated by the author according to Viola (2010)

Several actors played a key role in this context. First, national agencies strengthened their institutions and implemented laws to combat deforestation by coordinating monitoring, and enforcement activities. In addition, the federal government created extensive protected areas such as national parks, ecological stations, and ecological reserves. NGOs, both national and international, played an important role in raising public awareness through an intensive campaign and contributed to the moratorium on the purchase of cattle and soy from deforested areas.

State governments also gradually began to cooperate with the federal government in controlling deforestation. Finally, there was an economic paradigm shift that decoupled deforestation from soy and meat prices, unlike in other countries where the reduction of emissions led to an economic collapse. In Brazil, the economic growth rate was 3.5% per year, exceeding the historical average of the previous two decades (Viola, 2010).

Before 2009, public policies to address climate change were extremely limited. The agencies responsible for dealing with climate change, such as the Ministry of Science and Technology and the Ministry of Environment, received very scarce resources for this purpose. Furthermore, the 2007 Pluriannual Plan[50] did not allocate significant resources for climate change mitigation and adaptation measures. It was only in 2008 that advances began to occur in relation to the theme in Brazilian legislation, when the Executive Power sent a Climate Change Law to Congress. However, this law did not adequately address the issue of climate change in public policies (Viola, 2010).

In turn, the National Policy on Climate Change (Portuguese acronym, PNMC[51]) was only instituted at the end of 2009, after the COP 15, in Copenhagen. COP 15 took place in December 2009, as result of a two-year negotiation process on a new climate agreement to replace the Kyoto Protocol and incorporate the key objectives set out in the Bali Action Plan. The broad process aimed at the full, effective and sustainable implementation of the Convention through long-term cooperative action, covering the period up to and beyond 2012, with the goal of reaching an agreed outcome and taking a decision. It addresses five main categories: shared vision (including a long-term goal for emission reductions), mitigation, adaptation, technology, and financing (UNFCCC, 2007).

The Bali Plan was incredibly ambitious and received important additions during COP15. It raised the political level of climate change discussions, boosted negotiations on the infrastructure necessary for global cooperation in this area, and resulted in the Copenhagen Accord (Motta, 2010), which was outlined in three main objectives: 1) developed countries to make more ambitious commitments and targets, aiming for reductions of up to 40% by 2020 and 80% by 2050; 2) developing countries to voluntarily contribute with monitorable, reportable and verifiable actions; and 3) developing countries to provide financial resources to finance these voluntary actions and provide adaptation assistance (UNFCCC, 2007).

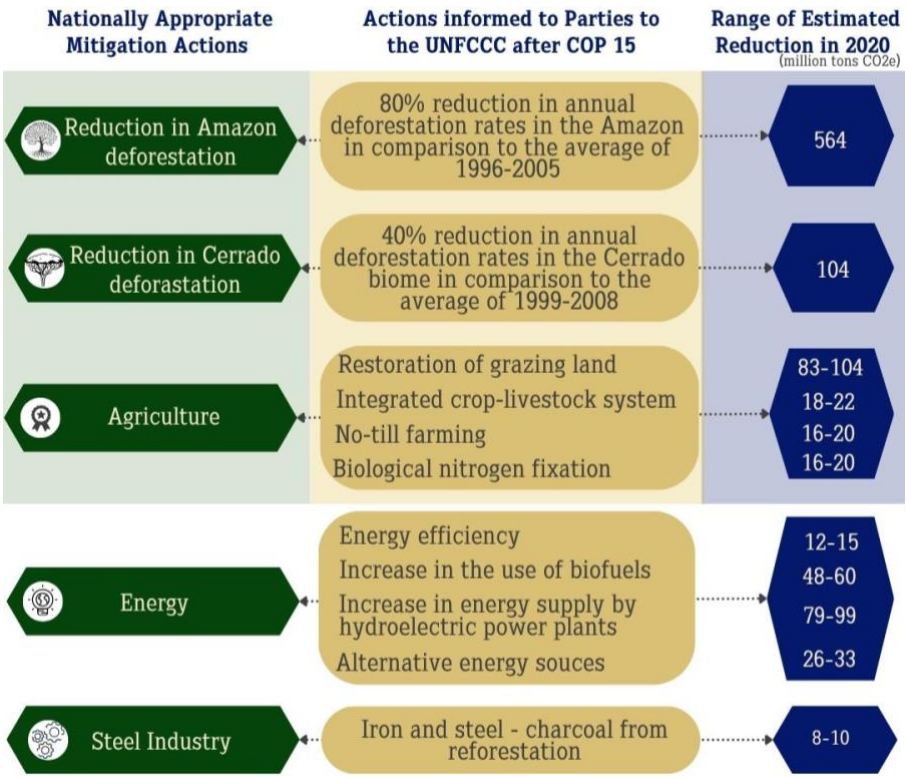
However, the results of COP 15 fell far short of the goals set. A new binding agreement for all participants was not reached, resulting only in the signing of the so-called Copenhagen Accord. In this agreement, however, the commitment to limit temperature increase to 2.0°C was reaffirmed, along with the requirement for national emissions reports every two years. In

[50] The Pluriannual Plan is a medium term plan provided in Article 165 of the Federal Constitution, which establishes the guidelines, objectives and goals to be followed by the Federal, State or Municipal Government, with the purpose of enabling the implementation of its Programs (BRASIL, 2023a).
[51] Política Nacional sobre Mudança do Clima

addition, signatories were called to submit their proposals for commitments announced during the conference by January 31, 2010 (Motta, 2010).

As for Brazil's behavior, it is possible to state that the country played a prominent role in this conference. During his speech, President Lula presented Brazil's voluntary commitment to reduce greenhouse gas emissions by 36.1% to 38.9% by 2020 (Malerba, 2011). This goal was transformed into Law nº12.187/2009 by the Brazilian Senate in December of that year and sanctioned in January 2010. In addition, the Brazilian government communicated to the Climate Convention Secretariat in January its NAMAS[52] (Figure 22), that is, nationally appropriate mitigation actions.

Figure 22 - NAMAs presented by Brazil



Source: elaborated by the author according UNFCCC (2010)

When the PNMC was approved by the National Congress (Law nº12.187/2009), the national targets announced at COP 15 were officially confirmed. In addition, the PNMC indicated the economic instruments that would be used to promote these goals, such as credit and fiscal mechanisms, as well as the carbon market.

[52] The NAMAS is a reference to the idea that a given country's response must be within its capabilities and a reflection of its historical emissions. In practice, NAMAS can be a goal, a strategy, a program or policy, a project, or concrete actions.

In this context, it was established that the Executive, in line with the PNMC, would be responsible for establishing the sectoral plans for mitigation and adaptation to climate change. These plans aimed to consolidate a low carbon economy in various sectors, such as power generation and distribution, urban public transportation and interstate passenger and cargo transportation systems, manufacturing industry and durable consumer goods, fine and base chemical industries, paper and cellulose industry, mining, civil construction industry, health services, and agriculture and cattle raising. Within these sectors, it was necessary to meet gradual targets for the reduction of anthropic emissions that could be quantified and verified, considering the specificities of each one of them. For this, the Clean Development Mechanism (CDM) and the NAMAs were established as tools to drive such emission reductions (BRASIL, 2009).

On December 9, 2010, an important decree was published, Decree 7.390. This decree regulated Articles 6, 11 and 12 of the PNMC. At the agricultural level, it established the creation of a plan called the ABC[53] Plan (Low Carbon Agriculture). This initiative is a public policy that details the actions to mitigate and adapt to climate change in the agricultural sector. Furthermore, the plan indicates how Brazil intends to fulfill its commitments to reduce greenhouse gas emissions in this sector. The ABC Plan was elaborated in a participatory way, involving more than 30 meetings and the formation of a Working Group (WG) coordinated by the Ministry of Agriculture, Livestock and Supply and the Civil House of the Presidency. Initially, the WG was composed of representatives from the federal government, the Brazilian Agricultural Research Corporation (Portuguese acronym, Embrapa[54]), the Ministry of Agrarian Development, the Ministry of Finance, the Ministry of Science and Technology and the Ministry of Environment (BRASIL, 2012).

Later, the WG was expanded to include representatives of organizations appointed by the Brazilian Forum on Climate Change (Portuguese acronym, FBMC[55]) and the Climate Observatory. Among these organizations are the Confederation of Agriculture of Brazil (Portuguese acronym, CNA[56]), the National Confederation of Agricultural Workers (Portuguese acronym, CONTAG[57]), the Organization of Cooperatives of Brazil (Portuguese

[53] Agricultura de Baixo Carbono.
[54] Empresa Brasileira de Pesquisa Agropecuária.
[55] Fórum Brasileiro de Mudança do Clima.
[56] Confederação da Agricultura e Pecuária.
[57] Confederação Nacional dos Trabalhadores na Agricultura.

acronym, OCB[58]), the Central Workers Union (Portuguese acronym, CUT[59]), the Institute of Socioeconomic Studies (Portuguese acronym, INESC[60]), Conservation International and the World Wildlife Fund (WWF) - Brazil. In addition, representatives of entities from the productive sector directly linked to the programs also participated, such as the Brazilian Federation of Planting Directly in Straw (Portuguese acronym, FEBRAPDP[61]), the Brazilian Association of Planted Forest Producers (Portuguese acronym, ABRAF[62]), the National Association of Producers and Importers of Inoculants (Portuguese acronym, ANPII[63]) and Itaipu Binacional (Mozzer, 2011; BRASIL, 2012).

During the conception of the ABC Plan, a joint effort took place between 2010 and 2011 to design an ambitious plan capable of transforming agriculture and addressing the environmental challenges of the time. It was a period of thorough analysis and adjustments to the agricultural commitments originally established at COP 15.

The result of this dedication was the creation of seven main actions, each bringing with it a promise of regeneration and sustainability: the Recovery of Degraded Pastures, the adoption of Crop-Livestock-Forestry Integration System (ICLFS) and Agroforestry Systems (AFs), the No-Tillage System (NTS), Biological Nitrogen Fixation (BNF), the establishment of Planted Forests, the Treatment of Animal Waste, and Adaptation to Climate Change (BRASIL, 2012).

Imagine a vast expanse of pasture, once vigorous and productive, now degraded and unable to recover naturally. This is the worrying scenario that the ABC Plan's Recovery of Degraded Pastures action proposes to change. Through proper management and correct fertilization, 15 million hectares of these suffering lands have the chance to return to their vitality and, in addition, reduce CO_2 emissions, contributing to the planet's health (BRASIL, 2012; 2016a).

Additionally, an ingenious strategy emerges that unites agriculture, livestock, and forests in a harmonious dance of intercropping. ICLFS is a sustainable approach that not only restores degraded areas, but also promotes income generation, adoption of good farming practices, and improves social conditions. Moreover, its embrace of nature helps reduce

[58] Organização das Cooperativas do Brasil.
[59] Central Única dos Trabalhadores.
[60] Instituto de Estudos Socioeconômicos.
[61] Federação Brasileira de Plantio Direto na Palha.
[62] Associação Brasileira de Florestas Plantadas.
[63] Associação Nacional dos Produtores e Importadores de Inoculantes.

greenhouse gas emissions, providing a greener future. The Plan's proposal is to increase the adoption of ICLFS and AF systems by 4 million hectares (BRASIL, 2012; 2016a).

NTS refers to technological processes used in the exploitation of productive agricultural systems. It involves adequate soil mobilization, constant maintenance of vegetation cover, diversification of species, and the reduction or elimination of the interval between harvest and sowing. This system contributes to soil and water conservation, increases the efficiency of fertilization, and mitigates GHG emissions. The Plan's proposal is to expand the use of NTS by 8 million hectares (BRASIL, 2012; 2016a).

The expansion of BNF by 5.5 million hectares is also a proposal of the ABC Plan. Agricultural production depends significantly on the supply of nitrogen (N_2). Biological nitrogen fixation is an essential process for maintaining life on the planet and plays a strategic role in agricultural sustainability. In addition to contributing to the reduction of GHG emissions, BNF also increases the organic matter content in the soil, promoting carbon sequestration, and improves soil fertility (BRASIL, 2012; 2016a).

Another action proposed by the ABC Plan is to increase the area allocated to Planted Forests, currently used for the production of fibers, wood and cellulose. The intention is to expand this area by 3.0 million hectares, from 6.0 to 9.0 million hectares. The establishment of planted forests on rural properties not only provides a source of income for the families of producers, but also reduces the pressure on native forests and contributes to the capture of CO_2 from the atmosphere (BRASIL, 2012; 2016a).

The proper disposal of waste and effluents resulting from the creation of stabled animals is another crucial factor for the environmental sustainability of the properties. The proper treatment of these effluents contributes to the reduction of methane emissions. The ABC Plan proposes to expand the use of treatment technologies for 4.4 million m^3 of animal waste to generate energy and produce organic compost (BRASIL, 2012; 2016a).

Finally, changes in temperature and rainfall distribution patterns can have significant consequences on the cycle of crops and vegetation, resulting in smaller harvests and lower quality products. To deal with the consequences of climate change, the ABC Plan promotes diversified systems by making sustainable use of biodiversity and water resources, helping to adapt to climate change (BRASIL, 2016a).

In the context of climate change, the agricultural sector plays a strategic role due to its need to expand production to meet present and future demands for food. However, this

expansion should not contribute negatively to increased GHG emissions or result in the loss of native vegetation areas, compromising environmental sustainability (Mozzer, 2010).

To solve this dilemma, it is necessary to modify practices and processes in the agricultural and cattle-raising sector, aiming to gradually increase the efficiency of production systems and the sustainable use of agricultural land. The ABC Plan aims to promote this transition by replacing the traditional, extensive, and inefficient model of livestock farming with a more efficient model that makes better use of the soil and helps reduce GHG emissions (Mozzer, 2010).

Brazil seeks to face the challenges of global climate change, ensuring the competitiveness and efficiency of national agribusiness, both through its position in the international arena and through the development of local policies, programs and practices. NTS actions, ICLFS and BNF, are already practices in Brazil resulting from our development in agricultural research (Mozzer, 2010).

Although there was a reduction in Brazil's emissions between 2005 and 2010 due to measures to control deforestation, emissions increased again in 2010. This time, the rates were no longer driven by deforestation, but by significant growth in other economic sectors. In 2005, deforestation and land use change accounted for 60% of emissions, while agriculture accounted for 18.9%, the energy sector for 15%, industry for 3%, and waste for 1 percent. In 2010, deforestation contributed 35% of emissions, the energy sector 32%, agriculture 25%, industry 5% and waste 3% (Viola; Franchini, 2011; Malerba, 2011).

The analysis carried out so far has shown us the political and environmental landscape of Brazil during the period between 2001 and 2010 through key-events. In the first part of the chapter, during the Fernando Henrique Cardoso government, the country took significant steps to improve water resources management by creating the National Water Agency. From a global perspective, Brazil was involved in international environmental conferences, such as Rio+10, demonstrating a commitment to sustainability and the search for renewable energy.

In the second part, under the leadership of Luiz Inácio Lula da Silva, the Fome Zero Program stood out as a key initiative to address hunger and poverty, promoting food security, and strengthening family farming. Attention to the environmental issue has also deepened, with significant efforts to combat deforestation in the Amazon and reduce greenhouse gas emissions in the agricultural sector through the ABC Plan.

Chapter 4 highlights the evolution of Brazil's socio-environmental policy during the first decade of the 21st century. The country played an active role in international conferences, committing to sustainability goals and reducing inequalities. The Gambit represented the search for balanced development, where economic growth could be achieved without being at the expense of environmental degradation and social marginalization.

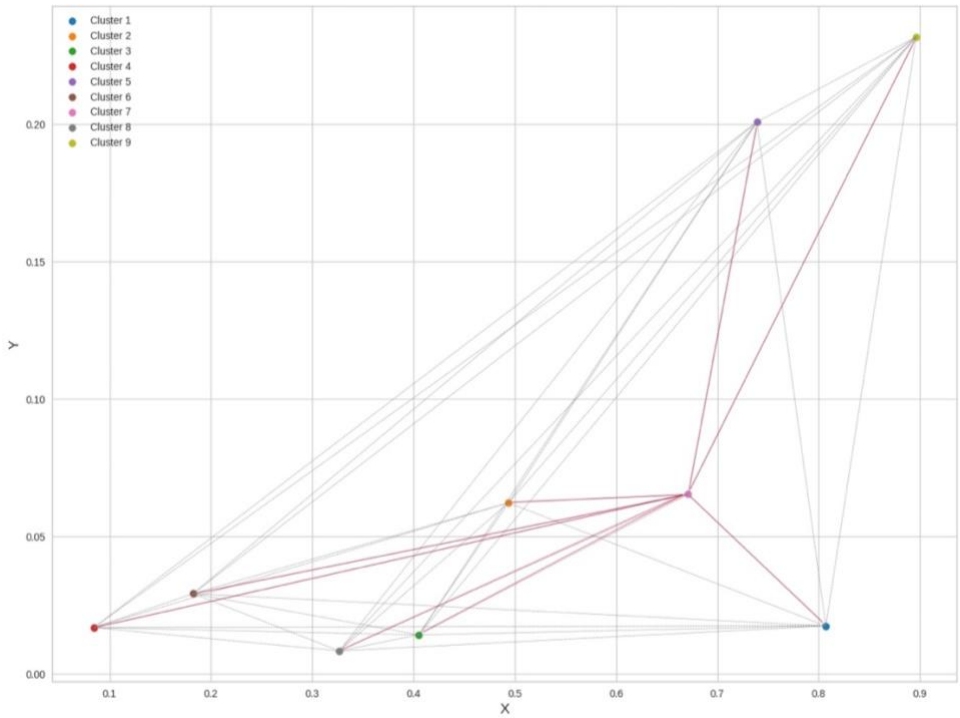
The following section will conduct a more in-depth analysis of the data clusters from 2001 and 2010, validating the discussion in Chapter 4. This analysis will allow us to understand the trends and patterns that emerged over the period and how they relate to the policies and actions implemented by Brazil. In this way, it is possible to investigate the areas where there has been the most success in this pursuit and where there are still challenges to be addressed.

4.4 Building Captain Triadic

To quantitatively evaluate the trade-offs among Triad spheres, the data between 2001 and 2010 were clustered. Before applying the K-means algorithm to obtain the clusters, the data were standardized using the MinMaxScaler technique (Pedregosa *et al.*, 2011). This process is advantageous because it ensures that all variables have the same scale, thus preventing characteristics with higher values from dominating the clustering process over others with lower values. With the standardized data, we have a more balanced analysis of the similarity between the variables and the identification of the groups that best reflect the structure of the data. Thus, K-means can be applied, and clusters created.

Nine clusters were observed. By analyzing the distance among the clusters' centroids, we calculated the distances between the centroids of each cluster and used this information to understand how the groups are dispersed in space. Each cluster is represented by a point on the Cartesian plane, where the X-axis corresponds to the first value (coordinate) of the cluster and the Y-axis corresponds to the second value (coordinate) of the cluster. This technique is useful to identify overlapping clusters, well-separated clusters, or if there is any specific pattern in the distribution of the groups. Analyzing the scatter plot (Graph 1), we can observe how the clusters are distributed and delimited in space, as well as the links between them - inserted through the red lines of the graph.

Graph 1 - Distances Between Centroids from 2001 to 2010



Source: elaborated by the author

The distance among the clusters' centroids showed remarkable proximity to each other, despite having distinct and well-defined spaces. This finding points to a significant connection and linkage between the clusters, suggesting a possible convergence of interests. In the context of the thesis, this first analysis is extremely relevant, as it indicates a high probability of confirmation of the hypothesis.

By deepening the analysis, it was possible to identify that the clusters' connection is directly related to the most representative variables in each of them. These variables proved to be defining elements of the direction of the clusters in three specific categories: Food Security, Climate Change & Agriculture. In other words, each of the 9 clusters had a deeper connection with a specific sphere of the Triad, as shown in Chart 4. However, it is important to note that all clusters were also related in some way to other spheres of the Triad.

Chart 4 - Predominant aspects of clusters

Cluster	Triad Spheres	Most Representative Variables
7	**Food Security**	• Bean area • Manioc area • Gini Index • Wheat productivity • Manioc production
6	**Food Security** Agric. & Livestock	• Corn production • Bean Production • Corn area • Wheat production • Wheat area
9	**Food Security** Agric. & Livestock	• Wheat_area • Gini Index • Wheat_production
1	**Food Security** Agric. & Livestock	• Dairy cattle head • Dairy cattle production • Degraded pasture area • Pasture area
2	**Agric. & Livestock** Climate Change	• Beef cattle head • Agric. & Livestock Emissions • Beef cattle production • Pasture area
5	**Agric. & Livestock** Climate Change	• Beef cattle head • Beef production • Soy production • Agric. & Livestock Emissions • Soy area • Degraded pasture area
8	**Climate change** Agric. & Livestock	• Sorghum area • Temperature • Soy area • Sorghum productivity
3	**Climate change**	• GDP • Sugarcane area • Gini Index • Sugarcane production
4	**Climate change** Food security	• Rice production • Rice area • Temperature

Main connections

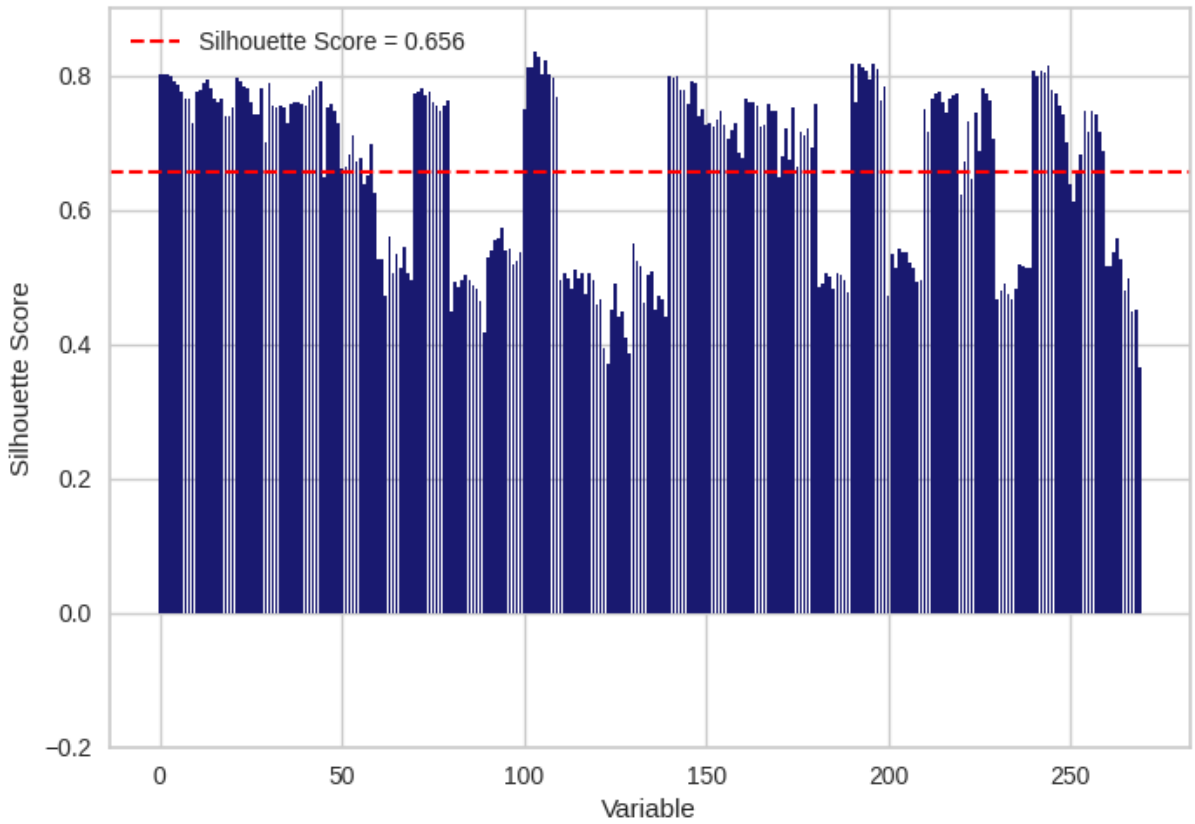
Source: elaborated by the author

Within the clusters analyzed, Cluster 7 stood out as a driver of the others, strengthening the conclusions presented in the previous sections and also being confirmed by the centroid analysis. This result reinforces the relevance of this cluster in the overall structure of the data and highlights its central role in the context of the analysis.

However, in order to validate the quality of the data and the clustering performed, the distance analysis between the centroids was complemented by another validation metric, for a more complete evaluation of the performance of the clustering algorithm and the interpretation of the groups found. For this, we used the metric known as silhouette score, which varies between -1 and 1, with values close to 1 suggesting that the samples are well-adjusted to their clusters.

The graph generated by the silhouette score presents a series of a vertical bars, representing each sample of the standardized dataset (Graph 2). The height of each bar indicates the value of the silhouette coefficient corresponding to the sample, which helps us understand how well each sample fits its own cluster relative to the other clusters.

Graph 2 - Silhouette Score from 2001 to 2010



Source: elaborated by the author

For the period under review, the value found for the silhouette score was 0.656. This value indicates that the clustering performed satisfactorily and that the groups identified are coherent and meaningful. The analysis of the silhouette score provides an objective measure of the quality of the results obtained in the research carried out, providing quantitative measurements of the quality of the clusters, and helping to make more informed decisions about the appropriate number of clusters and the validity of the clusters found.

This detailed analysis highlights the complexity of the cluster relationships, highlighting how each group is related to different aspects of the Triad. This deeper understanding of the patterns of proximity and interconnectedness provides valuable insights into the dynamics of the data and the diversity of existing interests and interrelationships studied in this Chapter. Moreover, the identification of the specific spheres to which each cluster is most aligned allows for a better contextualization of the results, contributing to a better grounded and more complete

analysis of the present study. The proximity of the clusters shows that they are considerably linked to each other, even though their spaces are very well delimited. Translating this information into the thesis, this first analysis shows a high probability of convergence among the clusters, with a possible convergence of interests.

Clusters 7, 6, 9, and 1 have a strong relationship with Food Security and are partially linked to the Agriculture sphere due to their economic value. These data shows a connection with socioeconomic development, revealing important trade-offs during the analyzed period between socioeconomic development and food security.

This group of clusters is related to the key event explored in this section, Fome Zero, and can be explained by the PAA, which combines stimulating food production with local consumption (Mattei, 2007a). In 2014, the PAA was recognized worldwide for fighting hunger by reducing the proportion of the population suffering from it by half (FAO *et al.*, 2014).

The PAA operates in six modalities: Purchase with Simultaneous Donation, Direct Purchase, Support for Stock Formation, Incentive to Milk Production and Consumption, Institutional Purchase, and Seed Acquisition, by purchasing food from family farming and allocating it to people in situations of food and nutritional insecurity, also contributing to the constitution of public stocks of food produced by family farmers (BRASIL, 2023c).

In addition, the PAA strengthens local and regional marketing circuits, values biodiversity and organic and agroecological food production, encourages healthy eating habits, and stimulates cooperativism and associativism (BRASIL, 2023c). With the PAA, the purchase of food considers the locality and the prices set by the government, ensuring greater freshness, nutritional quality, and rescue of local cultures (Xavier, 2017). Several benefits are observed in some research shown next.

The reports of Hespanhol (2013) in São Paulo show the benefits of the PAA for social entities benefited. By adhering to the program, they were able to offer more diversified meals and save on food expenses, since the food provided by the PAA was more nutritious and varied than that obtained by bidding. Another study conducted by Mattei (2007b) showed that the implementation of the PAA had a positive impact on school attendance, thanks to the improvement of the food offered, in the state of Santa Catarina. Regarding PAA-milk, Ortega, Jesus & Só (2006) found that the supply of milk by the program resulted in a 51% increase in children's attendance and a 48% increase in students' school performance in the state of Bahia.

Cunha, Freitas & Salgado's (2017) research in Minas Gerais showed multiple benefits of the programs, including increased production, work, and income in the economic aspect, as well as productive diversification and access to new markets. At the social level, there was a strengthening of local associative organizations, expansion of institutional relations, and greater involvement of families in production. In addition, the promotion of pesticide-free production, as observed by Grisa *et al*. (2019), encouraged the growth of planted areas, benefiting both producers and the environment.

Maize plays a significant economic role in Brazil, being used from animal feed to high-tech industries. For small-scale producers, maize also has social relevance, being fundamental to support their families. About 59.84% of producers consume the maize grown on their properties. This duality in production is remarkable, with small producers focusing on subsistence and a minority of large producers investing in technology and productivity for high-yield commercial production, highlighting the importance of maize for the Brazilian economy and society in different agricultural contexts (Cruz *et al.*, 2011).

If on the one hand, Food Security was the focus of this period, at the same time the gaze also turned to Agricultural interests. Clusters 2 and 5 have as main variables beef cattle and soybean production, central components of the Triad's Agriculture sphere. However, these clusters also have variables related to Climate Change, such as greenhouse gas emissions and degraded pastures.

During the 2000s, Brazil became a major exporter of beef due to internal changes in the production chain and external factors that reduced supply in other countries. These transformations impacted Brazilian trade relations in the beef market (Sanguinet *et al.*, 2013). Additionally, the growing global demand for food has increased the expansion of agriculture, raising GHG emissions and making this sector vulnerable to global warming. In both clusters, it is possible to observe the variables related to pasture (area and degradation) and GHG emissions by the sector. In the context of food security, mitigating GHG emissions would then be strategic - and the beef cattle subsector in Brazil has great mitigation potential (Assad, 2016).

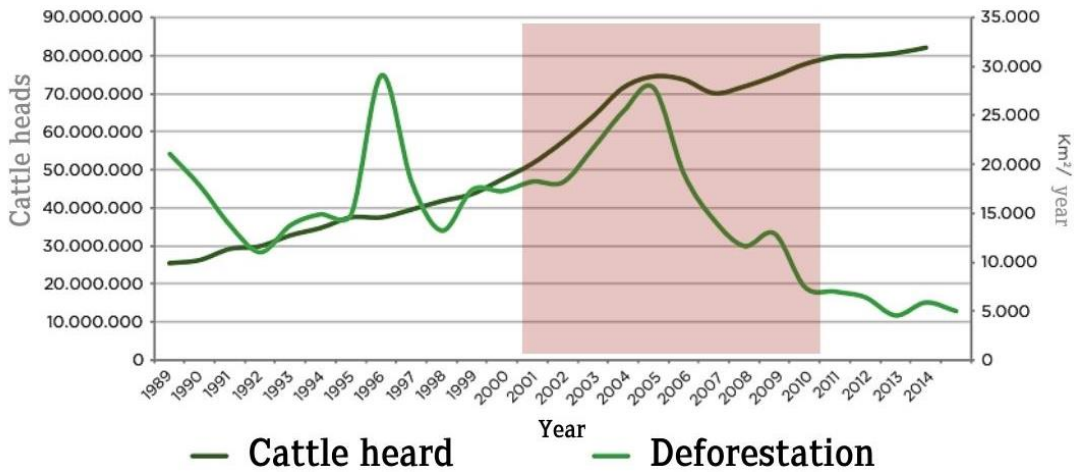
For this, the integrated production system, such as Crop-Livestock-Forestry Integration and Crop-Livestock Integration, offers advantages for livestock and crops. This integration provides a faster economic return, productivity recovery, improved soil structure, and nutrient cycling, increased animal production carrying capacity, and better soil conservation. In addition to increasing meat and grain production, reducing deforestation and problems of erosion and

fires, integrated systems contribute to improving social and economic conditions on properties, encouraging the adoption of good agricultural practices and compliance with environmental legislation, thus valuing the environmental services of agroecosystems (Balbino; Martinez; Galerani, 2011; Assad, 2016).

The analysis of data on cattle ranching in the Amazon state of Rondônia revealed a significant leap in its sustainability compared to other Amazon states. The state experienced a high gain in the share of the regional herd, while registering a sharp reduction in the regional deforestation (Caviglia-Harris, 2005; Browder *et al*., 2008; Mangabeira, 2010). This reflects an efficiency gain for the state in the conservation/livestock trade-off, a win-win strategy, as it would allow increased production in consortium with reduced deforestation (Vale; Andrade, 2012).

The increase in total carcass weight in relation to herd growth evidenced a jump in productivity, with carcass weight growing more than seven times compared to just over two times herd growth. To This combining data on deforestation in the Legal Amazon with geoinformation on the increase in cattle herds in the region, Assad (2016) shows that, since 2004, there has been an inverse trend in the increase in the number of animals and the representativeness of the national herd – a reduction in the rate of deforestation, contrary to what occurred in the previous decade (Graph 3).

Graph 3 - Evolution of cattle herd and annual deforestation in the Legal Amazon between 1988 and 2014



Source: adapted by the author according to Assad (2016) with data from INPE (2015; 2023) and IBGE (2015)

When analyzing these achievements, it is worth mentioning that Brazil has played a relevant role in the global scenario of GHG emissions. Between 1995 and 2004, the country was responsible for 6% of global emissions, mainly due to deforestation in the Amazon, but

reduced this figure to 3.8% in 2012. This 41% reduction in Brazilian emissions between 2005 and 2012 happened while the country registered a 32% growth in Gross Domestic Product and lifted 23 million Brazilians out of poverty (Aubertin; Jesus, 2021). This change in direction may be related to several factors, including a new environmental and economic situation in the country, stricter laws against deforestation, and competition with the advance of grain agriculture.

As for grains, the presence of soybeans in this set of clusters also draws attention, due to the discussion on transgenics (genetically modified organisms, GMOs) that occurred during this period. Transgenic seeds are those that have genes taken from different species and inserted directly into their genetic material, with the purpose of developing plants with specific desirable characteristics, such as resistance to insecticides or water stress. Their development is driven by both the pursuit of scientific advances and the strengthening of global economic structures. These seeds have rapidly become popular, especially in corn, soybean, and other crops, seen as a necessary solution to feed the growing world population in the coming decades (Lacey, 2000).

In Brazil, the regulation of GMOs is done through provisional measures, which have the force of law and have been used several times to amend laws already passed. The main objective of these measures was to legalize GMOs crops that were illegal, thus facilitating the increased cultivation and use of these plants in the country. More than half of the rules created are related directly or indirectly to these provisional measures (Camara; Nodari; Guilam, 2013).

Since the approval of Law nº11.105/2005, the National Technical Biosafety Commission (Portuguese acronym, CTNBio[64]) has been responsible for authorizing the release of GMOs in Brazil. Fernandes & Assunção (2017) point out that there was a lack of a biosafety policy with clear guidelines and defined objectives, making the lack of transparency and effective participation mechanisms an obstacle to the adequate performance of the Commission. The absence of the State in the inspection of illegal GMOs plantations and the lack of accountability for environmental or health damage resulting from the use of GMOs are also issues pointed out by Fernandes & Assunção (2017).

In addition, the contamination of conventional and organic crops by transgenic seeds was a problem pointed out, which could make organic production unfeasible. The minimum distance established by CTNBio for the isolation of genetically modified commercial crops

[64] Comissão Técnica Nacional de Biossegurança.

does not guarantee coexistence with other varieties, and studies indicate that contamination by transgenic pollen can occur at greater distances than established (Fernandes; Assunção, 2017).

Additionally, the fact that each country has different regulations can impact import and export processes, where transgenic products encounter legal barriers. Thus, a product is manufactured according to the standards of its country and when it is exported, it does not comply with the standards of the buyer country (Camara; Nodari; Guilam, 2013).

Clusters 8, 3 & 4 are related to Climate Change. Cluster 8 also relates to Agriculture: sorghum and soybean are directly associated with temperature, with the former being resistant to water stress and the latter sensitive to high temperatures. Cluster 3 reveals the connection between socioeconomic indicators and sugarcane production, important due to Brazil's position as the largest producer of this crop and the role of ethanol as a biofuel and clean energy source. Finally, Cluster 4 also relates to Food Security, showing the relationship of rice cultivation with temperature, a crop sensitive to high temperatures.

From the beginning of this thesis, the impact that agriculture has on climate change is addressed, as well as the impact that climate change has on agriculture. Therefore, some cultivars will undergo considerable changes. Sorghum, for example, is a plant adapted to hot climates, with efficient drought tolerance mechanisms. In general, extreme temperatures, both high above 38°C and low below 16°C, limit the growth of most sorghum cultivars and can result in up to 33% reduction in yield due to increased night respiration rate. However, because it belongs to the C4 group of plants, it has a good ability to cope with high levels of solar radiation, which implies higher productivity, provided that the other conditions are favorable (Rodrigues, 2015). Such factors may also influence the increase in the sorghum production area.

Soybean, however, shows better adaptation at temperatures ranging between 20°C and 30°C, with around 30°C being the ideal temperature for its growth and development (EMBRAPA, 2004). However, at high temperatures, there is a higher incidence of flower and pod drop, resulting in significant reductions in productivity and even early flowering and decreased plant height. This scenario can be aggravated by a lack of water and/or exposure to inadequate light periods during growth. In addition, high temperatures can accelerate the soybean maturation process and affect grain quality, resulting in higher oil content at the detriment of protein (Centurion; Ghini, 2008). All of this makes it evident that increased temperature could compromise the soybean planting area.

Rice is one of the most important and globally consumed cereals, forming part of the staple diet of people all over the world. As it is consumed directly, the possible negative effects of climate change on rice cultivation have direct implications for food security (Muthayya *et al.*, 2014; Walter *et al.*, 2010; Sheehy; Mitchell; Hardy, 2008). The increase in CO_2 concentration in the atmosphere can, in theory, increase rice productivity. However, if it is accompanied by an increase in air temperature, as predicted, the beneficial effects of CO_2 may be overridden by the negative effects of high temperatures. This may shorten the rice crop cycle and increase spikelet sterility, resulting in a reduction in yield (Walter *et al.*, 2010).

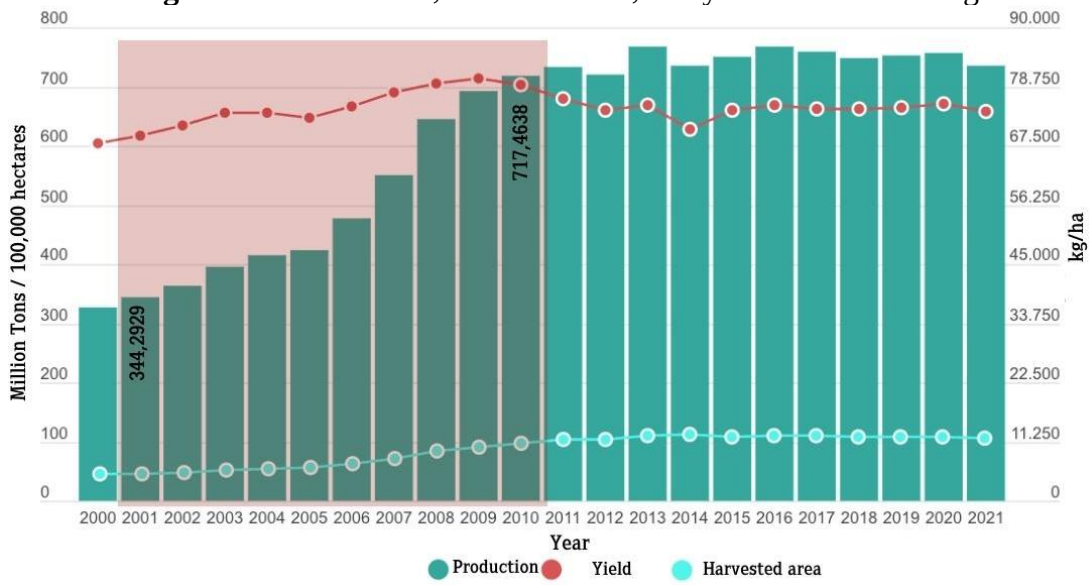
Finally, sugarcane brings a duality in its impacts: even if the increase in sugarcane production brings positive impacts on the economic development of a region and on the use of fossil fuels, on the other hand, negative impacts must be considered both in the environmental and social spheres (Teixeira; Couto, 2013). In the current global scenario of energy and environmental crisis, with the trend of fossil fuel scarcity and excessive greenhouse gas emissions, the search for alternative sources of renewable energy has grown. In this context, biofuels, especially those derived from sugarcane, have stood out as priority options for the energy market. The sugar-alcohol sector in Brazil has undergone rapid expansion due to the National Energy Plan (Portuguese acronym, PNE[65]) and the growing domestic and foreign demand for fuel ethanol (Teixeira; Couto, 2013).

However, it is important to consider that the accelerated and poorly planned expansion of biofuel production can have negative impacts on the environment and society. The production of sugarcane, from planting to the final production of ethanol, generates major impacts on air, land, and water. The high consumption of water and the pollution generated by vinasse are issues of concern. According to Silva, Griebeler & Borges (2007), for each liter of ethanol produced in a sugarcane industry, about 18 liters of vinasse are generated.

In addition, the growing demand for biofuels in Brazil has led to the expansion of sugarcane cultivation (Figure 23). Between 2001 and 2010, sugarcane production more than doubled, standing at over 700 million tons in the period from 2010 onwards. Moreover, there was strong yield growth from 2006 to (EMBRAPA, 2022).

[65] Plano Nacional de Energia.

Figure 23 - Production, harvested area, and yield of Brazilian sugarcane



Source: adapted by the author according to EMBRAPA (2022)

This expansion is a cause for concern in the Cerrado biome and may lead to an increase in the widespread practice of burning and advancement on areas of remaining vegetation and other crops. These impacts significantly affect the agrarian and social structure of the region (Castro *et al.*, 2010). On the other hand, a study conducted by the Climate Policy Initiative showed important data on the scope and impact of the expansion of sugarcane mills in municipalities of Mato Grosso do Sul state (Assunção; Souza; Pietracci, 2016).

The study revealed that the mills have profoundly reshaped the economic structure of the municipalities where they are located. On average, the municipalities studied recorded an annual increase of 30% in Gross Domestic Product (GDP) over three years. The arrival of the mills also resulted in land use changes, with a significant conversion of pasture areas to sugarcane cultivation. In addition, positive impacts on agricultural production, the labor market, and the flow of financial resources were documented, as well as a reduction in deforestation (Assunção; Souza; Pietracci, 2016).

The findings presented in this study provide relevant insights into cluster dynamics and the interactions between family farming and agribusiness. By overcoming the false dichotomy between these two approaches, we realize the complementation between them as a crucial strategy to promote social inclusion and sustainable development in Brazil. It is evident that the responsible adoption of agricultural technologies, such as GMOs, combined with public policies that value family farming, such as the PAA, can result in more efficient, diversified, and sustainable food production.

This connection between family farming and agribusiness also sheds light on issues such as the expansion of soybean production in response to foreign market demand and the pressure for deforestation to expand planted areas, driving the rise of the Ruralist Front and the following negotiation of the Forest Code. In this context, economic and demographic occupation plays a crucial role in a vision of national security and territorial sovereignty. Therefore, it is essential to consider how these interconnected aspects can influence Brazil's socioeconomic development.

In conclusion, the country's development is intrinsically linked to the way family farming and agribusiness complement each other, the way GMO legislation is implemented, and the structuring of food procurement programs. By valuing family farming, adopting agricultural technologies responsibly, and promoting food security, Brazil can move towards a more prosperous, inclusive, and sustainable reality for its entire population, contributing to a more promising future for the country and the planet.

In addition, it is essential to emphasize the importance of aligning domestic policies with international ones, as is the case with the ABC Plan. The implementation of strategies that promote the adoption of sustainable practices in the agricultural sector, such as the low-carbon agriculture provided for in the PEB, can further boost the complementation between family farming and agribusiness, resulting in significant socioeconomic and environmental gains.

Thus, by integrating the valorization of family farming, the responsible adoption of agricultural technologies, food procurement programs, and policies aligned with the ABC Plan, Brazil can not only strengthen its position in the global agricultural market but also contribute to a more sustainable and resilient future, promoting social inclusion and protecting its natural resources. This holistic and integrated approach is essential to address global challenges, reduce carbon emissions and boost socio-economic development in an equitable and responsible manner.

Chapter 4 highlights the evolution of Brazil's socio-environmental policy during the first decade of the 21st century. The country took an active role in international conferences, committing to sustainability goals and reducing inequalities. The "Triadic Gambit" represented the search for a balanced development, where economic growth was not achieved at the expense of environmental degradation and social marginalization. Brazil's participation in climate conferences highlighted its role as a regional and global leader in the struggle for a more sustainable future.

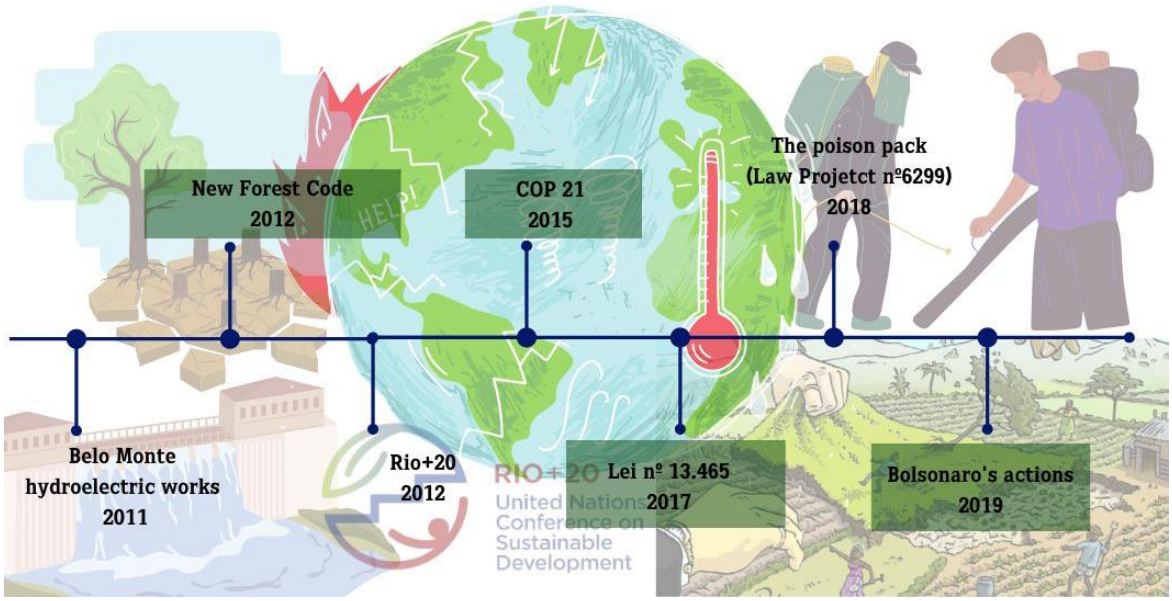
Chapter 5
THE SHREDDING

"Man is by nature a political animal".
Aristotle

In 2010, Brazil was in a moment of political transition. Lula was concluding his second term as president and Dilma Rousseff (PT) was about to take office the following year. It was in this context that Rousseff, as Lula's Minister of the Civil House, played a prominent role in the COP 15 negotiations. However, some voices questioned whether her participation had electoral motivations. During this debate, something curious happened during her intervention at the event: she stated, in a Freudian slip, that the environment posed a threat to sustainable development and the future of the planet. This gaffe can be analyzed at the political level, revealing a change in Brazil's orientation towards the environment. It is on this shift that this section will focus.

In this section, we will immerse into the environmental issue and explore a succession of important events occurring between 2011 and 2018: the new Forest Code, COP 21, the Grilagem Law and the redirection of Brazilian foreign policy, and the first years of the Bolsonaro government. Through these events, we will be able to better understand the challenges faced in relation to the environment in this period and the consequences arising from the decisions taken (Figure 24).

Figure 24 - Events during the government of Dilma, Temer and Bolsonaro and the key-events chosen



Source: elaborated by the author according to Fundação FHC (2023)

5.1 The (Un)Code

In 1934 the Brazilian Forest Code (FC) was established, a government initiative to promote the sustainable use of natural resources and environmental preservation on private rural properties. The FC provided clear guidelines on where native vegetation should be maintained and where diversified rural production activities could take place. It was only in 1965, through Law nº 4.771/1965, that the CF received a more detailed definition, establishing fundamental principles to protect the environment and ensure the well-being of the population, especially through Permanent Preservation Areas (Portuguese acronym, APP[66]) and Legal Reserves (Portuguese acronym, RL[67]). However, it was only in the 1990s that the FC became an organized law made effective through a series of presidential decrees and has been discussed for updating ever since (Garcia, 2012; Soares-Filho *et al.*, 2014).

At their core, APPs have a fundamental objective: the conservation of water resources. They cover lands located along the margins of rivers, water springs, lakes, steep areas, hill tops and high altitudes, regardless of whether they are covered by vegetation or not. In these areas, it is forbidden to carry out agricultural activities, forest extraction, or recreation. Unlike the

[66] Área de Preservação Permanente.
[67] Reserva Legal.

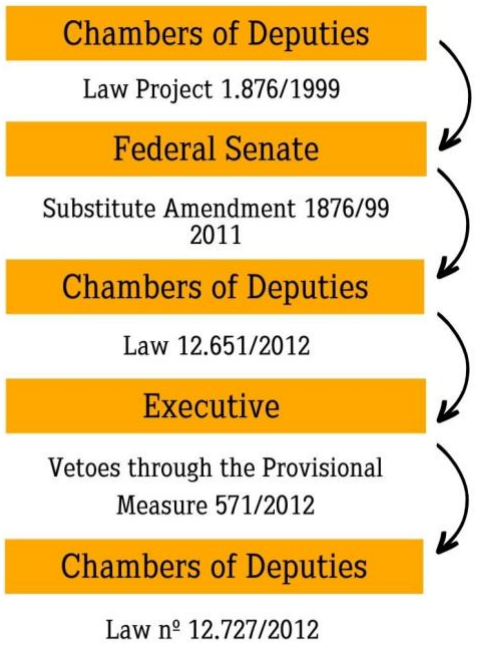
Legal Reserve, the size of the property is not a relevant factor, as the rules are applied uniformly throughout the country (BRASIL, 2011).

On the other hand, RLs correspond to a part of the rural property that must be maintained with its original vegetation, with the aim of preserving biodiversity. In these lands, the sustainable use of natural resources is allowed, if it is carried out with low environmental impact. However, mechanized agricultural activities, such as the cultivation of soybeans, corn, and sugarcane, as well as livestock, are prohibited. In case the original vegetation has been replaced by plantations, it is necessary to remove these crops, restore the original vegetation cover or compensate for the use through another area outside the property (BRASIL, 2011).

The control of deforestation by the FC on private properties was a challenging scenario. This challenge was especially complex in the Amazon, where the alarming increase in deforestation rates triggered the need to strengthen enforcement. However, this measure ended up generating pressure on the agricultural sector, which resulted in a backlash against the Code itself. It was in 2001 that the FC began to require landowners to maintain native vegetation on their rural properties. To ensure this, it was established that, in the Amazon, properties should allocate 80% of their area to Legal Reserve and 20% to other biomes (Soares-Filho *et al.*, 2014).

However, between 2005 and 2010, deforestation in the Amazon showed a significant drop. Taking advantage of this favorable political situation, the agribusiness lobby proposed updating the Forest Code, claiming that there was a conflict between forest restoration and agricultural production (Soares-Filho *et al.*, 2014). The entire subsequent process, which will be detailed later, is summarized in Figure 25.

Figure 25 - New Forestal Code transaction



Source: elaborated by the author

In 2009, a Special Commission was established with the aim of analyzing 11 projects that proposed modifications to the Brazilian Forest Code. Deputy Aldo Rebelo (Communist Party of Brazil, Portuguese acronym PCdoB[68]) was appointed as rapporteur of the project. To conduct this work, Aldo Rebelo organized several public hearings in Congress and in various cities of the country, especially in regions with strong agricultural production. During this process, he had the support of unions and organizations associated with the National Confederation of Agriculture (Garcia, 2012). Aldo Rebelo shared his perspective, saying:

> The Special Commission for Reform of the Brazilian Forest Code, of which I am a rapporteur, has spent a long time examining these issues. In more than 60 public hearings, almost 400 people were heard. Some testimonies were even moving. But that was not what guided the members of the committee. We realized that the regulatory tangle surrounding the old Forest Code makes vital activities for Brazil unfeasible: feeding the population, controlling domestic food prices, generating millions of jobs, and creating income of about R $ 850 billion, considering the GDP (Gross Domestic Product) agricultural and other interconnected areas[69] (BRASIL, 2010b, n/p).

[68] Partido Comunista do Brasil.

[69] Free translate of "A Comissão Especial de Reforma do Código Florestal Brasileiro, da qual sou relator, deteve-se demoradamente no exame dessas questões. Em mais de 60 audiências públicas, foram ouvidas quase 400 pessoas. Alguns depoimentos foram mesmo comoventes. Mas não foi isso que guiou os membros da comissão. Percebemos que o emaranhado normativo que envolve o velho Código Florestal inviabiliza atividades vitais para o Brasil: alimentação da população, controle dos preços internos de alimentos, geração de milhões de empregos e criação de renda de cerca de R$ 850 bilhões, considerando o PIB (Produto Interno Bruto) agrícola e das demais áreas interligadas" (BRASIL, 2010c, n/p).

However, this process has also intensified the historical conflicts between ruralists and environmentalists. The Brazilian Society for the Advancement of Science (Portuguese acronym, SBPC[70]) and the Brazilian Science Association presented proposals for changes in the book entitled "The Forest Code and Science: Contributions to the Dialogue" (Silva *et al.*, 2012), emphasizing the importance of stricter rules for preservation and conservation.

The changes in the Forest Code, presented in the Substitute of Deputy Aldo Rebelo, did not take into account the position of the scientific community, but rather the interests of a portion of Brazilian society, the agricultural sector, which was interested in the expansion of the agricultural frontier, without considering the need to protect biodiversity and the diverse landscapes of the country, as well as the well-being of the entire population and food security (which, in this case, does not mean the need to expand the agricultural frontier). Reducing RL areas and APPs - which are biodiversity habitats - could weaken the system and impact food security, making the food supply vulnerable (Silva *et al.*, 2012).

In 2011, the final report was approved in the Chamber of Deputies by a wide margin of 410 votes in favor, 63 votes against, and 1 abstention. Aldo Rebelo stated that the new Forest Code contemplated environmental protection and sustainable development. However, the debates on changes to the Forest Code were marked by polarized speeches between environmentalists and ruralists – which puts at risk not only the environmental balance but also the very viability of agricultural activities in the country (Trindade, 2010).

Among the various aspects of the project, at least four caused great controversy: the regulation of APPs and RL areas; the productive activities allowed in protected areas; the definition of competencies in environmental matters; and the incentives aimed at the restoration of APPs and RL areas (Garcia, 2012).

After approval in the Chamber, the text was forwarded for analysis in the Federal Senate, passing through the Committees of Constitution, Justice and Citizenship, Environment, Agriculture and Science, Technology, Innovation, Communication, and Informatics. In order to draft an updated and comprehensive law, the Senate heard scientists, producers, farmers, and jurists formulate more precise definitions for RL and APPs areas. It is important to note that the participation of national universities and research centers was limited during the debates in the Chamber (BRASIL, 2011).

[70] Sociedade Brasileira para o Progresso da Ciência.

In November 2011, the senators met and, after a series of discussions and deliberations, approved the substitute proposed by Senators Luiz Henrique (Brazilian Democratic Movement Party, Portuguese acronym PMDB[71]) and Jorge Viana (PT) for the text prepared by then-deputy Aldo Rebelo. The vote was quite expressive, with 59 votes in favor and only 7 against the basic text. However, during the analysis process, the rapporteur welcomed 26 amendments, while another 60 were rejected. These changes proposed by the Senate were named EMS 1876/1999 and made it impossible to immediately approve the new Forest Code in the House of Representatives (Garcia, 2012).

Back in the Chamber, it was up to the then federal deputy Paulo Piau (PMDB) to take over the rapporteur and present a preliminary proposal of the Forest Code, aligned with the interests of ruralists. After 21 amendments, the report was approved by the Federal Chamber in 2012, with 274 votes in favor, 184 against, and 2 abstentions. One of the main changes made to meet the agricultural sector was the exclusion of Article 1, which defined the principles that characterize the Forest Code as an environmental law (Garcia, 2012). Then, the new Forest Code was forwarded for sanction by President Dilma.

The proceedings of the new Forest Code gave rise to the movement known as "Veto it, Dilma" (Figure 26), which involved several actors, including the artistic community. In May 2012, the President presented the vetoes and proposed changes through a Provisional Measure, MPV[72] 571/2012, to regulate the points that had been intervened. To avoid amnesty for land cleaners and prohibit agricultural production in APPs, 12 vetoes, and 32 changes were made to the original text. The guidelines followed were recompose the text approved by the Senate, preserve agreements and respect the National Congress, not grant amnesty to land cleaners, protect smallholders, hold everyone responsible for environmental recovery, and maintain the statutes of APPs and RL (Garcia, 2012).

[71] Partido do Movimento Democrático Brasileiro.
[72] MPVs são Medidas Provisórias, uma espécie de leis urgentes emitidas pelo Presidente da República. Elas têm efeitos imediatos, mas precisam passar pela Câmara dos Deputados e pelo Senado para se tornarem leis permanentes.

Figure 26 - Protest the New Forest Code

Source: elaborated by the author

According to Roriz & Fearnside (2015), the main feature of the construction of the new Forest Code was the controversy of the constant discussion between the so-called "big farmers" and environmentalists around the economic costs of a stricter code versus the environmental costs of a permissive code (Covre; Clemente; Lírio, 2017). The New Forest Code, sanctioned by President Dilma, promised to reduce the inequalities present in the 1965 code by applying the same laws to landowners and family farmers.

However, Pereira, Botellho and Ferreira (2015) suggest in their article that, although the strengthening of small farmers was one of the main arguments for the approval of the law, there was no significant improvement in their standard of living in the following years. There is a lack of public rural assistance policies that strengthen the small farmer and assist them in sustainable production. The imposition of a law that seeks to change the way farmers, especially small ones, deal with the land can be considered an imposition of an ecological vision, and environmental awareness, which is the perspective of the legislator and the State (including environmental and legal bodies), and not of small farmers, who are the actors who live and depend on the land for their survival (Pereira: Botelho; Ferreira, 2015).

According to Covre, Clemente and Lírio (2017), the changes in APPs and RLs were made without an adequate scientific basis. Often, the same rules are applied to all biomes, ignoring their specific peculiarities. These changes have been criticized by the scientific

community, as they weaken the protection of natural resources and benefit landowners who were not complying with the law. However, these changes were approved due to the composition of the Legislative House, allowing the regularization of infractions, and paving the way for unilateral economic development (Roriz; Fearnside, 2015).

Candiotto & Vargas (2018) state that the legislative changes in the new Forest Code have adverse impacts on the environment and, consequently, on society. Some of these impacts include the generalized decrease of forests and other habitats, the compromise and loss of the integrity of APPs and RLs, as well as the relativization of the duty to repair environmental damage (Candiotto; Vargas, 2018).

Soares-Filho *et al*. (2014) showed in his study that the New Brazilian Forest Code provided a large amnesty for those who deforested until 2008, reducing by 58% the environmental liabilities of rural properties in Brazil, ranging from 20 hectares in southern Brazil to 440 hectares in the Amazon. As a result, the illegally deforested area that under previous legislation should be restored was reduced from 50 to 21 million hectares, 22% of which were APPs on river margins and 78% RL areas.

One of the strongest arguments defended by the agribusiness lobby[73] is that forest restoration conflicts with agricultural production. However, the results of Soares-Filho (2014) suggest that this concern regarding land availability is unfounded. Of the 4.5 million hectares of APPs scheduled for restoration, only 0.6 million hectares are currently occupied by plantations, which represents less than 1% of all arable land in the entire country.

Furthermore, if restoration of the remaining RL debt were to occur exclusively on pastureland unsuitable for agriculture, only about 550,000 hectares of the required restoration would remain on arable land. This large-scale transition from livestock to agriculture would require substantial increases in stocking densities to sustain current levels of meat production and allow for forest restoration. To address this challenge, the ABC Plan could assist in this process by offering about US$1.5 billion in annual subsidized loans aimed at increasing agricultural productivity while reducing associated carbon emissions and supporting forest restoration (Soares-Filho *et al.*, 2014).

This conflict between agricultural and environmental actors influenced the international scenario with Brazil's behavior at COP 21 in 2015. At COP 21, countries presented their NDCs,

[73] Although the term "lobby" is not regulated in Brazil, it was used in the thesis to translate the pressure of groups in the formulation of public policy.

which incorporated three fundamental principles: ambition, differentiation, and transparency. The ambition guided these contributions, which sought to exceed the current expectations of States by setting audacious targets to achieve by the year 2020. Differentiation, where each country considered its own national circumstances, recognizing that there was no "one size fits all" approach. Lastly, transparency, with the public disclosure of contributions through the UNFCCC website as soon as they are received by the secretariat (Aubertin; Jesus, 2021).

In 2016, 162 contributions had already been published, representing 190 parties to the Convention. This milestone broke with the previous multilateral system, focusing now on individual country contributions. Thus, the search for a sustainable development model began to involve not only political and economic aspects but also social ones (Aubertin; Jesus, 2021). The NDCs were presented in a range of forms, allowing each country to present its strategy in a concise document that reflected the context of each nation, such as its economic realities, energy potentials, and territorial and development issues. In addition, they showed the desire of each country to stand out on the world scene, affirming its sovereignty (Aubertin; Jesus, 2021).

However, despite the efforts and targets set by the NDCs, the sum of all of them still projected a global temperature increase of more than 3.5°C, which contradicted the Paris Agreement, established during COP 21, to keep global warming below 2°C by 2100, with additional efforts to limit it to 1.5°C. Even with the funds available to promote mitigation and adaptation strategies, the assumed compromises were still insufficient to achieve the goal set by the Paris Agreement (Aubertin; Jesus, 2021).

During COP 21, Brazil stood out as the first major developing country to commit to an absolute emissions reduction, breaking with the tradition of reductions based on future projections or in relation to GDP. The country chose the base year of 2005 as a reference and made a commitment covering a ten-year period, from 2020 to 2030, expanding the NAMAs through its NDC (Silva *et al.*, 2018).

Aiming to prove to the world that it was already a low-carbon economy, Brazil presented a list of achievements and strengths, highlighting the renowned biofuels program, showing impressive results in reducing deforestation – with an 82% drop in the Amazon between 2004 and 2014 – and an energy matrix already composed of 40% renewable sources, a figure three times higher than the world average, emphasizing the country's commitment to a sustainable approach (Aubertin; Jesus, 2021).

In addition, Brazil emphasized its independence in relation to the precepts of the Convention, arguing that the measures adopted to achieve its reduction targets were already part of its policies, such as the PNMC (BRASIL, 2009), the ABC Plan (BRASIL, 2012), the National System of Conservation Units (UNFCCC, 2010), the Forest Code (BRASIL, 2011) and the National Water Security Plan.

The objective of the Brazilian NDC was to reduce greenhouse gas emissions through specific targets in relation to 2005. By 2025, the goal was to achieve a 37% reduction, and by 2030, the ambition extended even further, seeking a 43% reduction, corresponding to 1200 $MtCO_2e$. These targets were quantified considering a real baseline situation, as opposed to a mere hypothetical situation, known as business-as-usual. By 2030, the plan included reducing emissions per unit of GDP by 75%. In addition, per capita emissions would be capped at 5.4 tCO_2e, reaching one of the lowest levels among G20 countries. However, it is important to note that most of these targets were already present in previous government plans and programs, and many of them had already been achieved (Aubertin; Jesus, 2021).

Additionally, the NDC included information on how to achieve the goals, divided into six sectors: biofuels, land and forests, energy, agriculture, industry, and transportation. Among the goals, there is "zero illegal deforestation", which is understandable since it already belonged to the Brazilian forest policy. However, since 2012, deforestation of the Amazon rainforest has increased again (INPE, 2023), mainly due to the continuation of the policy of large infrastructure works, such as hydroelectric dams and roads.

A large part of the Brazilian delegation at COP 21 was composed of agribusiness actors, demonstrating a broad mobilization of a sector whose activity represented 23% of Brazil's GDP at that time (BRASIL, 2016b). This participation revealed a contradiction between the discourse presented to the international community and the national reality.

On the one hand, Brazilian agribusiness would have incorporated in its speech, and in some of its practices, the socioenvironmental criticisms it received, to rebuild its international image tarnished by its bad reputation due to its practices (Demeulenaere; Castro, 2015). On the other hand, the Minister of Agriculture, Kátia Abreu, supported by the ruralist lobby, defended all causes that seek to encourage greater production and increase of agricultural area that impact the environment and climate system - such as the extension of roads in the Amazon, the expansion of monocultures, the intensive adoption of genetically modified seeds and the expansion over protected areas and indigenous lands, which are considered as blockages to the

expansion of agricultural production (Aubertin; Jesus, 2021). With both speeches, the shift in focus from forests to agriculture became evident, which will continue to be covered in the following sections.

Thus, Brazil's behavior was understandable when it refused to participate in the New York Declaration on Forests in 2014, which supported the goal of "zero deforestation", because, according to the country, it was first necessary to distinguish legal deforestation from illegal deforestation (Aubertin; Jesus, 2021). The justification for this behavior may be based on the domestic debate on deforestation. As pointed out by Rajão & Soares-Filho (2015), the compensation of CO_2 emissions due to the legal removal of vegetation, i.e. "zero deforestation" in 2030, was interpreted in the light of the FC[74] and the full use of the possibilities of legal deforestation offered by it.

In 2015, the Rousseff government began its second term in office and, with that, the Workers' Party completed 12 years in power. With the outcome of the elections, a serious political crisis was growing in the domestic sphere, in a dance between society's dissatisfaction with the political apparatus and the growth of conservative forces. An institutional process was then initiated that gave even more strength to agricultural actors: the impeachment of President Dilma Rousseff[75].

With the justification of violating the Fiscal Responsibility Law and broad support from society, the then-president of the Chamber of Deputies, Eduardo Cunha (Brazilian Workers Party, Portuguese acronym PTB[76]), proceeded with the impeachment request presented by Janaína Paschoal (later elected as a state deputy by the Brazilian Renewal Workers Party, PRTB[77]), Miguel Reale - both professors of Criminal Law at the University of São Paulo - and Hélio Bicudo, a retired prosecutor and former PT member. On August 31, 2016, the process ended with the removal of Rousseff's mandate. Thus, Michel Temer (PMDB), then-Rousseff's vice-president, assumed the presidency (BRASIL, 2016d).

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[74] The new Forest Code offered the opportunity to trade transferable environmental reserve quota certificates, with each certificate corresponding to 1ha of natural vegetation set aside for conservation. However, these certificates could come from already protected areas, or from the legal reserves of smallholders who respected the authorized deforestation percentages. Thus, landowners can continue to deforest their properties and those who should compensate for their illegal clearings can resort to buying cheap titles. In other words, the application of the Forest Code did not make the fight deforestation effective (Aubertin; Jesus, 2021).

[75] It is not the focus of this thesis to get into the details that led to the impeachment but to analyze the events during the chosen period. However, it does not mean that there is no importance and influence on the impeachment of Dilma Roussef in the political behaviors that followed the event.

[76] Partido Trabalhista Brasileiro.

[77] Partido Renovador Trabalhista Brasileiro.

5.2 The silent cricket

During the government of Michel Temer (PMDB), between 2016 and 2018, the interests of ruralists were the central focus of policy. In this context, important entities representing the agricultural sectors, such as the Confederation of Agriculture and Livestock, the Brazilian Rural Society, and the Parliamentary Front of Agriculture (Ruralist Front), expressed their political support to the Temer government. This close connection between the ruralists and the government resulted in a series of benefits and concessions (Leite; Castro; Sauer, 2018), influencing the government structure and decision-making, such as the extinction of the Ministry of Agrarian Development and the creation of facilitating measures for the development of agribusiness, such as Law nº13.465/2017.

Since its creation, the Ministry of Agrarian Development has undergone significant transformations over time, shaping its own trajectory and capacity to intervene in Brazil's rural areas. With the change of government in 2003, the importance of the MDA was intensified. The government's rapprochement with the social and union movements of family farming, together with intense state activism evidenced in several initiatives, contributed to the emergence of innovations in the institutional structure and public policies (Medeiros; Grisa, 2019).

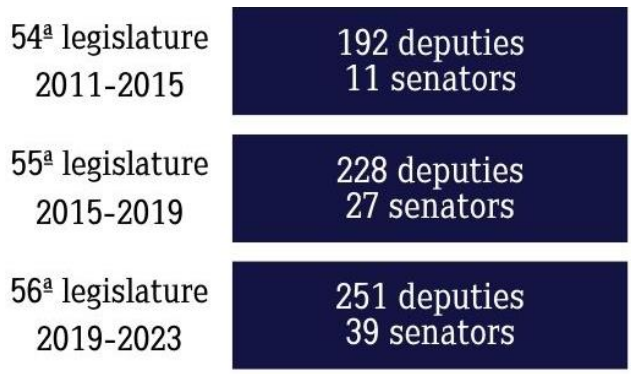
On the political scene, an atmosphere favorable to dialogue with social movements and organizations emerged, opening doors for greater interaction between the MDA and society. This process not only strengthened the democratic capacity of the Ministry but also elevated its political importance in the Esplanade of Ministries. As the demand for comprehensive policies for rural areas and family farming increased, it became essential to strengthen the MDA's policy coordination capacity. In addition, bureaucratic rituals were created to confer legitimacy on the Ministry's actions, necessary to meet the growing demands and ensure that the policies implemented were recognized and accepted (Medeiros; Grisa, 2019).

In 2011, a new presidential change marked the beginning of a phase of institutional fragility. Despite belonging to the same political group as the Lula government, the change brought with it budget cuts due to the economic crisis, resulting in a weakening of the MDA and its actions. Despite maintaining some dialogue and welcoming society's demands, the relationship with social movements has changed due to resource constraints and political choices related to development projects. With the loss of political weight, the MDA's bureaucratic and political coordination capacities deteriorated over time, culminating in its

extinction in 2016 (Medeiros; Grisa, 2019).Thus, the attributions of the MDA were divided between the MAPA and the MDS (Alentejano, 2018).

This alignment could be observed in the political support in the National Congress for agribusiness interests, in the number of deputies, and, especially, senators being part of the FPA (Sauer, 2010) (Figure 27).

Figure 27 - Participants of the Parliamentary Front for Agriculture during three legislatures



Source: Câmara dos Deputados (BRASIL, 2023d)

During the 2011-2015 and 2015-2019 legislatures, the influential FPA had a significant number of members. It is interesting to note that during the 55th legislature, the FPA further expanded its representation in the Chamber of Deputies. Among the deputies was the then-deputy and former president of the Chamber of Deputies, Eduardo Cunha (PTB). Another relevant aspect is that, of the members of the FPA in the 55th legislature, 65 deputies were serving their first term, demonstrating that the Ruralist Front was able to attract new parliamentarians, even if they did not initially have a strong connection with rural issues (Lima, 2018).

The significant growth in the number of members of the FPA is a testimony to the ability of this influential front to mobilize parliamentarians around its agenda, even when they do not have an intrinsic connection with the interests of the rural sector[78]. In the 56th legislature, its power of attraction intensified, adding 251 federal deputies and 39 senators, almost 50% of the composition of the National Congress (Lima, 2018).

[78] According to Lima (2018), the number of rural parliamentarians who declared professions not linked to the rural area, such as businessmen and lawyers, is noteworthy. In the 54th legislature, 35 deputies said they were lawyers, 35 businessmen, 31 said they were doctors, five said they were industrialists, 1 said he was a police chief. In the 55th legislature, 42 deputies reported being businessmen, 40 declared themselves lawyers, 31 teachers, 26 doctors, and 3 deputies held police positions.

This reactionary behavior of the Ruralist Front is associated with the international context in which land was appreciating and the demand for commodities was constantly growing. Additionally, this situation was reinforced by the discourse of the need to adopt austerity policies in the face of the economic crisis, i.e. cutting spending, reducing budget deficits, increasing taxes, or a combination of these actions. It is on this justification that the government relied on during the labor and social security reforms, as well as changes in agrarian policies and laws (Sauer; Leite, 2017). In December 2016, MPV 759/2016 was proposed, which

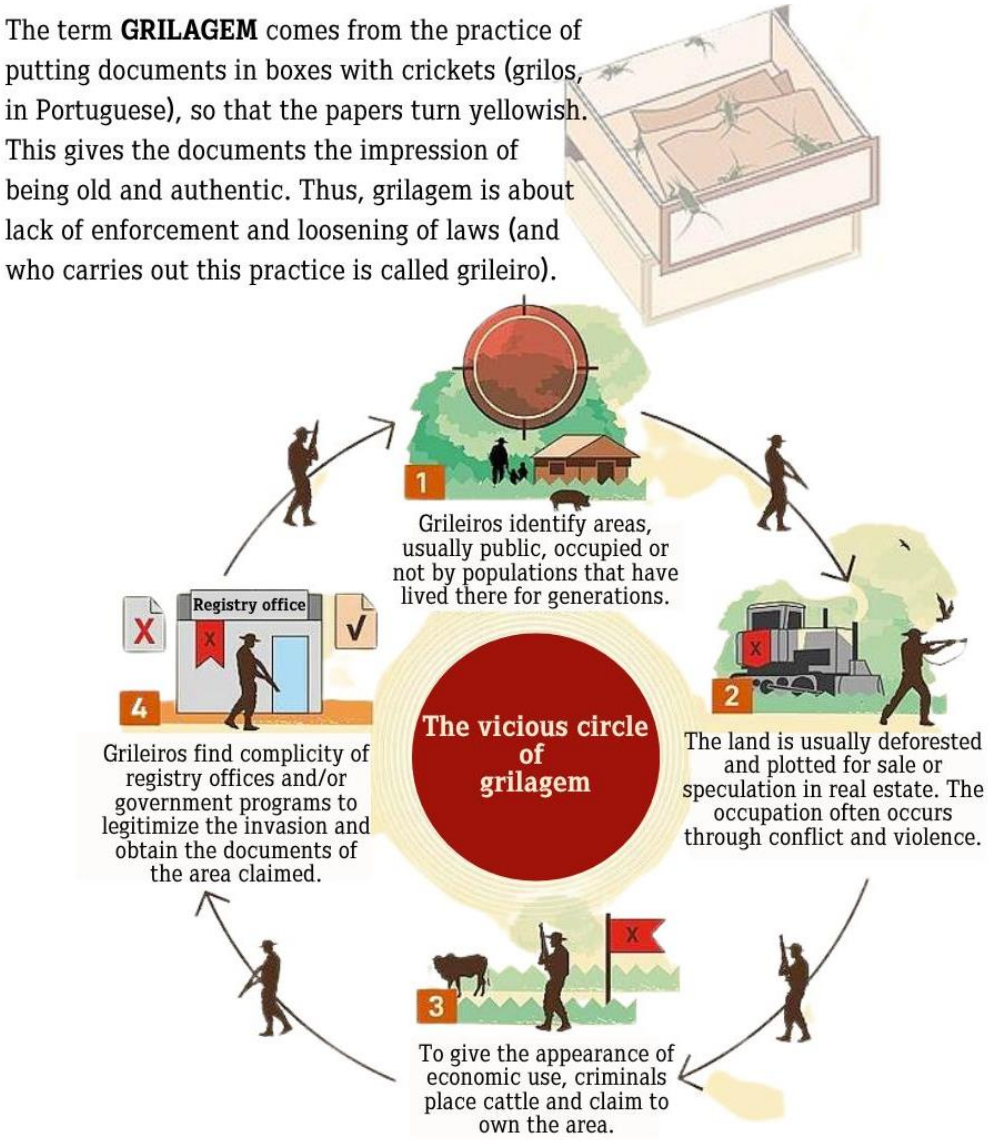
> Provides on rural and urban land regularization, on the payment of credits granted to agrarian reform settlers and on land regularization within the scope of the Legal Amazon, establishes mechanisms to improve the efficiency of the procedures for the sale of Federal properties, and makes other provisions[79] (BRASIL, 2016e).

MPV 759/2016 updates some laws related to land reform, regularization of occupations in the Amazon, and regularization of rural and urban properties. According to the MPV, this update is necessary because the old laws are not adequate to the current reality, which causes problems in the right to housing, land use planning, mobility, the environment, and public health (BRASIL, 2016e).

In 2017, MPV 759/2016 was approved and became Law nº 13465/2017, known as the "Grilagem Law" (Figure 28). This law changes Brazilian urban and rural land legislation, impacting both existing settlements and the political landscape of land and urban reforms. The law seeks to regularize the titling of plots in settlements, including in cases of irregular occupation, and establishes new criteria for the selection of beneficiaries of agrarian reform programs – which impacts the struggle and organization of rural social movements (Cunha, 2017).

[79] Free translate of "Dispõe sobre a regularização fundiária rural e urbana, sobre a liquidação de créditos concedidos aos assentados da reforma agrária e sobre a regularização fundiária no âmbito da Amazônia Legal, institui mecanismos para aprimorar a eficiência dos procedimentos de alienação de imóveis da União, e dá outras providências" (BRASIL, 2016e).

Figure 28 - The grilagem circle



Source: translated by the author according to Greenpeace Brasil (GREENPEACE, 2022)

Temer presented some justifications for the Provisional Measure, explaining its motivations as follows: i) the MPV seeks to guarantee the constitutional right to housing, especially in response to the disordered growth that has occurred in large cities. This growth often results from the lack of adequacy between the current legislation and the reality of the cities; ii) the MPV aims to correct irregularities in the implementation of the land reform policy; iii) the MPV aims to adapt the Legal Land Program to meet social demands, regularizing several clandestine occupations that occur in the Amazon region; iv) in addition, the MPV proposes the creation of new legal institutes, such as "land legitimation", in order to enable the regularization of clandestine occupations in urban areas of Brazil and; v) environmental protection is also shown as one of the priorities of the MPV, with the privatization of public lands, especially in areas belonging to the Legal Amazon, due to the serious problems arising

from the lack of occupation of these lands, such as deforestation, fires, illegal logging and other adversities (BRASIL, 2017a).

In addition to this justification, one of the significant changes was the possibility of cash payment as compensation for the expropriated land[80], instead of agrarian debt bonds[81]. The law also established that a settlement will be considered consolidated[82] after fifteen years, regardless of access to credit or the completion of public investments, relieving the federal government of its responsibility towards the settlements. This can lead to precarious conditions in the settlements (BRASIL, 2017b).

The main objective of this legal change was to insert about 37 million hectares in more than 9,300 agrarian reform settlement projects into the market, favoring agrarian capital interests (Araújo; Sobrinho, 2022). The law also allowed the regularization of illegal occupations up to four times larger than a normal plot, which can create small "latifundia" within settlements. This law weakens the National Institute for Colonization and Agrarian Reform (INCRA[83]) and social movements, bringing land reform closer to market interests. In addition, it seeks to legalize land grabbing of public lands carried out in recent decades, facilitating the sale of land to foreigners. Such objectives are aligned with the ruralists' project, undermining the rights of peasants and affecting the struggle for agrarian reform in the country (Cunha, 2017). According to the Federal Prosecutor's Office (Portuguese acronym, PGR[84]), this law:

> [...] authorizes the mass transfer of public assets to middle- and upper-income people, aiming to satisfy private interests, to the clear detriment of the neediest population, which will cause a serious and irreversible impact on the land structure throughout the national territory, either by encouraging the irregular occupation of land ("grilagem"), the increase of agrarian conflicts, or by suppressing the minimum conditions for the continuity of those constitutional policies. The application of the impugned law will result in one of the largest processes of loss of public assets in the history of Brazil, in addition to

[80] Expropriation is one of INCRA's instruments for obtaining unproductive land for agrarian reform. The expropriation of a farm is requested by INCRA to the courts when the agency identifies unproductive rural properties. In this case, the farmers would be paid for the expropriated land.
[81] Agrarian Debt Bonds are government-issued bonds used in expropriation agreements. They can be used for tax rebates or to pay for public financing.
[82] The consolidation of rural settlements encompasses the implementation of infrastructure improvements in settlement projects, such as topographic demarcation, construction or recovery of roads, establishment of supply systems, adoption of environmental management measures, supervision, inspection and monitoring of beneficiary families in the use of the Installation Credit, as well as other initiatives aimed at promoting the necessary conditions for the sustainable development of agrarian reform areas. In addition, resources are also directed to the regularization of lots in settlements and the implementation of agro-industries, as well as projects for the diversification and commercialization of production (BRASIL, 2020a).
[83] Instituto Nacional de Colonização e Reforma Agrária.
[84] Procuradoria Geral da República.

> promoting a significant increase in the concentration of land in the hands of a few[85] (BRASIL, 2017a).

In other words, the changes proposed by the ruralists in the legislation allowed the appropriation of public lands without this being considered a crime, benefiting the land grabbers, who could legalize occupied areas of up to 2,500 hectares without the need for public bidding. In addition, there was no requirement to return irregularly occupied areas exceeding 2,500 hectares. The extension of the deadline for the original occupation of the area also allowed for the future legalization of new irregular occupations (BRASIL, 2017b).

In 2017, 61 entities linked to the defense of the environment presented a representation addressed to the PGR, to provoke the Federal Supreme Court to declare the multiple unconstitutionalities of Law nº13.465/2017. They claim that this law leads to a wide transfer of public lands, forests, waters, and federal islands to private hands in the Amazon and on the coast of Brazil. In response to this request, the PGR filed a direct action of unconstitutionality against Law nº13.465/2017, seeking the immediate suspension of its validity (BRASIL, 2017a).

Provisional Measures are exceptional instruments. Thus, when the President of the Republic issues a MPV, he must strictly follow the requirements of urgency and relevance described in the Constitution (Article 62). In the case of MPV 759/2016, there is no convincing justification for its urgency, since issues such as land grabbing and deforestation are long-standing problems without effective solutions. The allegation of disordered growth in cities cannot be considered urgent either, since it is a structural problem faced for decades. In addition, MPV 759 refers much of the matter to future regulations, which demonstrates the lack of an imminent threat that justifies the exceptional action of the President Temer to the detriment of the National Congress (BRASIL, 2017a).

Another significant point is that, a few years earlier, Law nº 11.977/2009[86] promoted important changes in the legislation on the regularization of urban settlements. This fact weakens the MPV's justification that there is an incompatibility between reality and the current

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[85] Free translate of "[...] autoriza a transferência em massa de bens públicos para pessoas de média e alta renda, visando a satisfação de interesses particulares, em claro prejuízo à população mais necessitada, o que causará grave e irreversível impacto na estrutura fundiária em todo território nacional, seja por incentivar a ocupação irregular de terras (a "grilagem"), o aumento de conflitos agrários, seja por suprimir as condições mínimas para continuidade daquelas políticas constitucionais. A aplicação da lei impugnada resultará em um dos maiores processos de perda de patrimônio público da história do Brasil, além de promover sensível aumento do quadro de concentração de terras nas mãos de poucos" (BRASIL, 2017a).

[86] According to Sauer (2017; 2018), the enactment of Law nº11.977/2009 resulted in the acceleration of the processes of regularization of the occupation of public areas in the Legal Amazon, being interpreted as a possible way to legalize the illegal appropriation of public lands and giving this measure as "MPV of grilagem".

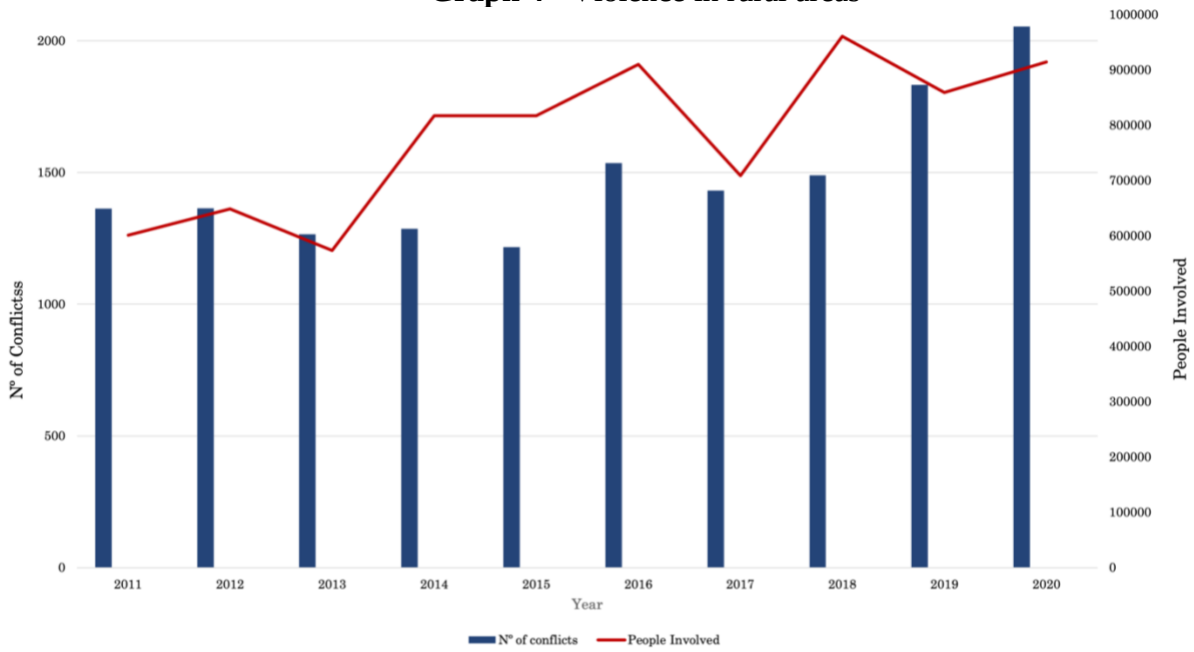
legal order, as Brazilian municipalities were already adapting to local policies and norms according to existing legislation. If the new law persists, they will have to readapt to the model brought by Law nº13.465/2017, negatively affecting the urgency promised by MPV 759 and counteracting the objective of accelerating the regularization of urban settlements (BRASIL, 2017a).

In addition, it is worrisome to issue an extraordinary legislative measure to modify more than a dozen ordinary laws approved by the National Congress, some of which have been in force for more than a decade and are the result of legislative processes with popular participation. This represents a serious distortion of the democratic system and disrespect for the legislative function since Congress is the entity responsible for discussing and approving changes to ordinary laws. The President's action with the MPV seemed, then, inadequate and unjustifiable as to its exceptional use (BRASIL, 2017a).

The PGR argued that, in addition to having been created provisionally without meeting the constitutional requirements of importance and urgency, the Law violates several constitutional principles and rules. These principles and rules include the right to housing, the right to property and the fulfillment of its social function, environmental protection, urban development policy, the need to reconcile the use of public and vacant land with agricultural policy, and the national land reform plan, the prohibition of retrogression in fundamental rights, the existential minimum and the principle of proportionality, the competence of the Union to legislate on Civil Procedural Law, the provision that compensation for agrarian reform be paid in agrarian debt securities, the requirement for popular participation in municipal planning, and the constitutional rules of special urban and rural usucapion (BRASIL, 2017a). Thus, the Law was partially vetoed to be approved.

According to Cunha (2017), this total assistance to agribusiness allows agriculture to expand into areas where family farmers are established, which has negative effects on land policies and the distribution of property and income in the countryside. The reports released by the Pastoral Land Commission (CPT, 2023) showed that violence increased in the period analyzed, especially in relation to the number of conflicts and people involved related to land, water, and labor in the years 2019 and 2020 (Graph 4).

Graph 4 - Violence in rural areas



Source: elaborated by the author according to CPT (2023)

In the global scenario, foreign policy emerges as a board where different actors participate in the game, influencing the actions and decisions of the State. These strategies, intertwine and materialize through negotiations and positioning, often guided by diverse pressure groups. Thus, it is expected that changes at the domestic level are projected to the international level.

Thus, the ascension of Michel Temer to the presidency of Brazil brought with it a series of changes in the country's foreign policy paths, with Brazil's international insertion giving way to a more discreet external approach (Siebeneichler, 2021). The government began to adopt strategies different from those of previous governments, aiming to align the needs of the Executive with the necessary political support. This became clear in the speech of the then Minister of Foreign Affairs, José Serra, that diplomacy would reflect the genuine values of Brazilian society and the economic interests of the country, without being held hostage to the ideological preferences of a political party and its international allies (BRASIL, 2016f).

However, this discourse was opposed to domestic legislation and context. There were reductions in government regulations, labor reforms, and cuts in essential social programs – such as Bolsa Família and public policies aimed at family farming (Silva; Pérez, 2019).

With the change in the political scenario, there was a redirection of focus: agribusiness began to dominate, relegating other demands to the background. In this process, family farming and the rural economy gave way to a new dynamic. Lima, Pereira & Barbanti (2018) analyzed

the strengthening of agribusiness in the formulation of Brazilian foreign policy. The influential force that Brazil played in International Relations as an agri-food power, seemed to have been replaced by an approach more aligned with agribusiness. Temer's speeches highlighted the importance of agriculture and agribusiness in Brazil's GDP as the “strong pillars of any government” (BRASIL, 2018).

While Temer government decreased its support for food security agencies, it increased its support for international initiatives linked to agribusiness. Two examples of this shift were Brazil's leadership of the Biofuturo Platform and its efforts to elect a Brazilian to chair the Codex Alimentarius. This approach was adopted by the Ministry of Foreign Affairs during COP 23 in Germany, placing the country in the group of countries that intended to act jointly in the economic use of natural resources (Lima; Pereira; Barbanti, 2018).

The Biofuturo Platform is an international initiative that seeks to promote activities related to biofuels, bioenergy, and the modern economy. Despite the rationale behind the bioeconomy of including productive activities for a low-carbon economy, the Brazilian government presented a proposal supported by the National Confederation of Industry (Portuguese acronym, CNI[87]), the Federation of Industries of the State of São Paulo (Portuguese acronym, FIESP[88]), and other representations of the Brazilian industrial sector - a mark of government support for large agribusiness and industry sectors. While other countries exploit renewable resources, Brazil relied mainly on intensive land use for biofuels and bioenergy from crops such as soy and sugarcane (Lima; Pereira; Barbanti, 2018; Siebeneichler, 2021).

There was also a significant decision related to Codex Alimentarius: the support for the candidacy of the Brazilian Guilherme Costa for the presidency. Codex is an organization affiliated with FAO and the World Health Organization (WHO), responsible for establishing standards, guidelines, and recommendations for food safety, quality, and trade, aiming to protect the health of consumers and ensure fair practices in food trade (FAO, 2023). Even if voluntary, Codex has considerable political weight in these regulations and Guilherme Costa's appointment would be strategic for Brazilian interests (Lima; Pereira; Barbanti, 2018).

Guilherme's previous work in bilateral and multilateral negotiations related to food safety would provide greater support for the actions of developing countries in the formulation and monitoring of Codex rules. In addition, the Temer government has adopted a stance more

[87] Confederação Nacional de Indústria.
[88] Federação das Indústrias do Estado de São Paulo.

aligned with the release of the use of agrochemicals banned in many countries in Brazilian crops. Thus, the advance of this liberalization could find in Guilherme a defender in the Codex Alimentarius (Lima; Pereira; Barbanti, 2018).

While Temer government supported the interests of a sector that had conflicting actions with environmentalist actions, there was also an attempt at self-promotion in defense of environmental policies since the beginning of its mandate. The excerpt from José Serra's speech at the Ministerial Council Meeting of the Organization for Economic Cooperation and Development (OECD) in 2016 mentions the Brazilian effort on the environmental issue in the international arena:

> Brazilian society has a very positive track record on the path towards sustainability. Our clean energy matrix, our biofuels program, our commitment to the conservation and sustainable use of forests, our commitments to reduce greenhouse gas emissions, as well as the various actions aimed at eradicating poverty and creating opportunities for all, are permanent national goals, initiatives in which the Government of President-in-Office Michel Temer has been committed, improving what can be improved and correcting what needs to be corrected[89] (BRASIL, 2016f).

In 2018, Brazil was going through a serious crisis. The economy was weakened, politics was rocked by corruption scandals, and many Brazilians were frustrated with the situation. In this scenario, a strong feeling of rejection of the PT emerged from the Party that had governed the country and was seen as responsible for the economic decline and corruption cases. Also, it was at this scenario that Jair Bolsonaro entered the scene and was able to take advantage of this popular dissatisfaction, building a discourse against the Brazilian political system and speaking directly to the concerns of most voters, promising a renewal and a change of course (Pereira; Viola, 2022).

Two other important points were the support of the business community for Bolsonaro's candidacy and the conservative wing. From the beginning of his campaign, he made it clear that he would appoint a market-friendly economist as Minister of Economy, which attracted businessmen and financiers who feared a left-wing government. In addition, he defended traditional family values and stood against abortion, gay marriage, and drug legalization - ideas

[89] Free translate of "A sociedade brasileira tem um histórico muito positivo no caminho rumo à sustentabilidade. Nossa matriz energética limpa, nosso programa de biocombustíveis, nosso compromisso com a conservação e o uso sustentável das florestas, nossos compromissos em reduzir as emissões de gases de efeito estufa, bem como as várias ações visando à erradicação da pobreza e à criação de oportunidades para todos, são metas nacionais permanentes, iniciativas em que o Governo do Presidente em exercício Michel Temer tem-se empenhado, melhorando o que pode ser melhorado e corrigindo o que precisa ser corrigido" (BRASIL, 2016f).

that won the votes of evangelicals, who represent a significant portion of the Brazilian electorate (Pereira; Viola, 2022).

In the dynamics of the Institutional Continuum, the presence of three key characters was identified: Captain Degradation, who represents the unbridled pursuit of economic development to the detriment of any other consideration; Captain Gaia, who stands at the opposite extreme, prioritizing environmental preservation above all; and Captain Triadic, who is located in the middle of the Continuum, in a dance between the two extremes, seeking convergence of interests and cooperation between them. Analogously to this structure, the political choices made over time can be situated on this Institutional Continuum, oscillating between the direction of Captain Gaia and the direction of Captain Degradation.

In the period analyzed in this section, it is possible to observe a turbulent political moment, characterized by conservative, anti-democratic speeches and the criminalization of social movements and their struggles for rights (Leite; Castro; Sauer, 2018). From the Dilma government, through the Temer government and the subsequent election of Jair Bolsonaro, there are possible inclinations toward Captain Degradation. This is reflected in the control and access to land, with actions that may neglect environmental preservation, in the increased use of chemicals and transgenics in crops, in precarious working conditions, and in violence against workers and social movements. These trends may result in the deepening of social inequalities and a new scenario of a dispute over agrarian reform, food sovereignty, access to land (Dal Moro; Moreira, 2019), and environmental dismantling – which will be analyzed in the next section.

5.3 The Demovement

The progress in environmental conservation is clear, given the densification of national and international institutions to address this issue. Environmental legislation, for example, has progressed positively in several aspects, establishing itself as an important legally backed instrument through agencies and enforcement agents that ensure compliance with environmental laws and protections (Nascimento *et al.*, 2023). However, the last decade in Brazil was characterized by a series of events that gave voice to those who went against this path. This voice has been gaining space and support, both politically and by society. And the Triad was notably impacted by the actions that followed.

Between 2010 and 2019, an analysis of the Brazilian Foreign Policy Reviews, carried out by Siebeneichler (2021) highlights that the focus on the environment decreased considerably in the formulation of Brazilian Foreign Policy. Environmental cooperation became a secondary theme, giving way to a discourse where the Ministry of Foreign Affairs prioritized the promotion of agribusiness, trade, investments, and technology, indicating a change of direction away from environmental concerns.

Bolsonaro's (Social Liberal Party, Portuguese acronym PSL[90]) arrival in government in 2019 crowned this process and brought with it an antagonistic view of the environmental progress achieved so far, through his anti-environmentalist agenda. His speeches materialized what had been encouraged by allied groups in the previous years: a skeptical approach towards environmental protection, devaluing the years of search for environmental balance and going against the widely accepted scientific opinion. This stance represented a drastic change from the record of previous governments, which, even with some flaws in their environmental policies, never denied the importance of climate change and biodiversity protection. These previous administrations sought to build an image of Brazil as an environmental leader, while the current government has adopted the opposite approach (Pereira; Viola, 2022; Scantimburgo, 2018).

This became evident through the various attempts to weaken the country's environmental policies, breaking with the commitment established over the decades. Actions taken during his mandate, such as the relaxation of inspection and the dismissal of many employees who worked as inspectors at the Brazilian Institute of the Environment and Renewable Natural Resources (Portuguese acronym, IBAMA[91]), the entity responsible for the preservation and inspection of environmental resources and the promotion of the conscious use of these resources by society. These actions characterize a weakening of environmental public policy, representing a dismantling of this system and an increase in environmental crimes (Nascimento *et al.*, 2023).

To combat environmental crimes, Law nº 9.605/1998, known as the Environmental Crimes Law, was created to comply with and organize the legal protection of the environment, unifying the criminal laws related to this subject, following what is provided in Article 225 of the Federal Constitution of 1988. This Law divides crimes into several categories, including crimes against fauna and flora, pollution crimes, crimes related to urban planning and cultural

[90] Partido Social Liberal.
[91] Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis.

heritage, as well as crimes against environmental administration. Responsibility for these crimes falls on both individuals and legal entities (Nascimento *et al.*, 2023).

An important point concerns the way they deal with individuals who commit environmental crimes. This Law does not automatically adopt imprisonment as a punishment for these people. Instead, it values the intervention of the Public Administration, which acts through authorizations, licenses, and permits, focusing on educating the offender and restoring nature as a form of punishment. According to Nascimento *et al*. (2023), this strategy can be seen as more efficient and logical, since when the environment is destroyed, its complete recovery is difficult or even impossible.

To identify environmental damage, an assessment is carried out to confirm the occurrence of environmental crime and, if possible, to calculate the value of the damage caused. This report is made by the environmental expert, whose objective is to prove the existence of the crime and, when possible, to determine the value of the damage caused by the environmental crime. Based on this value indicated in the expert report, the bail amount will be set and the fine calculated in the conviction (Nascimento *et al.*, 2023).

Even during President Jair Bolsonaro's campaign in 2018, his speech was against the environment. Already elected, the president expressed the objective of making Brazil similar to what it was decades ago, that is, to return to a perspective that promoted great transformations, through incentives for infrastructure and agricultural and mining expansion (Gielow; Fernandes, 2018).

With this thought, there was the government's intention to merge Environment and Agriculture into a single Ministry, which attracted a negative repercussion from various sectors of Brazilian and international society that made Bolsonaro retreat from his purpose. According to Scantimburgo (2018),

> Merging the Ministry of Environment with the Ministry of Agriculture would actually mean the extinction of the first. The government would be subjecting the regulator to the sector that should be regulated. More than that, the proposal revealed the inability to understand the need for a well-structured set of laws and supervisory institutions in a country that has 30% of the territory covered by protected areas, between Conservation Units and indigenous lands, and that concentrates the greatest biodiversity on the planet, with 50% of native

> vegetation, in addition to having the largest hydrographic basin in the world[92] (Scantimburgo, 2018, p.105).

Bolsonaro's subsequent retreat on the proposal to merge Ministries does not suggest, however, that the portfolio would follow the environmental agenda to which the country had been committed in recent decades. On the contrary, other actions were taking place during President Bolsonaro's term.

The speeches and actions aimed at easing environmental legislation in Brazil have opened loopholes for offenders, encouraging practices that violate environmental laws. This permissiveness resulted in a significant increase in deforestation, as evidenced by an episode in which the president disallowed an IBAMA inspection operation in Cujubim, state of Roraima, leading to a 455% growth in deforestation in the municipality (Ramos, 2021).

These ambiguous speeches and controversial actions gave rise to interpretations that encouraged or even legitimized such illegal practices (Ramos, 2021). In addition, Minister Salles, shortly after taking office, transferred the ANA to the Ministry of Regional Development, impacting the structure and competencies of the Ministry of Environment (ANA, 2019).

In 2019 and 2020, legal actions against forest degradation in the Legal Amazon reached the lowest level in two decades, which is remarkable considering the alarming levels of deforestation, with 10.1 thousand km² in 2019 and 10.9 thousand km² in 2020 – the highest in 12 years. There was also a drop in notifications for environmental infractions: between 2012 and 2018, the Legal Amazon had an annual average of 4,620 notifications for environmental infractions and fell to 2,610 between 2019 and 2020, a decline of 43.5%, despite the increase in deforestation. The same occurred with the drastic decrease in the number of environmental embargoes, falling from 2,589 in 2018 to 385 in 2020. This suggests a change in enforcement strategy, avoiding immediate economic sanctions to offenders by temporarily blocking the commercialization of products from the area affected by environmental damage (Rajão *et al.*, 2021).

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[92] Free translate of “Fundir o Ministério do Meio Ambiente ao da Agricultura significaria na verdade a extinção do primeiro. O governo estaria submetendo o regulador ao setor que deveria ser regulado. Mais do que isso, a proposição revelava a incapacidade de compreender a necessidade de um conjunto bem estruturado de leis e instituições fiscalizadoras num país que possuí 30% do território cobertos por áreas protegidas, entre Unidades de Conservação e terras indígenas, e que concentra a maior biodiversidade do planeta, com 50% de vegetação nativa, além de contar com a maior bacia hidrográfica do mundo” (Scantimburgo, 2018, p.105).

The IBAMA and the Chico Mendes Institute for Biodiversity Conservation (Portuguese acronym, ICMBIO[93]) are two important entities within the National Environment System. Their role is to execute and ensure the implementation of government policies and guidelines related to the environment, in accordance with their respective competencies. However, these entities faced a reduction in their staff and occupation by officers of the Armed Forces and Military Police in key positions. This change was the result of an orientation given by Jair Bolsonaro and implemented by the Minister of the Environment, with the aim of eliminating what they call "ideology" in the environmental area, promoting a restructuring in the institutes (ASCEMA, 2020).

ICMBIO, as well as IBAMA, has been subject to changes in its structure and a reduction in the number of employees: from 11 directorates, the Bolsonaro government has reduced it to 5, one for each region of the country (BRASIL, 2020b). These directorates are responsible for 334 conservation units throughout Brazil, which cover a protected area of 171,424,192 hectares (ICMBIO, 2021). In addition, it began to allow people who are not part of ICMBIO's career to occupy management positions, with a more expressive presence of Military Police officers at the top of the Institute - the presidency of ICMBIO, for example, was occupied by a colonel of the Military Police of São Paulo, as well as other directors who held important positions within the agency (BRASIL, 2021a).

There was also a drop in the environmental budget of around 30% between 2019 and 2020. In 2019, the Environment Ministry's total budget was around R$ 807 million, and, as of 2020, it had an abrupt reduction to R$ 562 million (BRASIL, 2020c).

Prosecutors then called for the dismissal of the Environment Minister, arguing that he had been acting to weaken the institute. Early in Bolsonaro's government, on February 28, 2019, the Minister dismissed 21 regional superintendents of IBAMA, most of them responsible for areas in the North and Northeast of the country. These dismissals affected the agency's capacity to act in different regions, leaving some superintendencies without heads for months. In addition, some people appointed to leadership positions did not have the necessary requirements, while others did not have the adequate knowledge or experience to justify their choices by Minister Ricardo Salles (New Party[94]) (BRASIL, 2020d).

[93] Instituto Chico Mendes de Conservação da Biodiversidade.
[94] Partido Novo.

Additionally, the Brazilian Forest Service, responsible for the management of public forests and the Rural Environmental Registry, left the Ministry of Environment and was transferred to the Ministry of Agriculture, limiting its performance in environments with divergent objectives, since the former seeks to balance the conscious use of natural resources and the latter prioritizes production and efficiency (Nascimento *et al.*, 2023).

The folder was led by Deputy Valdir Colatto (PMDB). Colatto's appointment to the Brazilian Forest Service reinforces the government's intention to submit the Environment to the influence of the Ministry of Agriculture. This is due to the fact that the deputy has no previous experience in forest management and has a history of opposing positions on environmental issues, supporting the relaxation of the deadline for registration of rural properties in the Rural Environmental Registry and the presentation of bills that proposed the release of hunting wild animals and changes in the demarcation of indigenous lands (Scantimburgo, 2018; BRASIL, 2017c; 2017d).

In 2019, Bolsonaro signed Decree nº 9,760/2019 which established the Environmental Conciliation Center. Nucam, as it became known, would be responsible for "conducting preliminary analyses that may annul or validate infraction notices, as well as deciding on the maintenance, cancellation or conversion of administrative fines imposed" (ICMBIO, 2019). In addition, it would also hold conciliation hearings to present possible legal solutions to end the infraction process (discount for payment, installment payment or conversion of the penalty into preservation services) (ICMBIO, 2019). However, after 2 years of implementation of Nucam, only 252 conciliation hearings were concluded, about 2% of the infractions carried out in the same period - which could increase the risk of prescription of the processes and undue negotiations (Rajão *et al.*, 2021).

In the 1960s, the National Institute for Space Research (Portuguese acronym, INPE[95]) was created. Initially, its function was to coordinate space activities in Brazil and collaborate with other countries in this field. Over the years, INPE has expanded its areas of expertise, including weather forecasting, climate change research, and monitoring deforestation in Brazilian forests. In 2019, INPE released alarming data on deforestation in the Amazon, which displeased the president. In response, INPE's director, Ricardo Galvão, was dismissed and, in 2020, the situation was repeated when INPE's General Coordinator of Earth Observation responsible for monitoring, Lúbia Vinhas, was also dismissed during the release of partial data

[95] Instituto Nacional de Pesquisas Espaciais.

that indicated an increase in Amazonian deforestation for the 14th month in succession (Brzezinski, 2021). These actions and changes have generated debates about INPE's transparency and independence in disseminating important environmental information for decision-making and investments in the Amazon region, such as the Amazon Fund.

The Amazon Fund was created to receive donations that would be invested in efforts to protect the Amazon, such as preventing and combating deforestation, conservation, and sustainable use of the region. It also supports the development of deforestation monitoring systems in other parts of Brazil and in tropical countries (FUNDO, 2023). Since mid-2019, the Amazon Fund has been paralyzed due to changes made by the federal government, which displeased international donors. New projects are not being analyzed and resources already donated, amounting to R$ 1.54 billion, are frozen. In addition, donations to the Fund were suspended with the publication of a decree that revoked the authorization for the National Bank for Economic and Social Development to raise donations (Marcovitch; Pinsky, 2020).

The suspension of donations from Norway and Germany to the Amazon Fund was motivated by the increase in deforestation in the region and by conflicts in negotiations with the Minister of the Environment. The main points of conflict were the lack of a legal and technical basis to continue funding the Fund after the changes in its governance structure and the requirement of the Ministry of Environment to use part of the money to compensate landowners within conservation areas, which goes against previously established guidelines. As a result, the Amazon Fund ended 2019 with its resources frozen and no new projects approved (Marcovitch; Pinsky, 2020).

Between August and September of the same year, the Amazon was hit by devastating fires. The Bolsonaro government, instead of acknowledging the gravity of the situation, downplayed the problem, accused NGOs of starting the fires, and refused foreign aid. This sparked global outrage and further damaged Brazil's international image. In addition, the government questioned the ecological importance of the forest and incessantly reaffirmed the country's sovereign right over the Amazon. For the Brazilian government, global concern about the fires in the region was not considered justified, and the political condemnation of Brazil by the international community was seen as unfair and part of an ideological campaign against the country (Pereira; Viola, 2022).

The dismantling of the environmental agenda was maximized with the appointment of Ernesto Araújo as Foreign Minister, who believed that climate change was an ideology. In his

speech at the Heritage Foundation, the Minister said that globalism operates through three main instruments, one of them being the ideology of climate change, or "climatism", which is different from climate change and would have the purpose of ending normal democratic political debate, creating a "moral equivalent to war", to impose policies and restrictions that run counter to fundamental freedoms. According to the Minister, "They want us to believe that we are in a war for the survival of the planet and that every sacrifice is valid" (BRASIL, 2021b).

The ideology-based view on climate change is allied to the view of Minister Ricardo Salles who considers that the main national and international research bodies, such as the National Institute of Meteorology, INPE, the IPCC, the NASA - among others -, which attest to global warming and have been dedicated for decades to the study of climate problems, are nothing more than dens of left-wing conspiratorial "ideologies" (Scantimburgo, 2018).

Still in 2018, even before assuming the position, Bolsonaro's decision not to host the UNFCCC COP 25, which would continue the negotiations for the implementation of the Paris Agreement, was the first sign of the abrupt change that the new government would bring to the country's environmental policy (Pereira; Viola, 2022). As a result, COP 25 had to be relocated and, in December 2019, was held in Spain.

It is noteworthy here that agribusiness has played a central role in guiding foreign economic policy during the Bolsonaro administration (Lima; Pereira: Barbanti, 2018; Siebeneichler, 2021; Hirst; Maciel, 2021; Branco; Sorpijo; Azzi, 2021). In line with such interests, the Ministry of Foreign Affairs reduced its participation in global negotiations on environmental issues, reducing Brazil's diplomatic influence in this scenario (Hirst; Maciel, 2022).

In the contexto of the “anti-climatism" posture (BRASIL, 2021b, p. 39), the government imposed restrictions on the official delegation during the COP 25, excluding environmental NGOs and keeping only representatives of public authorities. Unlike other meetings, Brazil positioned itself with countries such as the United States, Australia, and Saudi Arabia in an attempt to obstruct the negotiations and with a clear position of discontinuing its leadership position. Minister Salles focused on economic development and agribusiness in the Amazon, ignoring increasing deforestation and violence against traditional populations. Brazil also opposed placing more ambitious obligations in the climate agreement and advocated the use of old carbon credits, as well as the non-inclusion of the expression "climate emergency" in the final declaration of COP 25 (Pereira; Viola, 2022).

However, the participation of agribusiness in the delegation was remarkable, driven by the close relationship between the Ministry of Foreign Affairs and the agricultural sector. In a joint event between Itamaraty and the Confederation of Agriculture and Livestock of Brazil, Minister Ernesto Araújo highlighted the cooperation between the government, the private sector and rural producers, emphasizing the joint role in the so-called "agrodiplomacy" (Siebeneichler, 2021).

In 2020, the country submitted a new NDC, increasing the targets of the previous NDC of 2015. However, the accounting of greenhouse gases that Brazil emitted in 2005, the base year for calculating the targets, was updated with the publication of the Third National Inventory, and there was an increase in the country's emissions that year, from 2.1 $GtCO_2e$ to 2.8 $GtCO_2e$ (BRASIL, 2016c). In other words, the new proposal allows Brazil to emit more greenhouse gases than before, making the target less ambitious (Figure 29).

Figure 29 - Brazilian NDCs

Source: elaborated by the author according to WRI (2021) and UNFCCC (2022b)

If adjusted to reflect the actual increase in emissions in order to maintain the targets of the first NDC, the new proposal should set at least a 57% reduction in 2030, instead of the 50% proposed. In other words, this left the commitment lower than that signed in the first NDC, allowing Brazil to emit up to 400 million tons more greenhouse gases than foreseen in the original target by 2030 (WRI, 2021; OBSERVATÓRIO, 2021). Thus, Brazil would not only fail to meet the target set in the Paris Agreement but would also go backward in the committed goals. This difference became known as "pedalada climática" and was challenged in the Brazilian courts by young activists, with the support of eight ex-Environment Ministers: Rubens

Ricupero, Gustavo Krause, Sarney Filho, José Carlos Carvalho, Marina Silva, Carlos Minc, Izabella Teixeira and Edson Duarte (OBSERVATÓRIO, 2021).

"The Shredding" is a reference to the act of dismantling or fragmenting something in a destructive way. The analysis of the above sections revealed a process of dismantling and discontinuity of environmental institutions and policies, which culminated in a significant increase in environmental crimes, weakening of enforcement actions, relaxation of environmental legislation, and minimization of the importance of protecting biodiversity and combating climate change.

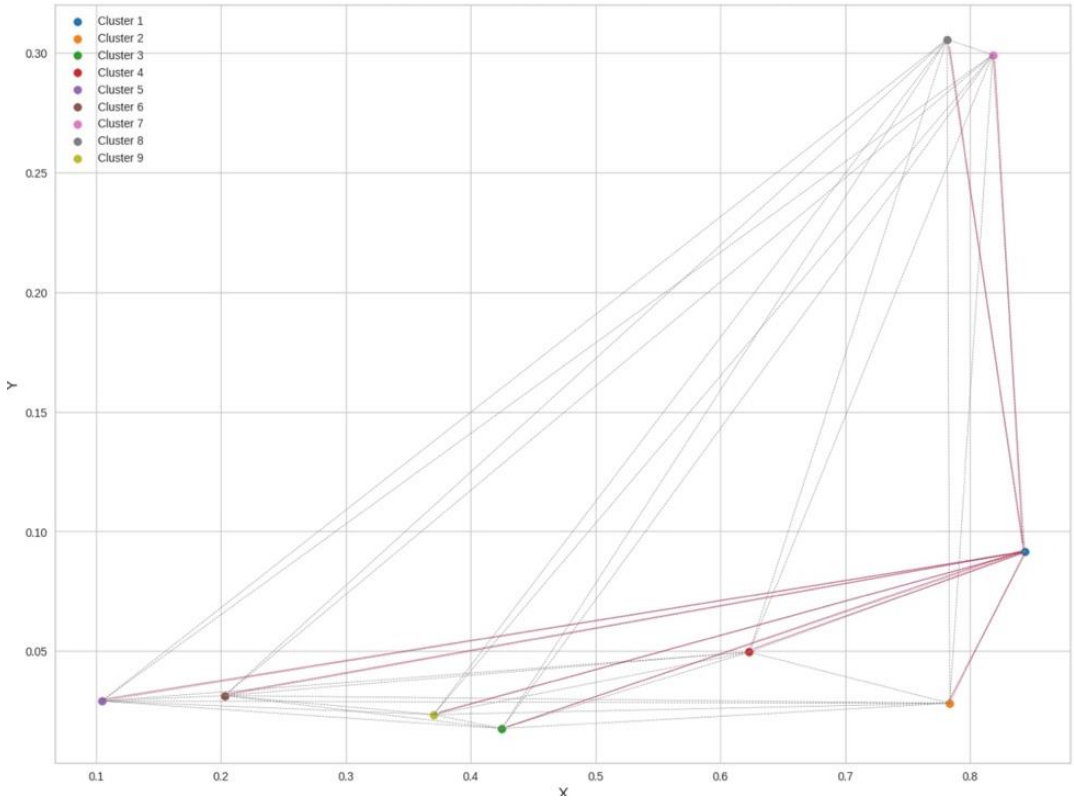
The advance of deforestation and fires in the Amazon was highlighted, as well as economic pressures, the advance of agriculture, and the lack of effective preservation policies were pointed out as the main driving factors of this scenario. In addition, patterns were observed in the expansion of agriculture, prevailing the predatory development model and the lack of incentives for sustainable practices. Finally, environmental policy in Brazil during the Bolsonaro administration revealed a dramatic setback compared to the previous period, with an anti-environmentalist stance and a skeptical approach towards climate change leading to a worrying increase in deforestation in the Amazon.

To validate the analysis presented throughout Chapter 5, the next section will examine the clusters related to data from the period between 2011 and 2020. Through this analysis, it will be possible to verify whether the trends and setbacks identified during the Bolsonaro administration have deeper roots in previous periods or whether they are unique to the period analyzed. In addition, the investigation of clusters will allow a better understanding of the dynamics and patterns of Brazilian environmental policies over the last decade. Through this approach, it will be possible to consolidate the conclusions of the chapter and contribute to a more comprehensive understanding of Brazil's environmental context.

5.4 Slithering on the Institutional Continuum

The same analysis performed on the data from 2001 to 2010 was also performed for the second period, from 2011 to 2020. Similarly, 9 clusters were observed. However, the distance analysis between the clusters' centroids showed that, even if the clusters are well separated, their distribution differs from the distribution of the previous decade, as well as the links between them (Graph 5) – highlighted by the red lines of the graph.

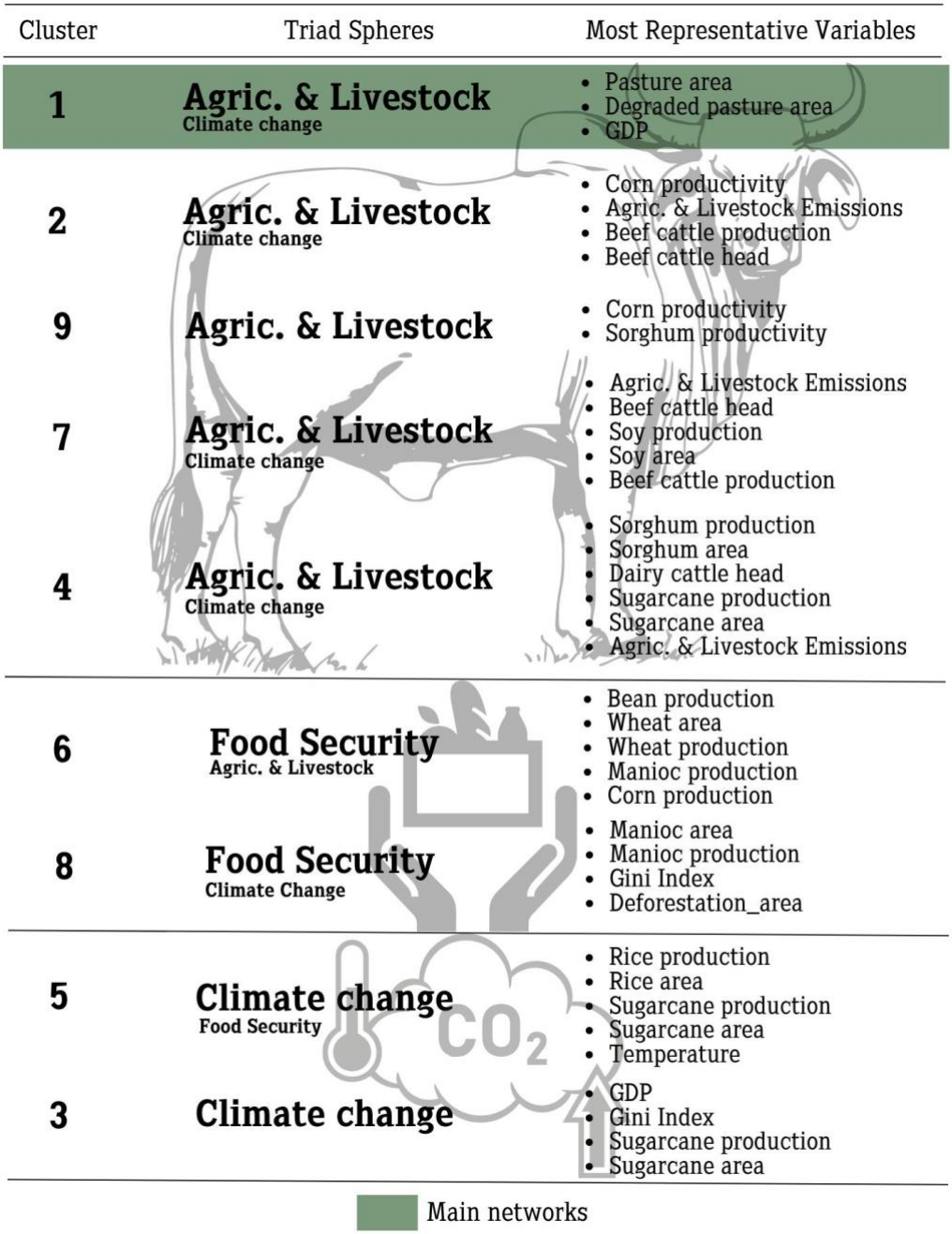
Graph 5 - Distances Between Centroids from 2011 to 2020



Source: elaborated by the author

Despite the very well-defined delimitation among the centroids, it is possible to observe a greater distance to each other. However, the analysis of the clusters' connections suggested a greater divergence of interests in the period analyzed, with a greater alignment with the Agriculture sphere (Chart 5). This validates the hypothesis that when actors have divergent interests, the group aligned with the government is favored.

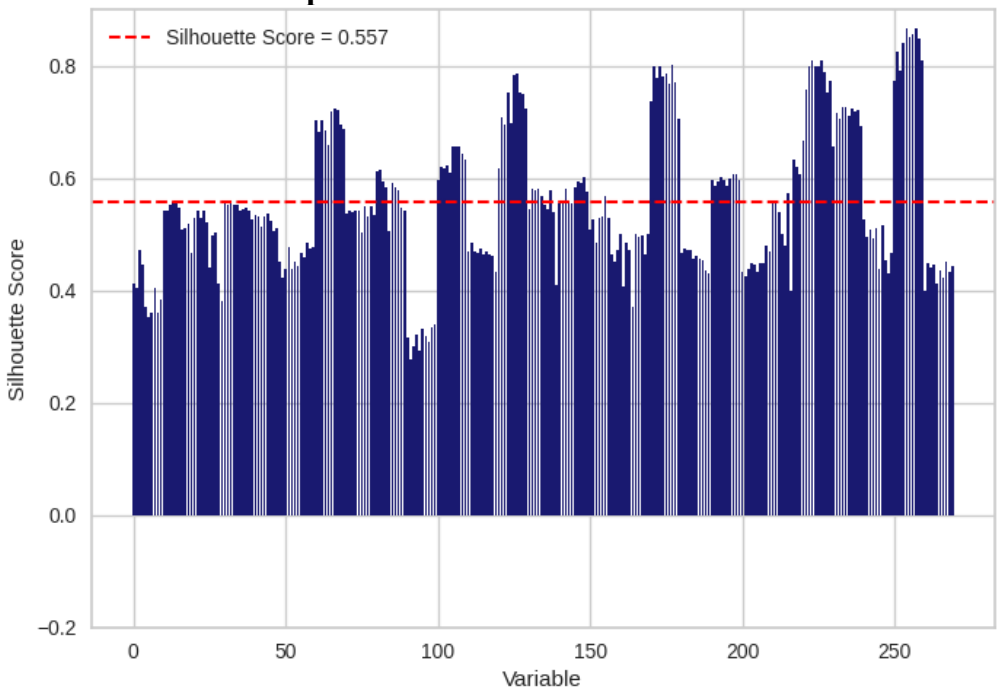
Chart 5 - Predominant aspects of clusters from 2011 to 2020



Source: elaborated by the author

The silhouette score analysis was slightly lower compared to the previous period, justified by the structure of the data. A silhouette score of 0.557 (Graph 6) indicates that the clustering performed less well than the previous one but is still positive. This lower score suggests that the samples are less well-matched to their groups. This may result in less distinct and more heterogeneous groups.

Graph 6 - Silhouette score from 2011 to 2020



Source: elaborated by the author

Comparing a silhouette score of 0.656 to one of 0.557 allows us to understand the nature of the data. A higher silhouette score indicates a clustering with a clearer group structure, while a lower score may suggest a more challenging data structure and a less accurate clustering. This comparative analysis is essential to ensure reliable results and a proper interpretation of the clusters identified in the analysis performed in this thesis.

Even without a more visible delimitation as the clusters of the previous period, it is still possible to analyze some points from the perspective of the events reported previously involving, mainly, the strength of agribusiness interests and the environmental dismantling that occurred in this period. This lack of trade-offs and convergence of interests is visualized in the distribution of clusters among the spheres of the Triad: five clusters are related to Agriculture. With the environmental dismantling in the period, its complexity can be observed during data clustering.

However, as in the previous period, it can be observed that there was a direction of the period by Cluster 1, related to the economic exploitation of pastures for two sets of clusters: grain and livestock production and domestic supply. But always with the emission of greenhouse gases inserted in the clusters. In addition, clusters 2, 9, 7, and 4 join the group of clusters linked directly to Agriculture.

This group of clusters does justice to the considerable increase of the Ruralist Front and its interests in political decision-making in Brazil in the period from 2011 to 2020. With a very solid economic justification, the decisions validate the environmental dismantling and achievements acquired in the field of food security since the beginning of the analyzed time series, 2001. Some points are observed during the analysis of these clusters: the combination of agricultural and economic variables and GHG emissions.

Since 2012, deforestation of the Amazon Forest has increased again (INPE, 2023), and one of its sources was the continuation of large structural projects, such as the Jirau and Santo Antônio hydroelectric dams in the state of Rondônia, the paving of the Cuiabá-Santarém Highway and the Belo Monte hydroelectric in the state of Pará (Aubertin; Jesus, 2021). Hydroelectric dams are seen as an economically viable, clean, and renewable form of energy – and the Amazon, especially, has great hydroelectric potential due to the abundance of water and topographic drops in the tributaries of the Amazon River (Santana; Brzezinski, 2018).

However, the construction of hydroelectric dams, such as the Belo Monte, was the scene of significant social and environmental impacts, something observed in other parts of the world (WCD, 2000). The discourse in favor of hydroelectric dams was old and emphasized progress, jobs, and the expansion of the electricity grid. During the Lula administration, this project was developed under the Growth Acceleration Program, but it was only realized under Dilma Rousseff. By 2020, 10 more medium and large power hydroelectrics were planned in the Amazon basin (Malerba, 2012).

These projects resulted in vegetation loss not only due to direct flooding of the areas but also due to deforestation caused by displaced residents and new immigrants and investors attracted to the region, especially due to the creation of roads to the dam sites and the development of agribusiness driven by the associated waterways (Fearnside, 2019). In addition, there is also a considerable impact on greenhouse gas emissions.

A study by Bertassoli Jr. *et al.* (2021) showed that, even though it is a fraction of what would be emitted by a thermo power station, the construction of Belo Monte tripled greenhouse gas emissions at the site of the current reservoir. These emissions are influenced by factors such as vegetation and soil types, temperature, climate, and activity characteristics. Areas with unremoved pasture, for example, can present significant methane emissions, as the amount of organic matter in the upper part of the soil influences GHG emissions. So, these variations must be considered to properly measure the environmental impacts of a hydroelectric dam, mainly

due to the carbon credits sold without correctly estimating their emissions, which can compromise the effectiveness of mitigation measures (Bertassoli Jr. *et al.*, 2021)

This occurs because many of the dams that receive credit would be built even without this subsidy, allowing credit-buying countries to continue emitting gases without effectively neutralizing the impact of emissions (Fearnside, 2019). Something that has been strengthened over the period is the absence of a serious discussion based on the development of the absorption of new technologies, which impacts and slows down the overall development of the country.

According to Fearnside (2019), there was a structural misinformation regarding Belo Monte. Dam licensing faced several problems that compromised its effectiveness in avoiding serious problems in project execution and left the process without fulfilling its important role of providing information for decision-making on this topic. Thus, the violation of regulations has become the main cause of many of the problems associated with these structures, leading to an imbalance between energy generation, environmental preservation, and economic development.

Belo Monte, as well as the Forest Code, were landmark events in Brazil's environmental scenario in the period analyzed. While the former favored the interests of energy sectors under the developmental justification, the latter involved the interests of agribusiness actors. The variables related to degraded pasture and GHG emissions in the clusters related to agriculture demonstrate not only the strengthening of agricultural actors but also the direction of the type of agriculture carried out: unsustainable and extensionist.

Several policies have contributed to the growth of agribusiness, including labor measures, revision of environmental regulatory frameworks, investments in infrastructure, land use planning, land regularization, and financing (Heredia; Palmeira; Leite, 2010). The result was a concentration of land, without promoting a significant transformation in the land structure. In 2020, INCRA (2020) registered 6,562,058 million rural properties in Brazil, totaling 731,059,518 million hectares of land. The 2017 agricultural census confirms this concentration, with 77% of the land of agricultural establishments in the hands of agribusiness owners (IBGE, 2019).

Consequently, between 1990 and 2018, the area planted with temporary crops in Brazil increased from 45.98 to 73.23 million hectares, mainly concentrated in three products aimed at export or industrial transformation (commodities) - soybean, sugarcane, and corn, consistent

with what was observed in the clusters (Oliveira; Barboza; Alentejano, 2020). The area planted with these three products grew from 27.2 million hectares in 1990 to 61.43 million hectares in 2018 (IBGE, 2020a).

A study conducted with data from soybean-producing municipalities in the state of Mato Grosso between 2004 and 2017 analyzed the relationship between changes in forest cover and the destination of soybean trade annually. The results showed that although 60% of the soy produced in Mato Grosso during the study was destined for international markets, municipalities with the highest and most consistent soy production not destined for export were more associated with deforestation. In addition, in these municipalities, soybean production also showed a significant correlation with the expansion of cattle ranching and pasture areas (Silva *et al.*, 2023).

Another important fact is the growth of cattle breeding, which already exceeds the Brazilian population, reaching 213.5 million heads according to IBGE data (2020b). This activity has expanded in all regions of the country, especially in the Amazon, where the herd grew 40.6% in 2018. Meanwhile, corn production increased by 285.5%, sugarcane by 184.3%, and soybean by 492.5%, indicating the prioritization of export-oriented products or the production of raw materials for the industry to the detriment of food production for the population, resulting in greater food insecurity (IBGE, 2020b; Oliveira; Barboza; Alentejano, 2020).

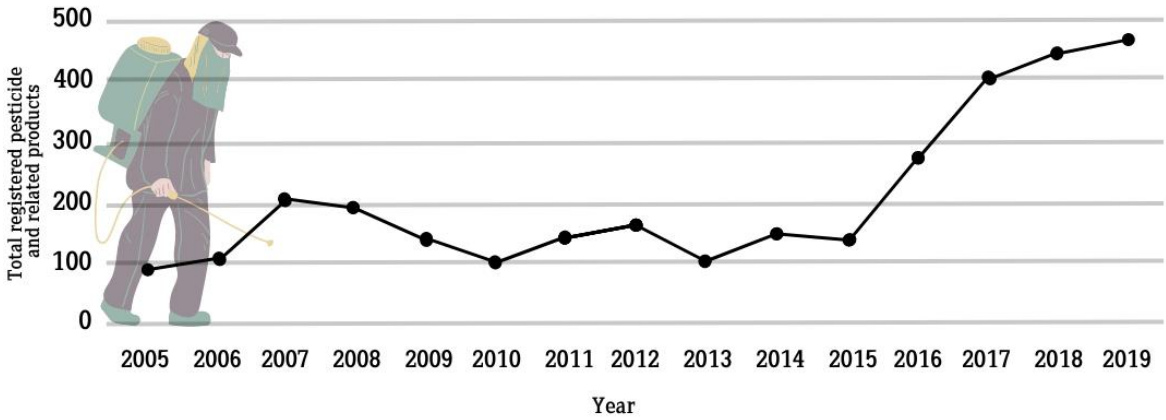
Along with economic growth, agribusiness has gained political strength, with prominent figures from this sector assuming the position of Minister of Agriculture over the past two decades. This political influence is also reflected in the performance of the Ruralist Front in Congress, which has become the largest and most influential sectoral caucus in the Brazilian parliament, corresponding to almost 50% of the House and 40% of the Senate - already deepened earlier in the previous section.

The strengthening of the Ruralist Front goes beyond the defense of agribusiness interests in Congress, as it establishes articulations with other caucuses, such as the evangelical and arms caucuses. This political influence increases the ability of agribusiness to push for public policies favorable to the sector (IBGE, 2020b; Oliveira; Barboza; Alentejano, 2020), such as the loosening of environmental standards observed in this period. One of the results of this was a considerable increase in agrochemicals.

Brazilian legislation defines agrochemicals as products and agents of physical, chemical, or biological processes used in the sectors of production, storage, and processing of agricultural products, pastures, protection of forests (native or planted), and other ecosystems (BRASIL, 1989). Since 2015, the average consumption of agrochemicals per person in Brazil has been high, exceeding 16 liters per year in some regions. This scenario has worsened since 2016, with a significant increase in the release of new agrochemicals, especially from 2019, during the Bolsonaro government (Carneiro *et al.*, 2015).

In 2019 alone, the government registered the release of almost 500 pesticides (G1, 2019b), setting a record for the number of products authorized in a single year. This amount was the largest ever documented by Mapa, the agency responsible for disclosing this data since 2005 (Graph 7).

Graph 7 - Agrochemicals and related products registered by year in the period 2005 to 2019



Source: based to Souza *et al.* (2020) and BRASIL (2019)

Even during the pandemic situation, pesticide-related activities were considered essential under Provisional Measure 926 and Decree 10.282/20. To this end, there is support for the acceleration and approval of new agrochemicals by actors linked to agribusiness, who claim that these products are inevitable for the viability of the current production system, such as Bayer, Syngenta, Basf, Du Pont, besides the Brazilian Nortox and the Chinese Adama. These actors even supported Law nº 6,299/2002, known as the Poison Law, which proposes measures to further streamline the approval of agrochemicals, allowing automatic authorization if it has already occurred in countries such as Europe or the United States – however, this project does not address the fact that many products banned in these countries are approved in Brazil (Lima; Oliveira, 2020).

The fact that only two clusters related to the Food Security sphere appear shows the weakening of agrarian reform and family farming in this period analyzed. Since the beginning of the period analyzed, a movement has gained strength in Brazil with the aim of elevating agribusiness to the position of one of the fundamental pillars of the country's economy.

In this process, agrarian reform was often considered outdated, and rural social movements were labeled as violent and backward. Small farmers, with land up to 10 hectares, represented only 2.3% of the total agricultural establishments in the country (Oliveira; Barboza; Alentejano, 2020). The growth of agribusiness has not translated into improvements in the food conditions of the Brazilian population. On the contrary, food insecurity in the country has increased.

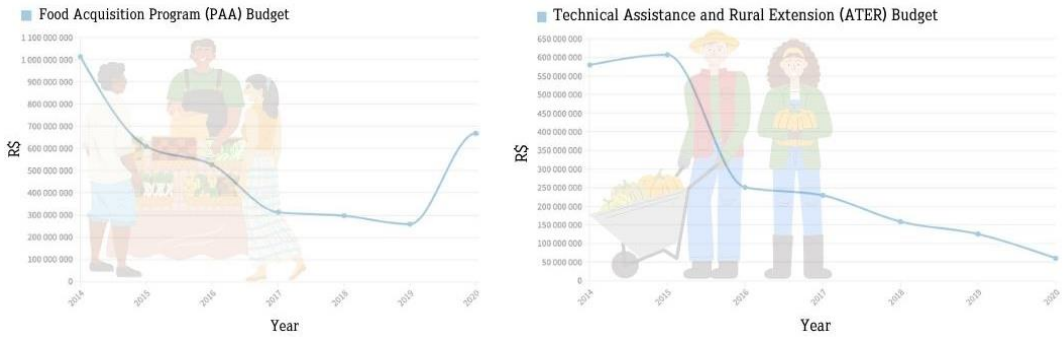
The production of three essential foods for Brazilians' diet - rice, beans, and manioc - has undergone a significant change. Even though rice production outpaced population growth between 1990 and 2018, bean production lagged population growth. The most alarming scenario is that of manioc, whose production decreased by 27.5%. As a result, the availability of food per inhabitant was reduced by 1 kg of beans and almost 80 kg of manioc country (Oliveira; Barboza; Alentejano, 2020; IBGE, 2020b).

The relationship between manioc and the Gini index is directly linked to poverty reduction in rural areas. Small farmers and agroindustries have increasingly invested in the production of delicacies, providing added value to the root and improving income, quality of life, and sustainability in rural areas. Genetic improvement research has also allowed access to more nutritious varieties suited to the demands of the industry, benefiting around one million rural workers, and contributing to leaving poverty among those who work with this crop behind (EMBRAPA, 2015).

An FAO report highlights that the increased demand for manioc offers farmers the opportunity to intensify production and increase their income. Considered the "food of the poor", manioc is a versatile crop that meets the needs of developing countries and the challenges of the global economy to adverse climatic conditions and can be grown with little water. In addition, the combination of ecosystem processes and proper use of non-chemical fertilizers creates a sustainable crop nutrition system – the use of agrochemicals is generally ineffective and rarely economical. As a multipurpose crop, manioc serves as food, animal feed, and raw material for various products (FAO, 2013b).

Several food programs that were part of food and nutrition security policies faced significant budget reductions and, in some cases, were terminated. The PAA, for example, had a budget reduction of 77.3% in 2019 compared to 2014 (due to the pandemic, in 2020 the PAA received a budget increase of R$ 500 million by Provisional Measure 957 and pressure from the National Articulation of Agroecology). In addition, the Technical Assistance and Rural Extension Program (Portuguese acronym, ATER[96]) saw its budget fall by 89.6% in six years (Graph 8). In 2019, the National Council for Food and Nutrition Security, which monitored food programs, was abolished (O JOIO, 2022).

Graph 8 - PAA and ATER Budgets



Source: according to O Joio (2022) with Ministério da Cidadania and Ministério da Agricultura, Pecuária e Abastecimento data

One of the factors that contributed to the weakening of these programs was the fiscal crisis of the Dilma government (2011-2016). However, the situation was aggravated in the subsequent administrations of Temer and Bolsonaro, with the dismantling of ministries and secretariats responsible for strategies to combat hunger. The budget decline and bureaucratic disruption have hampered the performance of programs and affected the quality of work in the field (O JOIO, 2022).

As in the period analyzed before, the variables related to rice and sugarcane also appear in the clusters related to Climate Change, with the first being sensitive to high temperatures (Cluster 5) and influencing food security and the latter resistant to water stress (Cluster 3).

What draws attention in this period was the revocation of Decree 6,961, of September 17, 2009. The decree – revoked in 2019 by the Bolsonaro government – established limits on the expansion of sugarcane production in areas such as native forests, indigenous lands, the Pantanal, and the Amazon. On the one hand, the government argued that the 2012 Forest Code already placed limits on deforestation and that the previous legislation negatively impacted

[96] Programa de Assistência Técnica e Extensão Rural.

sugar and ethanol mills. On the other hand, environmentalists argued that, with this decision, there would be no more restrictions on planting the crop in the country, which could loosen environmental control against deforestation (G1, 2019a).

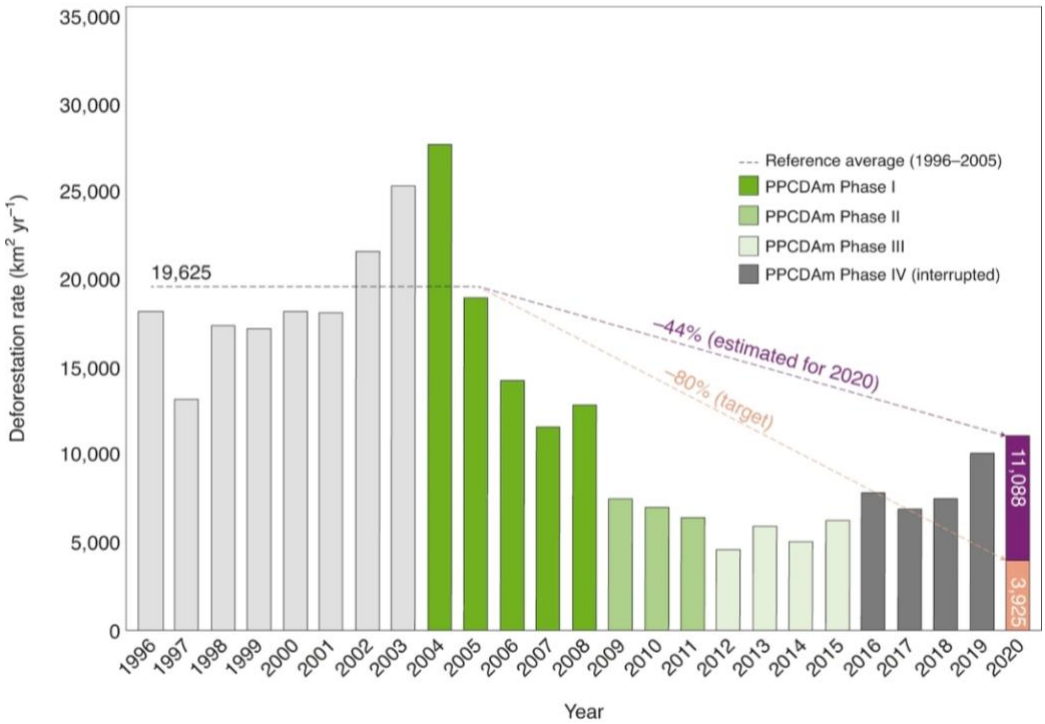
However, since 2005, Brazil has considerably decreased deforestation in the Amazon, and in 2012, the country achieved an unprecedented feat among tropical countries by reducing deforestation in the Amazon by 84%, equivalent to 4,571 km^2. This achievement was due to the combination of government initiatives, such as the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (Portuguese acronym, PPCDAm[97]), and international pressure, such as the soy and beef moratoriums (Silva Junior *et al.*, 2020; Nepstad *et al.*, 2014).

The soy moratorium was a historic milestone, being the first voluntary zero-deforestation agreement implemented in the tropics. Implemented in response to pressure from retailers and NGOs, this voluntary agreement set zero deforestation as a target for soy production in the tropics. Major soy traders agreed not to buy soy grown on deforested land after July 2006 (Gibbs *et al.*, 2015). Between 2004 and 2012, the soy moratorium proved to be a successful conservation policy, avoiding about 18,000 km^2 of deforestation in its first decade (Heilmayr *et al.*, 2020) and becoming an inspiring example for the adoption of similar zero-deforestation commitments in other commodities such as beef and palm oil (Gibbs *et al.*, 2015).

A remote sensing study showed that the soy moratorium played a key role in reducing deforestation for soy production. Before, the rate of deforestation and the conversion of forests into soybean cultivation areas were significantly higher than after its implementation (Kastens *et al.*, 2017). However, since 2013, the official deforestation rate has shown an upward trend, worsening in 2019 and 2020 (Graph 9). In 2019, 10,129 km^2 of forest was cleared, and in 2020, 11,088 km^2. An increase of 34% and 47% compared to 2018, respectively – considered the highest rate of the decade. This represented a rate 182% higher than established (emitting about 648 Tg CO_2), causing Brazil to fail to reach its deforestation reduction target (Silva *et al.*, 2020).

[97] Prevenção e Controle do Desmatamento na Amazônia Legal.

Graph 9 - High deforestation in the Amazon



Source: Silva Junior *et al*. (2020)

This growth was driven by environmental setbacks, including controversial changes to the Brazilian Forest Code in 2012, weakening of enforcement actions by the Ministry of Environment, and bills that could regularize the grabbing of public lands. This situation generated a national and international commotion for effective action, involving ex-Environment Ministers, environmentalists, business entities, NGOs, and international organizations, such as the OECD and the European Union (Silva Junior *et al*., 2020; Barlow *et al*., 2020; ASCEMA, 2020).

The environmental dismantling measures taken between 2011 and 2020 impacted foreign policy and previously agreed goals, diminishing Brazil's environmental prominence. Between 2010 and 2020, it was estimated that 197 billion reais would be needed for the ABC Program. However, the reality diverged from this scenario, as only 1.6% of this amount was allocated to low-carbon technologies (IMAFLORA, 2015). The ABC Program, which aims to finance sustainable agricultural practices, contracted only 11.15 billion reais between 2010 and 2015, indicating a weak demand according to the Getúlio Vargas Foundation (FGV, 2014).

Bureaucratic difficulties, lack of support, and inadequacy of projects for small farmers may have contributed to this scenario (IMAFLORA, 2015). Pasture recovery techniques, such as corn and soybean rotations, favor large properties and do not address the needs of family

farming (Aubertin; Jesus, 2021). This can be explained by the interest and alignment between Executive and Agribusiness actors.

Agrarian reform and the look at the small producer decreased in this period with the weakening of policies and programs aimed at this purpose, such as the extinction of the MDA. This reflects the duality in Brazilian agriculture, which can make it difficult to achieve mitigation goals in agriculture and livestock. While the Ministry of Agrarian Development was in charge of the National Plan for Agroecology and Organic Production, whose small scale was not considered relevant to the national contribution, it is in the MAPA that focuses on agribusiness projects for the future (Aubertin; Jesus, 2021).

Even favoring large producers, the ABC Program also faced difficulties in this group: although 5 million hectares of degraded pastures out of a total of 15 million were recovered, only 1 million hectares were destined to the Crop-Livestock-Forest Integration System, indicating a timid fulfillment of the goals – results presented at COP 21 (Aubertin; Jesus, 2021). These data reflect the growth of agribusiness to the detriment of the production of essential food for the people, impacting, being necessary a look to promote policies that value family farming and encourage sustainable food production.

Between 2011 and 2020, the divergence of interests was more pronounced. The analysis of the connection between the clusters pointed to greater distancing. The growth of agribusiness proved to be a determining factor in this period, with a greater prevalence of the discourse in favor of progress and economic development. Thus, it was possible to observe an alignment of the Agricultural sphere with the Executive through the strengthening of actors such as the Ruralist Front in Congress – influencing decision-making and weakening agrarian reform policies and support for family farming.

The production of commodities for export prevailed over the production of food for the population, and small farmers and family farming were relegated to the background. This has led to greater neglect in the environmental and social fields. The loosening of environmental standards and the lack of investment in sustainable agricultural practices demonstrated the prioritization of economic interests over health and the environment.

Brazil, once an environmental leader, has lost prominence in foreign policy and mitigation targets - and the duality in Brazilian agriculture has made it even more difficult to achieve mitigation goals. In addition, the fiscal crisis of the Dilma government contributed to

the weakening of environmental policies, which were aggravated in subsequent administrations.

In view of these analyzed challenges, it is possible to observe that there is a contribution from Brazil in the landslide between Captain Gaia and Captain Degradation in the Institutional Continuum. Thus, finding a balance between the Triad of Agriculture - to produce food and assist in economic development, and Climate Change - to prevent environmental collapse, and Food Security - to feed and nourish a growing population is essential to ensure a sustainable future. And walking a path in the materialization of the Captain Triadic may be the solution.

CONCLUSION

Writing using storytelling in the thesis was a challenge - which I could realize was greater during the writing. Despite the direction of Timothy Pollock's book "How to Use Storytelling in Your Academic Writing" (2021) for writing, it was necessary to adapt it to the reality of a thesis. It was fascinating and challenging to seek an intersection between Academia and history. Thus, this conclusion will be based on the storytelling steps used here.

The Exposition

In 2015 I watched the movie Interstellar while doing my Master's in Applied Meteorology, working with agricultural data. Working with food systems had been in my life for more than a year and that day I reflected on how sensitive agriculture is to climate change and how much it is needed on Earth. A while later, watching The Martian and seeing the survival of an astronaut on Mars by planting potatoes, I also saw the importance of agriculture in human survival - even if on another planet. With that, the connection of agriculture, climate change, and food security was inserted in my life, first in reflections and later materialized in my thesis.

In this way, developing the problem proposed in the "Exposition" stage through a historical magnifying glass shown in Chapter 1, allowed me to go deeper into the connection between Agriculture, Climate Change, and Food Security - a connection I called the Triad. The proposal was to bring the construction of the Triad throughout history, with the development of *Homo sapiens* influenced by the Neolithic Revolution.

It is interesting to realize that agriculture emerged not through commodities, but as a means of subsistence. The techniques of pastoralism and slash-and-burn allowed the development of a social organization. Thus, to evaluate all land use changes caused by agriculture with the same weight is to invalidate the whole process and the importance it had in human development; it is to invalidate the cultural weight that agriculture has in different parts of the planet.

With the Neolithic Revolution preceding the Industrial Revolution, it was possible to observe the transition from self-sufficient communities to a growing population concentrated in cities - which required the expansion of food availability. Thus, there was an advance beyond pastoralism and slash-and-burn techniques - justified in the transition from an agrarian and artisanal economy to an economic development pattern dominated by industries - which

impacted the balance between the agricultural system, the environment, and the Earth's climate. This has resulted mainly in the overuse of natural resources and higher GHG emissions.

Years later, there was the Green Revolution, with the goal of large-scale food production. The countryside started to work with genetically modified seeds, machinery, and expansion of cultivation area. But this did not make the world achieve food security, as food distribution still remained an issue. Additionally, there was an increase in land conversion for agricultural use, generating several environmental problems, such as uncontrolled deforestation and soil degradation.

In the cartoon, Captain Gaia went with the phrase "The Power is Yours!". And what I understand from this is that Homo sapiens has the power to modify its reality in the world, especially to protect it. Since the 70s, these attempts have been made with different motivations. In '72, Stockholm, aimed to curb the development of developing countries in favor of the preservation of natural resources. In 92, Rio, implemented sustainable development. In '97, Kyoto, aimed at agreements so that sustainable development incorporates the reduction of GHG emissions.

However, going through different agreements, different techniques, and different proposed contributions, we remain at 97 regarding the resolution of the problem - I recognize, with several advances, but without an effective solution – but with the increase in GHG emissions and the consequent increase in global temperature of 2023.

In this way, a New Hope would be the change of direction in the Institutional Continuum, instead of staying at the extremes and maintaining this dichotomy between Captain Gaia (protector of the environment) and Captain Degradation (economic development at any cost), building a Captain Triadic, who remains in a balanced dance of the Continuum. To do this, it was necessary to understand the trade-offs that occur in the Triad.

The Rising Action

In This is the Way I show how the way to build Captain Triadic, using Brazil as an example, for its agricultural potential, exporter, and holder of natural resources. For this, I had as a guiding question: how do the actors linked to the spheres of the Triad articulate themselves at the domestic level influencing the formulation of Brazilian foreign policy in the International Climate Change Regime?

The hypothesis suggests that if actors have common interests, then there is a greater likelihood of a Triad articulation and a common proposal for foreign policy formulation. On

the other hand, if the interests are divergent, this articulation will be more difficult, and, most likely, the formulation of foreign policy will be favorable to the Triad sphere aligned with the interests of the Executive. To this end, it was necessary first to identify the groups and their interests in each sphere of the Triad; second to analyze the influence of the Triad on the formulation of Brazilian foreign policy and to identify the convergence and divergence of interests in the articulation of the Triad.

To understand the actors, it was necessary to understand the network of games in which they were involved. Thus, a previous analysis of the analyzed period was carried out. In this way, the academic texts and technical reports allowed me to better understand the construction of the Triad and possible trade-offs between its spheres – as well as to identify the actors. This allowed me to separate some key events to analyze in the following sections – which was necessary due to the time series worked on: the period from 2001 to 2010 and from 2011 to 2020.

With the key-events selected, I was able to analyze nested games and two-level games, allowing me to understand what was happening at the domestic level, the main focuses of the political agenda of the government in office and the influence of this on its behavior in the International Climate Change Regime.

In fact, analyzing key events from the two proposed periods makes me swim in interpretive limitations and analytical biases. However, having used quantitative data to support these analyses allowed the in-depth analysis to be grounded in the interpretation carried out. Thus, the selected dataset aimed to cover the spheres of the Triad and its main interests. However, it was not possible to collect data related to foreign policy, which was done only through documentary analysis.

With such data, the correlation between the variables and the possible convergences and divergences of interest between the spheres of the Triad could be observed through the clusters generated by KMeans, an unsupervised learning algorithm.

In Lights, Camera, Action! – and supported by the theory of Tsebelis of nested games, – I was able to deepen my understanding of the actors of the Triad. It was possible to observe that there was not a significant change in the actors themselves but in their influence on public policymaking - including foreign policy. Analyzing a few decades before the chosen time series, Brazil's behavior in the International Climate Change Regime has always been of protagonism, even if with different motivations.

The Climax

When analyzing the time series, a break in political direction was observed that began with Dilma Rousseff's first term and strengthened until the Bolsonaro government. Thus, it was chosen to divide the time series into two periods, as previously mentioned, from 2001 to 2010 and from 2011 to 2020. This break was also observed in the strengthening of actors present in Brazilian politics in previous decades, such as the Ruralists.

In the first period, analyzed in The Gambit, the last years of President FHC there were some movements towards environmental issues, such as the creation of the ANA, but with a more developmental bias. The breakthrough came, in fact, in the Lula government - especially in relation to the Triad. The Fome Zero Program clearly demonstrated the government's purpose with socioeconomic development and food security. Externally, the ABC Plan was presented during COP15, showing Brazil's behavior motivated by increasing agricultural production and mitigating climate change. In the future, it was developed as a public policy through the ABC Program.

So, it was possible to observe a greater convergence of interests between the spheres of the Triad: there was an increase in socioeconomic development, incentives aimed at agribusiness and family farming, and a considerable decrease in greenhouse gas emissions, a gain for environmental actors.

In the second period, however, t was observed that the agribusiness sector was further strengthened, initiating a fragmentation of environmental policies. In The (un)Code, I addressed the discussion of the new Forest Code in the first Dilma government, which was not well accepted by environmentalists nor by the agricultural sector. While one side claimed that there would be greater openness to deforestation in protected areas, the other side claimed that the code was too rigid. This clash was also perceived in the National Congress. At the international level, Brazil published its NDC at the UNFCC, with bold targets for reducing GHG emissions.

In Temer government, the apparatus of favoring ruralists was strengthened, such as actions that favored land grabbing. In addition, it paved the way for the election of Bolsonaro in 2018 - who, since the election period, was skeptical about climate change and, in the future, surrounded himself with ministers who supported his beliefs.

The Dismovement addresses the Bolsonaro government due to the fact that this period was observed as a setback on the political chessboard. There was an advance in the discontinuity of environmental and agrarian reform policies, which considerably impacted several previous

achievements. The alignment of the Ruralist Front with the Bolsonaro government was perceived both domestically and internationally. In the former, there was an increase in land deforestation, food insecurity, and environmental crimes due to improper occupation. Externally, there was the suspension of the Amazon Fund and, during COP 26, the Brazilian delegation was formed mostly by agribusiness sectors.

The Falling Action

Cluster analysis confirmed the political redirection that took place in the two analyzed periods. In Chapter 4, the suggestion for the build of the Captain Triadic is due to the observed convergence of interests. Even though Food Security guided the other clusters, it was a period marked by the trade-offs of Agriculture, Climate Change, and Food Security. Public policies such as the ABC Program and the PAA show that a convergence of interests favoring the three spheres of the Triad is possible.

Alignment with food security allows other clusters to develop. Therefore, it was observed that having this focus on the Triad as a guide allows for favoring the other spheres. On the other hand, the analysis carried out in Chapter 5 demonstrated the strengthening of clusters linked to Agriculture. It is possible to conclude that the divergence of interests focused on the agricultural sector harms the other spheres of the Triad.

As for deforestation, it was observed that it was not shown as a weight variable in any of the clusters. Possibly due to the division of the time series into two periods. To analyze this point, a better exploratory analysis of the data would be necessary.

Dénouement

According to Freytag's Pyramid adapted for the writing of this thesis, *Dénouement* would be the final message, the moment when tensions are relieved and a sense of resolution to the problem is established.

However, kind reader, I regret to inform you that such a sense cannot be established here. There is, of course, a conclusion to the thesis based on what has been written and researched. But for the topic addressed, there is much to be done and researched to ease tensions.

Politics is a chessboard. You do not need to be an expert player to understand that many moves require the sacrifice of some pieces for a greater move; that you will hardly enter the game keeping all the pieces intact, without losing any. In a game of chess, players strategically

place their pieces on the board, aiming to protect their king and capture the opponent's king - that is, aiming at their own interests. However, at a certain point in the game, a player is faced with a situation where he or she needs to make a strategic move that may involve sacrificing a valuable piece in exchange for a positional advantage or giving up an offensive move to strengthen the defense.

At this point, the player needs to make a difficult decision, considering both short- and long-term consequences. Just like in chess, these political trade-offs involve carefully assessing the possible consequences and calculating the risks and benefits involved. Each policy decision is like a move on the board, where leaders must consider not only their own strategies but also the actions and reactions of other policy actors. The goal is to find the balance between different interests, make decisions that benefit society, and move towards the set political objectives. As in chess, the political game requires strategy, careful analysis, and the ability to deal with the trade-offs inherent in each move.

However, the political polarization that has fortified in Brazil since the second period has made these moves increasingly difficult, based on the belief that if a side that is historically considered antagonistic benefits, automatically the balance will be negative for the other side. What I show in this thesis goes beyond the influence of domestic politics on foreign policy; I show that according to the data analyzed, the convergence of interests is the best solution for the balance not to be negative for any sphere - in the present and in the future.

On the Brazilian political board – and I believe on the democratic board - movements are expected to aim at the main game. And it is understood that when this does not occur, in the nested games, it is still for a greater benefit in the main game. What has been observed since the second political period analyzed in this thesis, is a lack of purpose in these moves that constantly target the main game, as the only necessary and available game. There are no strategic moves, only single moves towards the Institutional Continuum that the whole interest of that sphere is based on.

That way, there are no win-sets. There are no small victories or bargains. And, when there are, the small victories do not take that sphere towards its Institutional Continuum. What the data shows is that movements aiming only at the end (greater production, greater environmental preservation, greater productivity) are not sustainable. Food on the table, lower greenhouse gas emissions, reduced deforestation, and increased crop and livestock production are not seen as a victory for Brazil when the opposition is in power. Even if actors benefit

indirectly from the public policies put in place, they will fight against them to change the *status quo*.

And it is important to stress that the economic factor is a driving force in the behavior of countries at the national and international levels. Therefore, it should not be put aside or as an antagonist when developing issues related to the Triad, but should be incorporated into decisions, in a joint manner, building the Triadic Captain in the Institutional Continuum. The main reason for working with this theme in the thesis, bringing quantitative data, is to make a chorus for this, that it is not necessary to choose, but to incorporate.

In addition, the issue of food production and Brazil as one of the main stakeholders shows that it does involve logistics and cooperation but, more than that, the will to solve this problem. The lack of international movements, such as meetings and agreements focused on this issue, as there is for climate change, can greatly reduce the possibilities of solving this issue.

Food should also be treated as a natural resource since it is necessary for the maintenance of life. If food security is not seen as a problem that should be addressed by Heads of State and Government, it will be difficult to maintain food access, availability, and maintenance for all. I believe that Brazil is a powerhouse for the great challenge of supplying humanity if there is sustainable development, which looks inwards wisely without leaving the outside aside.

Besides, the monitoring of the entire agricultural chain is essential for greater intertwining of the Triad – unfortunately, it is still comfortable for the trader not to have a traceability of the production chain. However, there is a need for alignment between the two levels of the game: for one side to opt for sustainable measures in the production chain, the other side must demand it – or at least have some kind of incentive even before there is legislation on it. It would be a golden opportunity for Brazil to dominate this market and be, once again, a protagonist in the Institutional Continuum.

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APPENDIX

Source data

The data were chosen according to availability in the database and relationship with the spheres of the Triad.

Chart 1A -The Triad dataset

Variable	Unity	Data Source
Temperature	ºC	CRU TS v4.05
Deforestation_area	ha	MAPBIOMAS
Hotspots_area	ha	MAPBIOMAS
Rice_area	ha	CONAB
Rice_productivity	kg/ha	CONAB
Rice_production	kg	CONAB
Corn_area	ha	CONAB
Corn_productivity	kg/ha	CONAB
Corn_production	kg	CONAB
Bean_area	ha	CONAB
Bean_productivity	kg/ha	CONAB
Bean_production	kg	CONAB
Sugarcane_area	ha	CONAB
Sugarcane_productivity	kg/ha	CONAB
Sugarcane_production	kg	CONAB
Soy_area	ha	CONAB
Soy_productivity	kg/ha	CONAB
Soy_production	kg	CONAB
Sorghum_area	ha	CONAB
Sorghum_productivity	kg/ha	CONAB
Sorghum_production	kg	CONAB
Wheat_area	ha	CONAB
Wheat_productivity	kg/ha	CONAB
Wheat_production	kg	CONAB
Manioc_area	ha	IBGE
Manioc_productivity	kg/ha	IBGE
Manioc_production	kg	IBGE
Dcattle_production	t	IBGE/SEEG
Dcattle_head	heads	IBGE/SEEG
Bcattle_production	l	IBGE/SEEG
Bcattle_head	heads	IBGE/SEEG
Gini Index	-	IBGE/SIDRA
GDP	R$	IBGE/SIDRA
Crop_area	ha	MAPBIOMAS
Pasture_area	ha	MAPBIOMAS
Agriculture & Livestock CO_2e Emissions	(t)GWP-AR5	SEEG
Degraded pasture area	ha	MAPBIOMAS

Source: elaborated by the author

The Code

The code was writing by using the Colaboratory, from Google, which allows to wirte and execute Python just by using some browser.

Importing the libraries

```
# Install the kmeans feature importance library
! git clone https://github.com/YousefGh/kmeans-feature-importance.git
! mv "./kmeans-feature-importance/kmeans_interp/" "."

import numpy as np # linear algebra
import random
import pandas as pd # data processing, CSV file
from pandas.plotting import table
import matplotlib.pyplot as plt
import seaborn as sns # data visualization library
import os

from sklearn.preprocessing import MinMaxScaler
from yellowbrick.cluster import KElbowVisualizer
from scipy.cluster.hierarchy import linkage
from scipy.cluster.hierarchy import dendrogram
from sklearn.decomposition import PCA
from sklearn.cluster import KMeans
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.metrics import mean_squared_error
from sklearn.linear_model import LassoCV
from sklearn.experimental import enable_iterative_imputer
from sklearn.impute import IterativeImputer
from sklearn.metrics import silhouette_score

from scipy.cluster.hierarchy import dendrogram, linkage, fcluster

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

import copy

import warnings

#from kmeans_interp.kmeans_feature_imp import KMeansInterp

warnings.filterwarnings('ignore')
```

Loading the dataset

```
from google.colab import drive
drive.mount('/content/drive')
```

```
# filepath = "drive/MyDrive/Doutorado/TESE/Dados/ZALF/"
filepath = "/content/drive/MyDrive/Colab Notebooks/Data_Thesis_Carol Maria/Data_New"
data = pd.read_excel(filepath + '/Dataset_2_2023_2001a2010.xlsx') #the data for the second period was Dataset_2_2023_2011a2020.xlsx
data.head(7)
```

```
data.shape[0]
```

Data preprocessing - mice algorithm

```
data.describe().T
```

```
# Remove 4 columns as index base
df = copy.deepcopy(data)

df.drop(df.columns[[0, 1, 2,3]], axis = 1, inplace = True)

df
```

```
# Check for missing values and zeros in the dataframe
missing_values = df.isnull().sum()
zero_values = (df == 0).sum()
print("Missing Values:")
print(missing_values)
print("Zero Values:")
print(zero_values)
```

```
#Replace zero values by NaN
df[df == 0] = np.nan
```

```
#Run the MICE algorithm for imputation of NaN values.
imputer = IterativeImputer(random_state=0)
imputed_values = imputer.fit_transform(df)
imputed_df = pd.DataFrame(imputed_values, columns=df.columns)
```

```
# Recheck for missing values in the new dataframe
missing_values_imputed = imputed_df.isnull().sum()
zero_values = (imputed_df == 0.00).sum()
print("Valores ausentes:")
print(missing_values)
print("Valores zero:")
print(zero_values)
```

Standardization

```
#Creating the MinMaxScaler object
scaler = MinMaxScaler(feature_range=(0, 1))

#Scaling the dataframe
df_scaled = scaler.fit_transform(imputed_df)

#Creating a new dataframe with the scaled data
df_scaled = pd.DataFrame(df_scaled, columns=imputed_df.columns)


df_scaled.head(7)
```

```
#Recheck for missing values
nan_values = df_scaled.isna().sum()
print("Valores NaN:")
print(nan_values)
```

Kmeans

```
#find outliers
def outlier_thresholds(dataframe, variable):
    quartile1 = dataframe[variable].quantile(0.01)
    quartile3 = dataframe[variable].quantile(0.99)
    interquantile_range = quartile3 - quartile1
    up_limit = quartile3 + 1.5 * interquantile_range
    low_limit = quartile1 - 1.5 * interquantile_range
    return low_limit, up_limit


def replace_with_thresholds(dataframe, variable):
    low_limit, up_limit = outlier_thresholds(dataframe, variable)
    dataframe.loc[(dataframe[variable] < low_limit), variable] = low_limit
    dataframe.loc[(dataframe[variable] > up_limit), variable] = up_limit

for col in df_scaled.columns:
    replace_with_thresholds(df_scaled, col)
```

```
plt.figure(figsize=(20,12))
sns.boxplot(data=df_scaled)
plt.xticks(rotation=90)
plt.title('Boxplot_thesis_dataScaled')

plt.savefig(filepath + 'FIG1_Boxplot')
plt.show()
```

```
#Clustering
km = KMeans()
ssd = []
K = range(1, 30)
```

```
for k in K:
    km = KMeans(n_clusters=k)
    km.fit(df_scaled)
    ssd.append([km.inertia_])

ssd

plt.plot(K, ssd, "bx-")
plt.xlabel("Distance Residual Sums for K Values")
plt.title("Elbow Method for Optimum Number of Clusters")

plt.savefig(filepath + 'FIG2_Elbow Method Data_scaled', dpi=300, bbox_inches = "tight")
plt.show()
```

```
kmeans = KMeans()
visu = KElbowVisualizer(kmeans, k=(1, 30))
visu.fit(df_scaled)
visu.show()
plt.savefig(filepath + 'Distortion Score Elbow1')

#shows K=9 clusters!
```

Silhouette Score

```
from sklearn.metrics import silhouette_score

kmeans = KMeans(n_clusters=9, random_state=1).fit(df_scaled)

clusters = kmeans.labels_

silhouette_avg = silhouette_score(df_scaled, clusters)

print("Silhouette Score:", silhouette_avg)
```

```
from sklearn.metrics import silhouette_samples
from matplotlib.lines import Line2D

# Calculates the silhouette score for each variable
silhouette_values = silhouette_samples(df_scaled, clusters)

# Filter the silhouette scores between 1 e -1
filtered_indices = np.where((silhouette_values >= -1) & (silhouette_values <= 1))
filtered_silhouette_values = silhouette_values[filtered_indices]

# Plot a bar chart
plt.bar(filtered_indices[0], filtered_silhouette_values, color='midnightblue')
plt.xlabel("Variable")
plt.ylabel("Silhouette Score")
```

```
plt.title("Silhouette Score from 2001 to 2010")

# Draw a red dashed line at the value of the silhouette score
plt.axhline(y=silhouette_avg, color='red', linestyle='dashed', linewidth=1.5)

# Define the limits and ranges of the y-axis
plt.ylim(-0.2, 0.9)
plt.yticks(np.arange(-0.2, 0.90, 0.2))

# Add the legend only to the red dashed line
custom_legend = [Line2D([], [], color='red', linestyle='dashed', linewidth=1.5, label=f"Silhouette
Score = {silhouette_avg:.3f}")]
plt.legend(handles=custom_legend)

plt.show()
```

```
#Insert clusters in the new dataset
from kmeans_interp.kmeans_feature_imp import KMeansInterp

kmeans = KMeans(n_clusters=9, random_state=1).fit(df_scaled)

kmeans = KMeansInterp(n_clusters=9,
                      random_state=1,
                      ordered_feature_names=df_scaled.columns,
                      feature_importance_method='unsup2sup',
                     ).fit(df_scaled)

clusters = kmeans.labels_
labels = kmeans.labels_

pd.DataFrame({"Id": df_scaled.index, "Clusters": clusters})
df_scaled["cluster_n"] = clusters
data_scaled_orig = copy.deepcopy(df_scaled)

pd.DataFrame(df_scaled)
```

```
#Find the value of each cluster
sns.countplot(x=df_scaled['cluster_n']+1, data=df_scaled)

plt.savefig(filepath + 'FIG4_ClustersCount')
plt.show()
```

```
order = df_scaled['cluster_n'].value_counts().index
print(order + 1)
```

```
palette_platform_cubehelix = sns.cubehelix_palette(15, start=8, rot=0, reverse=True)

numClusters = plt.figure(figsize=(15,10))
```

```
sns.countplot(x=df_scaled['cluster_n']+1,order = df_scaled['cluster_n'].value_counts().index +1,
              palette=palette_platform_cubehelix, data=df_scaled)

plt.xticks(fontsize=13)
plt.yticks(fontsize=13)
plt.xlabel('Clusters')
plt.ylabel('Count',fontsize=15)
plt.title('Cluster Values from 2001 to 2010',fontsize=21)


plt.savefig(filepath + 'FIG5_Cluster Values')
plt.show()
```

```
df_scaled["cluster_n"] = df_scaled["cluster_n"] + 1
mean_clusters = df_scaled.groupby("cluster_n").agg(np.mean)
mean_clusters
```

Hierarchical clustering

```
# Average Linkage Method
hc_average = linkage(df_scaled, "average")

plt.figure(figsize=(20, 10))
plt.title("Hierarchical Clustering")
plt.xlabel("Observations")
plt.ylabel("Distance")
dendrogram(hc_average,
           leaf_font_size=10,
           p=9,
           show_contracted=True,
          truncate_mode='level')


plt.savefig(filepath + 'FIG7_Thesis Hierarchical Clustering')
plt.show()
```

```
#Complete Linkage Method
hc_complete = linkage(df_scaled, "complete")

plt.figure(figsize=(15, 10))
plt.title("Hierarchical Clustering")
plt.xlabel("Observations")
plt.ylabel("Distance")
dendrogram(hc_complete,
           truncate_mode="lastp",
           p=9,
           show_contracted=True,
           leaf_font_size=10)
```

```
plt.savefig(filepath + 'FIG8_Thesis_Complete Linkage Method')
plt.show()
```

Identifying clusters

```
# Take the nfeat most important features only
nfeat = 15
palette_platform_cubehelix = sns.cubehelix_palette(15, start=8, rot=0, reverse=True)

for cluster_label, feature_weights in kmeans.feature_importances_.items():
    df_feature_weight = pd.DataFrame(feature_weights[:nfeat], columns=["Feature", "Weight"])
    fig, ax = plt.subplots(figsize=(20,6))
    sns.barplot(x="Feature", y="Weight", palette= palette_platform_cubehelix,
data=df_feature_weight)
    plt.xticks(rotation=-45, ha="left");
    ax.tick_params(axis='both', which='major', labelsize=22)
    plt.title(f'Highest Weight Features in Cluster {cluster_label+1} from 2001 to 2010', fontsize='xx-
large')
    plt.xlabel('Feature', fontsize=18)
    plt.ylabel('Weight', fontsize=18)
    plt.savefig(filepath + f'FIG11_Highest Weight Features in Cluster {cluster_label+1}')

plt.show()
```

```
#Distance to each cluster's center

from sklearn.metrics import pairwise_distances
import matplotlib.pyplot as plt

# Calculate the centroid coordinates
centroids = kmeans.cluster_centers_

# Calculate the distance among the centroids
distances = pairwise_distances(centroids)

# Get the x and y coordinates of the centroids
centroid_x = centroids[:, 0]
centroid_y = centroids[:, 1]

# Use the "tab10" color map
colors = plt.cm.tab10.colors

#Scatterplot
plt.figure(figsize=(16, 12))
for i in range(len(centroids)):
    plt.scatter(centroid_x[i], centroid_y[i], color=colors[i], label=f"Cluster {i+1}")
    for j in range(i+1, len(centroids)):
        plt.plot([centroid_x[i], centroid_x[j]], [centroid_y[i], centroid_y[j]], color='gray', linestyle='--',
linewidth=0.5)
```

```
plt.title("Distances Between Centroids from 2001 to 2010", fontsize=18)
plt.xlabel("X", fontsize=14)
plt.ylabel("Y", fontsize=14)
plt.legend()
plt.show()
```

The MaxMinScaler

MinMaxScaler is one of the most common methods of data normalization. This method aims to reduce the values of the current attribute to new values in the range [0; 1]. The general formula for the implementation of this method is given as:

$$X' = \frac{\mathrm{X} - \mathrm{Xmin}}{\mathrm{Xmax} - \mathrm{Xmin}}$$

where X' is the normalized attribute, Xmax and Xmin are the maximal and minimal values of the current attribute X in the presented dataset (Izonin *et al.*, 2023; Borkin *et al.*, 2019).

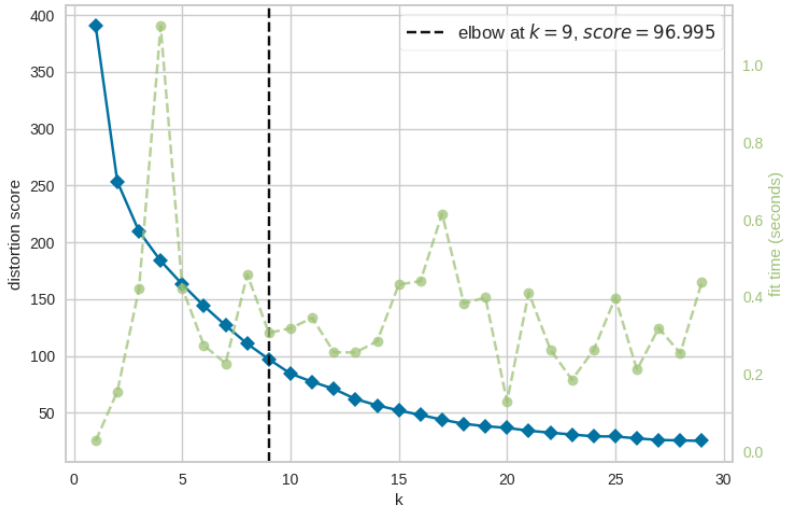
The graphs

Distortion Elbow

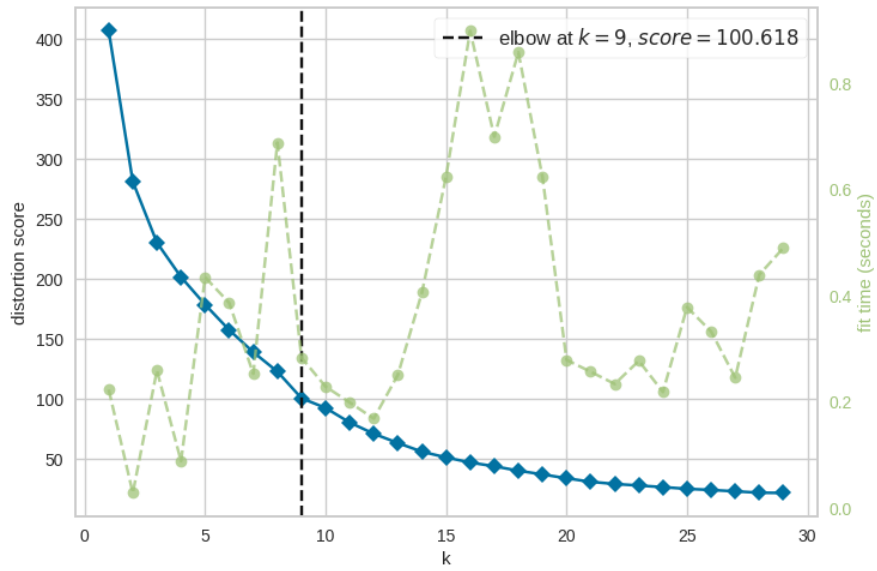
The graphs below show (Graph 1A). the inflection point, known as the "elbow", i.e. the optimal values of k and the identification of the position of the elbow, together with the sum of the squared error. The most favorable result for the cluster count, determined by the elbow method, will serve as the basis for clustering. A decreasing elbow plot can be correlated with better clustering results (Joshi; Nalwade, 2013; Syakur *et al.*, 2018)

Graph 1A - Distortion Elbow for KMeans Clustering

From 2001 to 2010



From 2011 to 2020



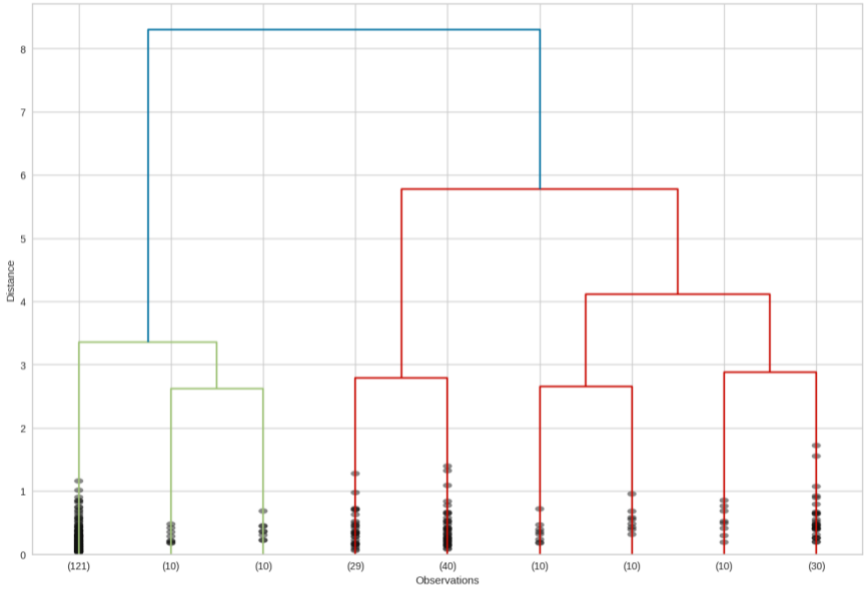
Source: elaborated by the author

Hierarchical Clustering

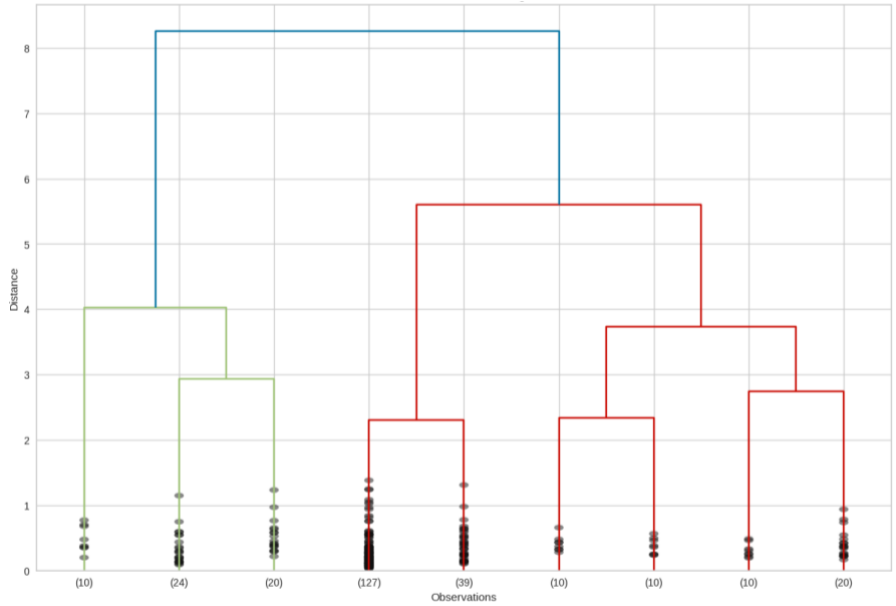
The graphs show the nine clusters found in each period analyzed (Graph 2A). The Hierarchical clustering shows a dendogram illustrating the clusters. This approach creates a cluster tree structure, also known as a dendrogram, which illustrates the similarity relationships between the data. The complete linkage method was used, which calculates the greatest distance between any pair of points belonging to these clusters (Nielsen, 2016).

Graph 2A - Hierarchical Clustering

From 2001 to 2010



From 2011 to 2020

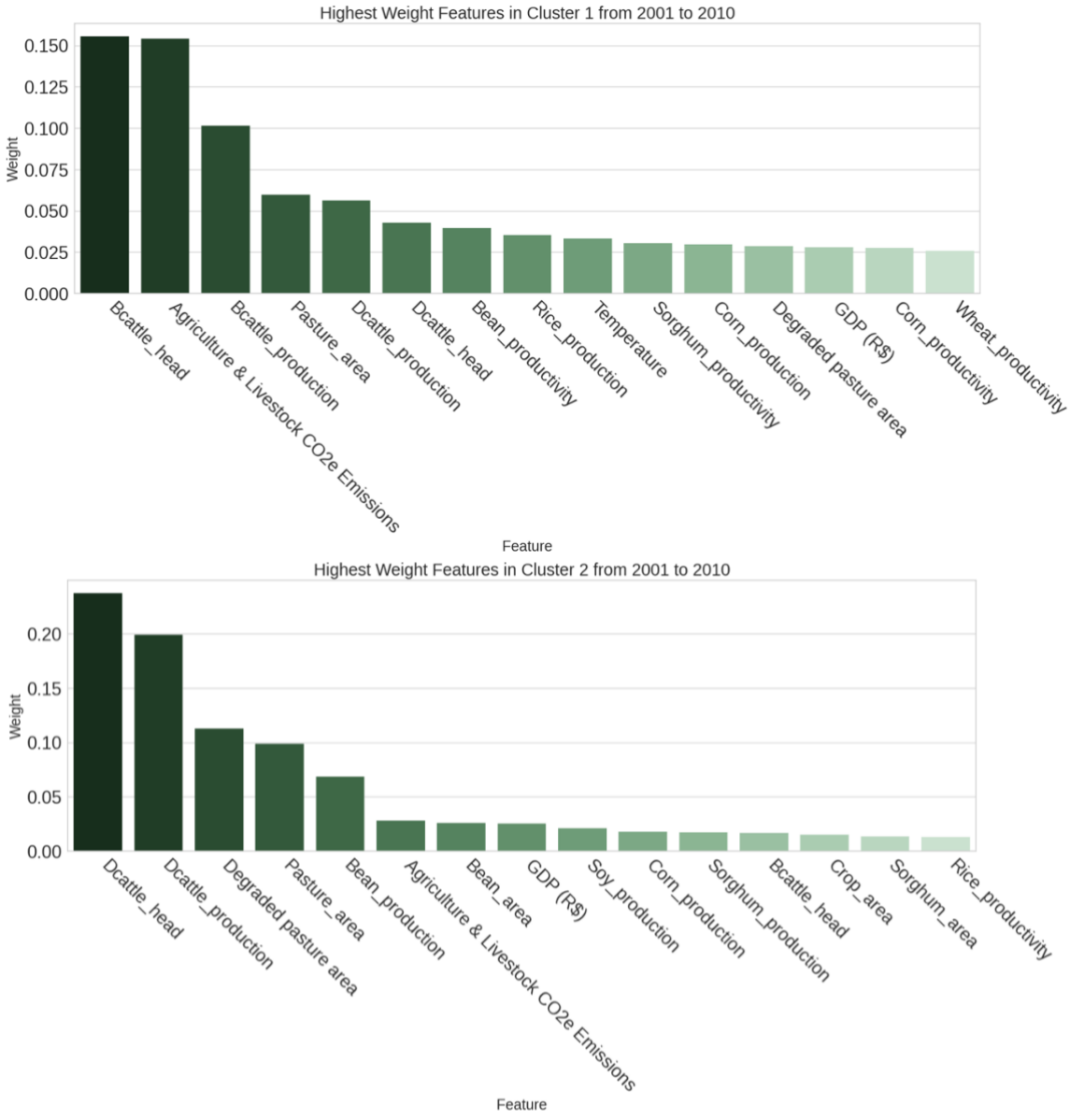


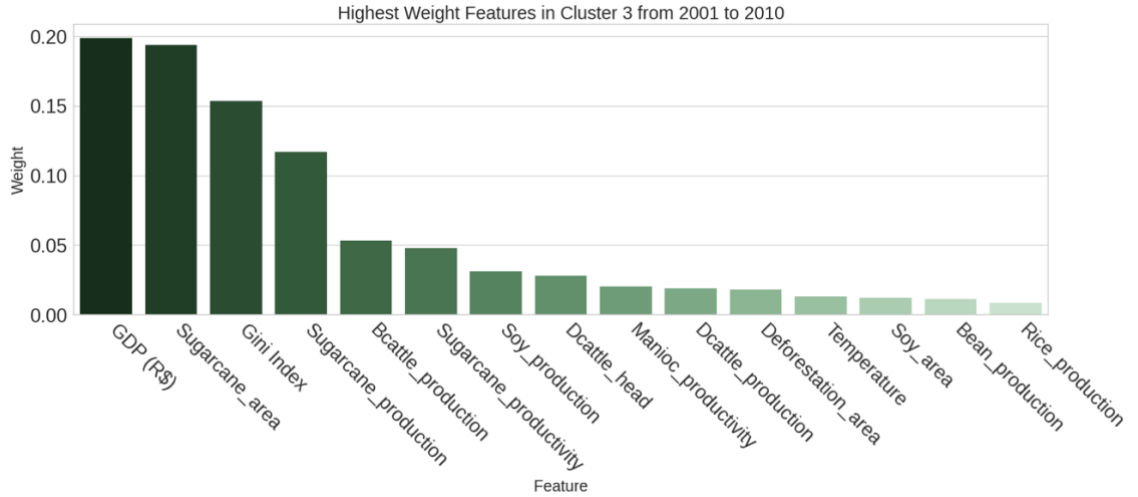
Source: elaborated by the author

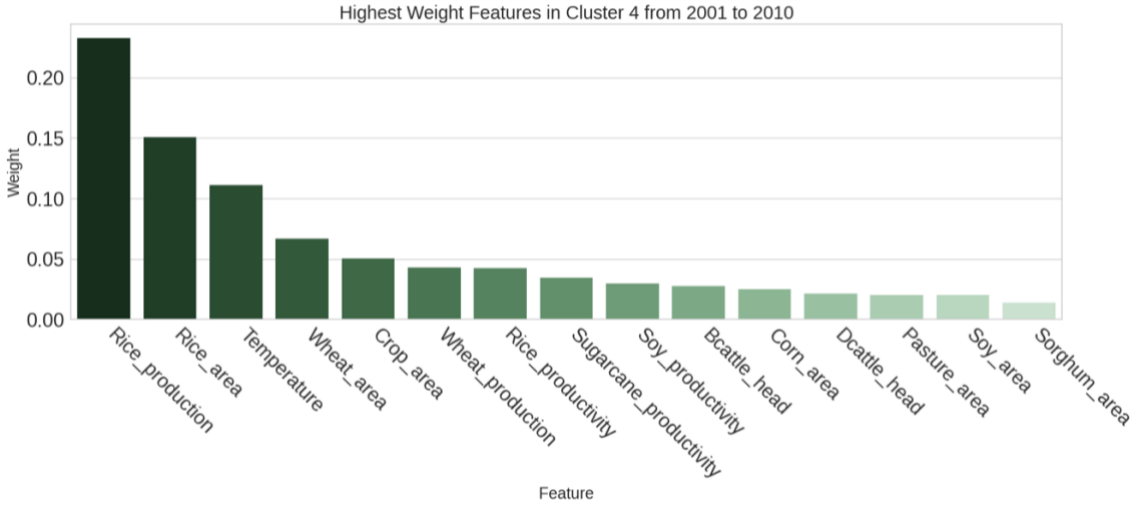
Highest Weight Features

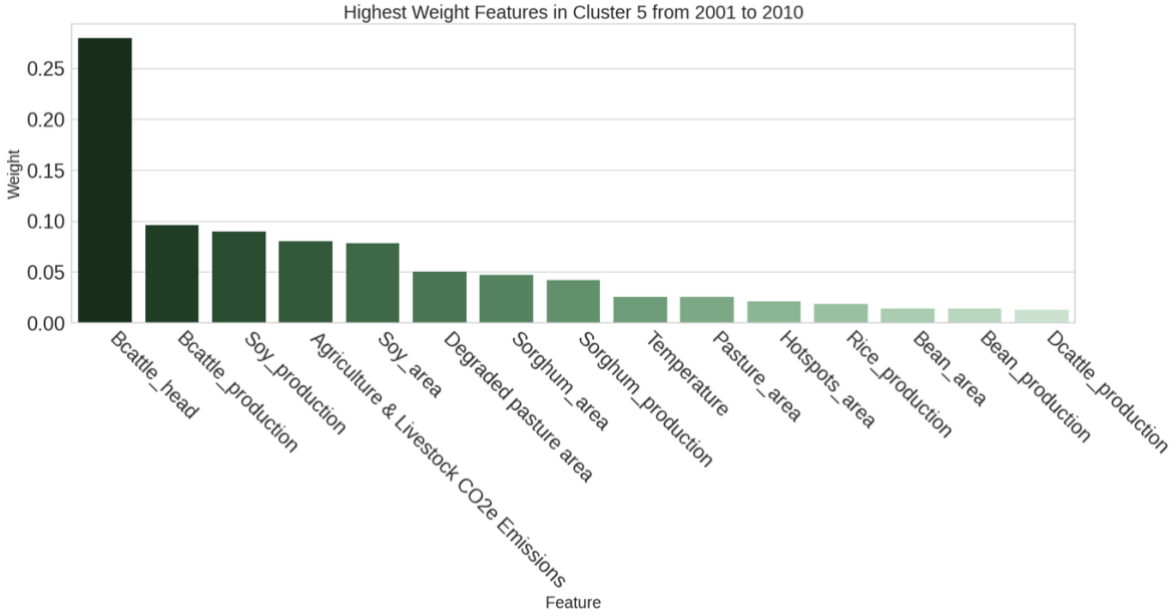
The set of graphs below (from Graph 3A and 4A) to show the highest weight variables in each of the nine clusters for the two periods analyzed. Weight Feature reflects the degree of relevance within the cluster of a given feature. In this way, features with relatively low weight are removed from the dataset (Panday; Amorim; Lane, 2018).

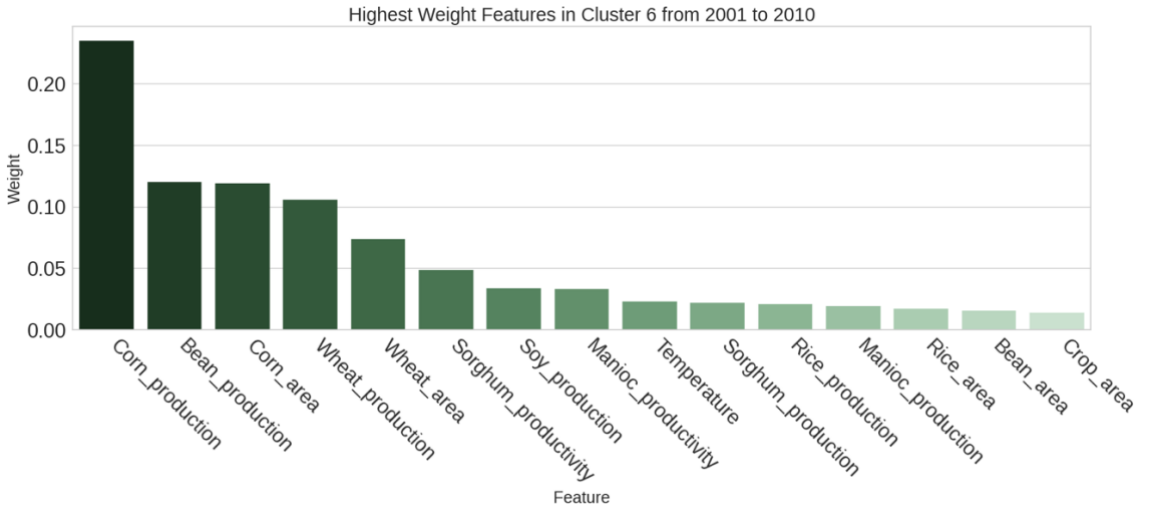
Graph 3A - Features Weight from 2001 to 2010

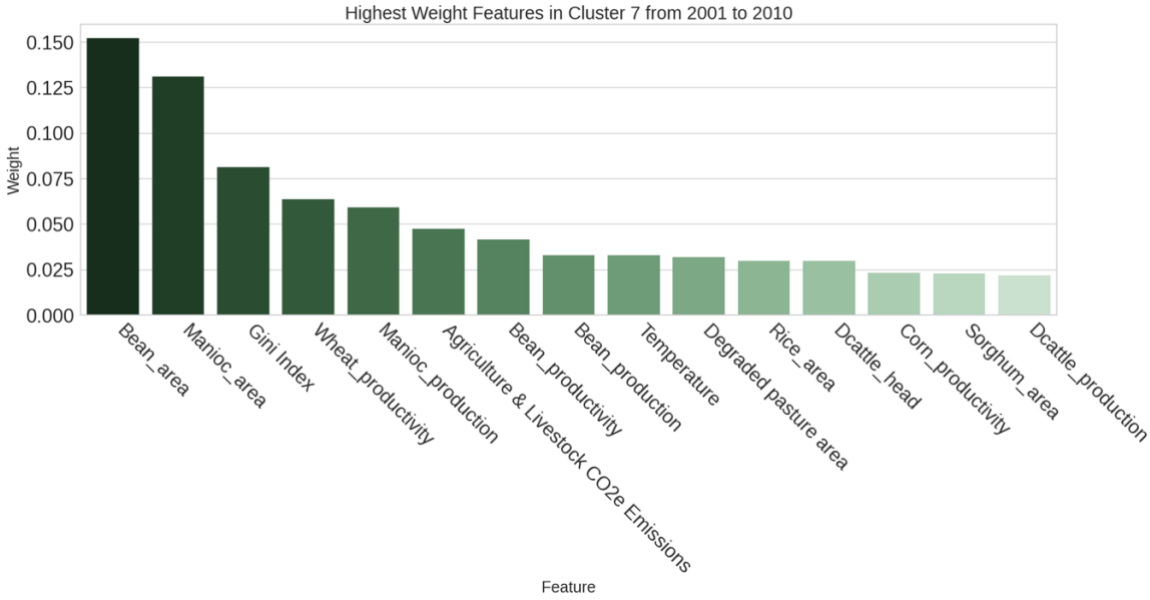


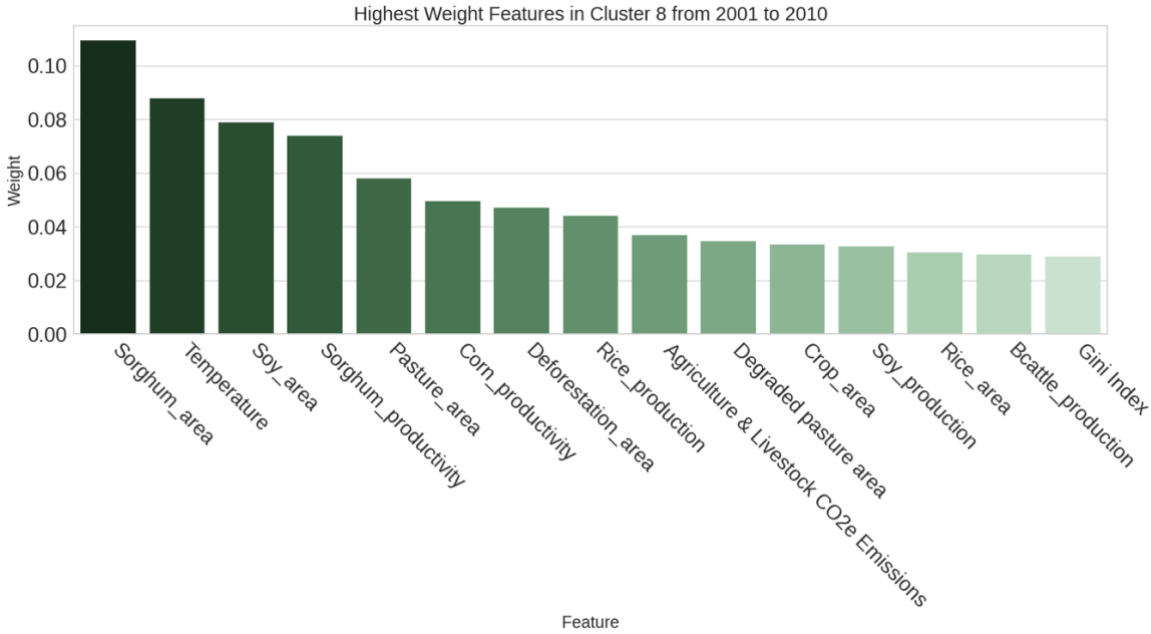

Highest Weight Features in Cluster 3 from 2001 to 2010
Weight
0.20
0.15
0.10
0.05
0.00
GDP (R$)
Sugarcane_area
Gini Index
Sugarcane_production
Bcattle_production
Sugarcane_productivity
Soy_production
Dcattle_head
Manioc_productivity
Dcattle_production
Deforestation_area
Temperature
Soy_area
Bean_production
Rice_production
Feature

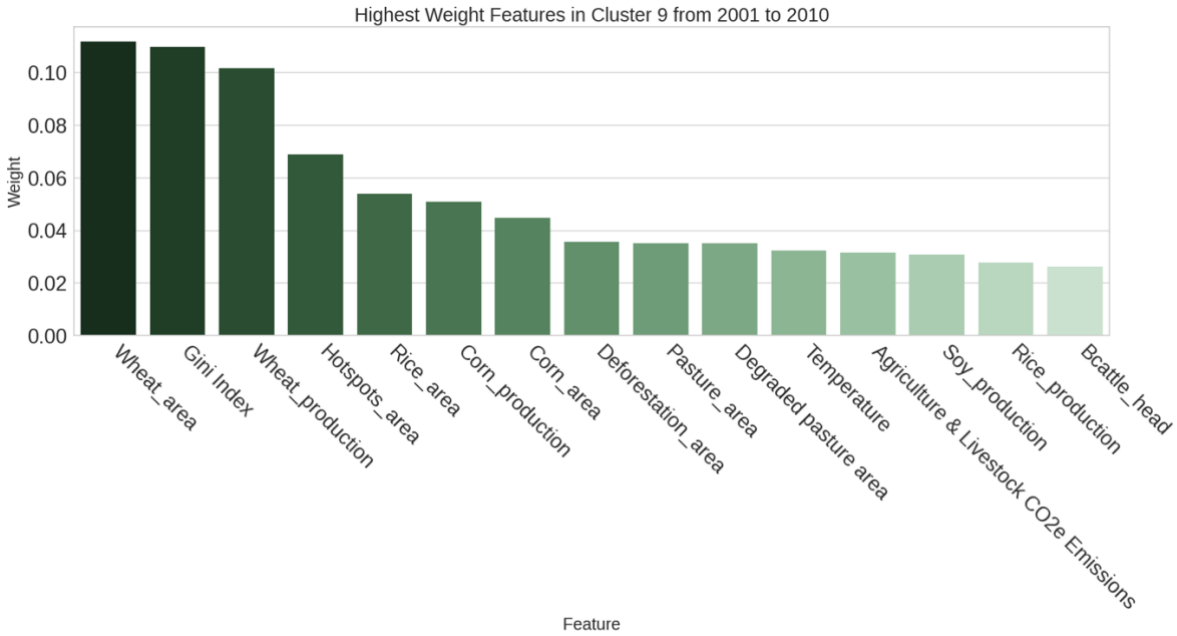

Highest Weight Features in Cluster 4 from 2001 to 2010
Weight
0.20
0.15
0.10
0.05
0.00
Rice_production
Rice_area
Temperature
Wheat_area
Crop_area
Wheat_production
Rice_productivity
Sugarcane_productivity
Soy_productivity
Bcattle_head
Corn_area
Dcattle_head
Pasture_area
Soy_area
Sorghum_area
Feature


Highest Weight Features in Cluster 5 from 2001 to 2010
Weight
0.25
0.20
0.15
0.10
0.05
0.00
Bcattle_head
Bcattle_production
Soy_production
Agriculture & Livestock CO2e Emissions
Soy_area
Degraded pasture area
Sorghum_area
Sorghum_production
Temperature
Pasture_area
Hotspots_area
Rice_production
Bean_area
Bean_production
Dcattle_production
Feature


Highest Weight Features in Cluster 6 from 2001 to 2010
Weight
0.00
0.05
0.10
0.15
0.20
Corn_production
Bean_production
Corn_area
Wheat_production
Wheat_area
Sorghum_productivity
Soy_production
Manioc_productivity
Temperature
Sorghum_production
Rice_production
Manioc_production
Rice_area
Bean_area
Crop_area
Feature

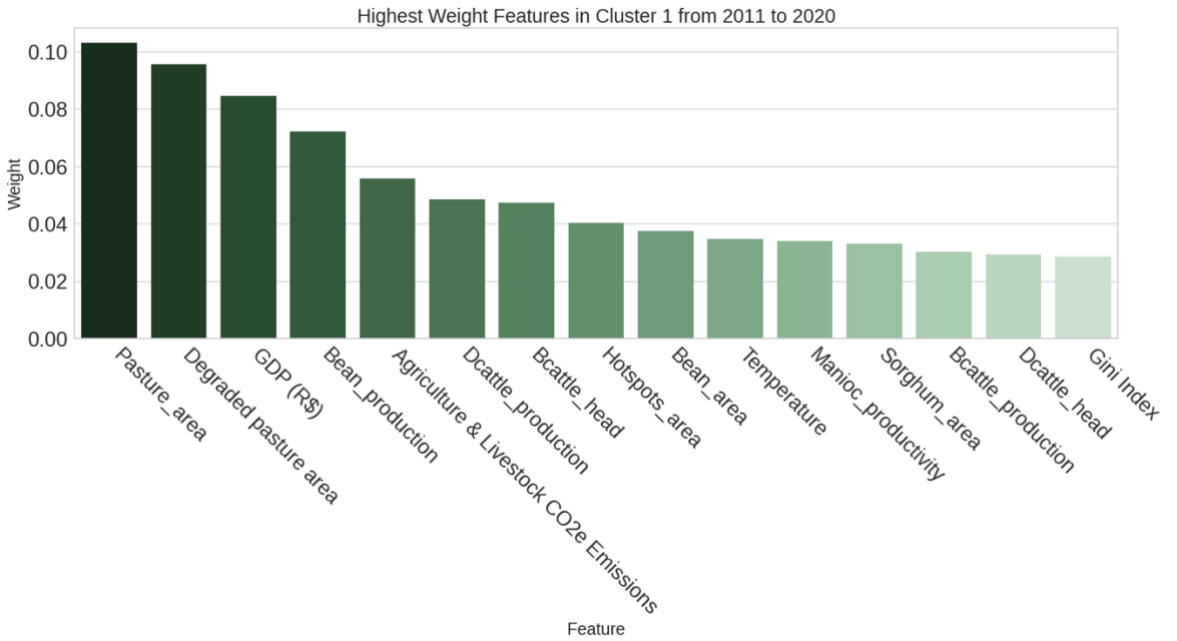

Highest Weight Features in Cluster 7 from 2001 to 2010
Weight
0.000
0.025
0.050
0.075
0.100
0.125
0.150
Bean_area
Manioc_area
Gini Index
Wheat_productivity
Manioc_production
Agriculture & Livestock CO2e Emissions
Bean_productivity
Bean_production
Temperature
Degraded pasture area
Rice_area
Dcattle_head
Corn_productivity
Sorghum_area
Dcattle_production
Feature

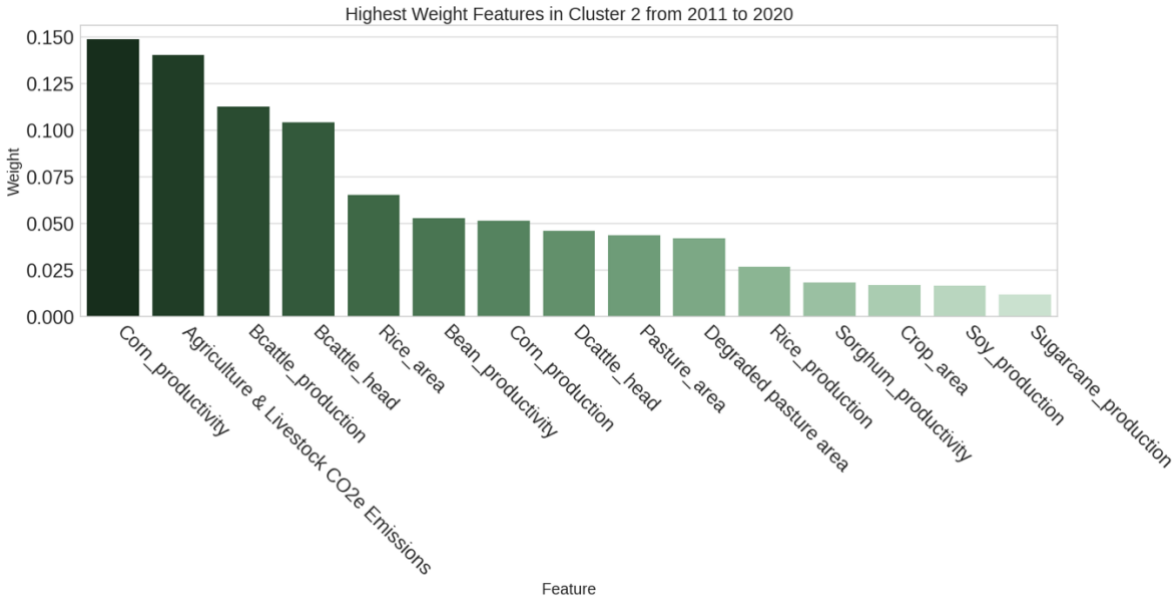

Highest Weight Features in Cluster 8 from 2001 to 2010
Weight
0.00
0.02
0.04
0.06
0.08
0.10
Sorghum_area
Temperature
Soy_area
Sorghum_productivity
Pasture_area
Corn_productivity
Deforestation_area
Rice_production
Agriculture & Livestock CO2e Emissions
Degraded pasture area
Crop_area
Soy_production
Rice_area
Bcattle_production
Gini Index
Feature

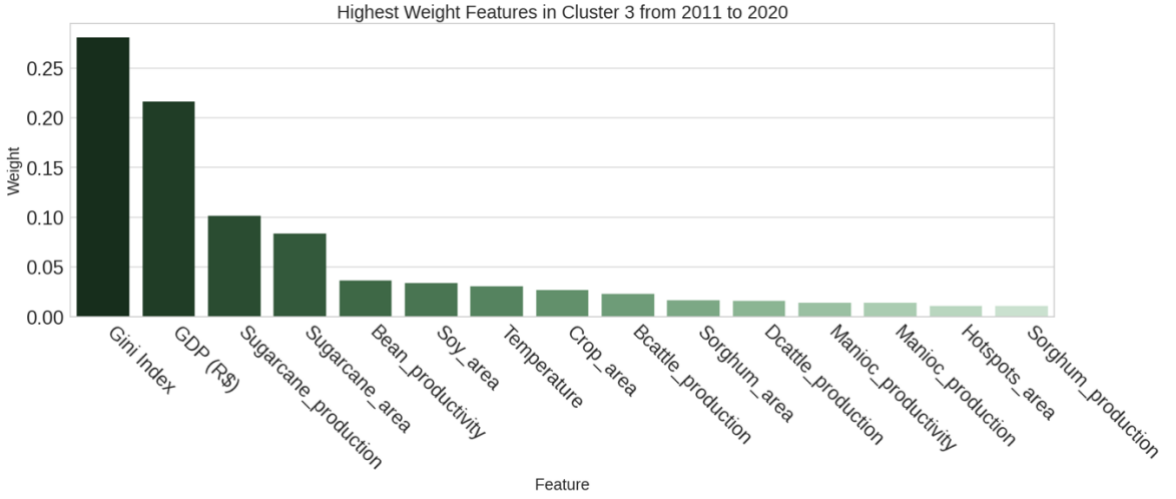


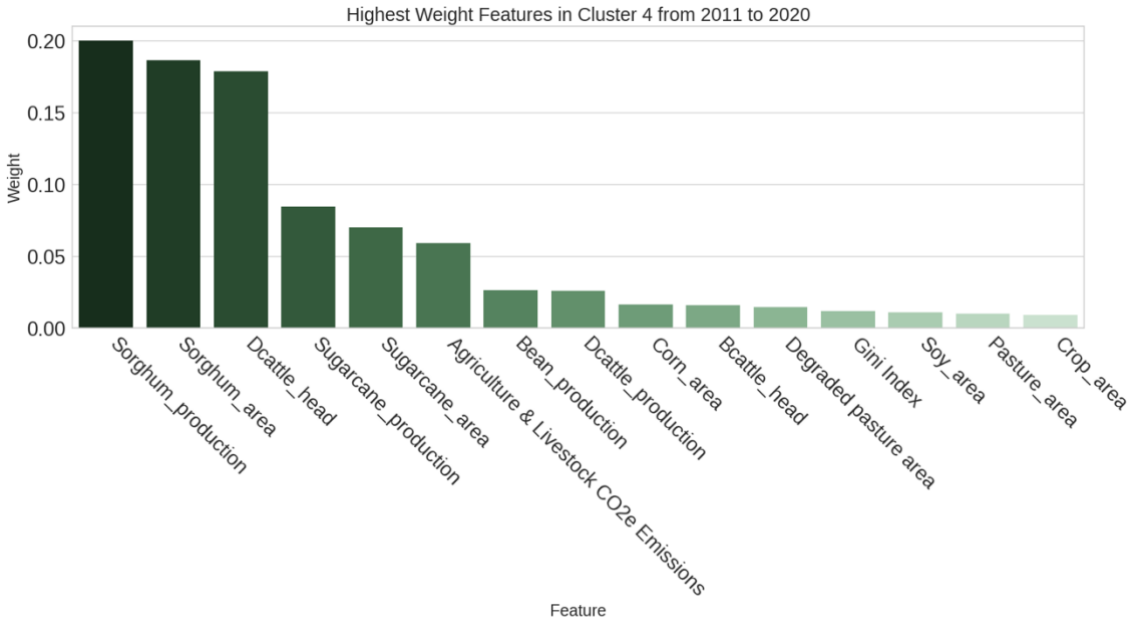
Source: elaborated by the author

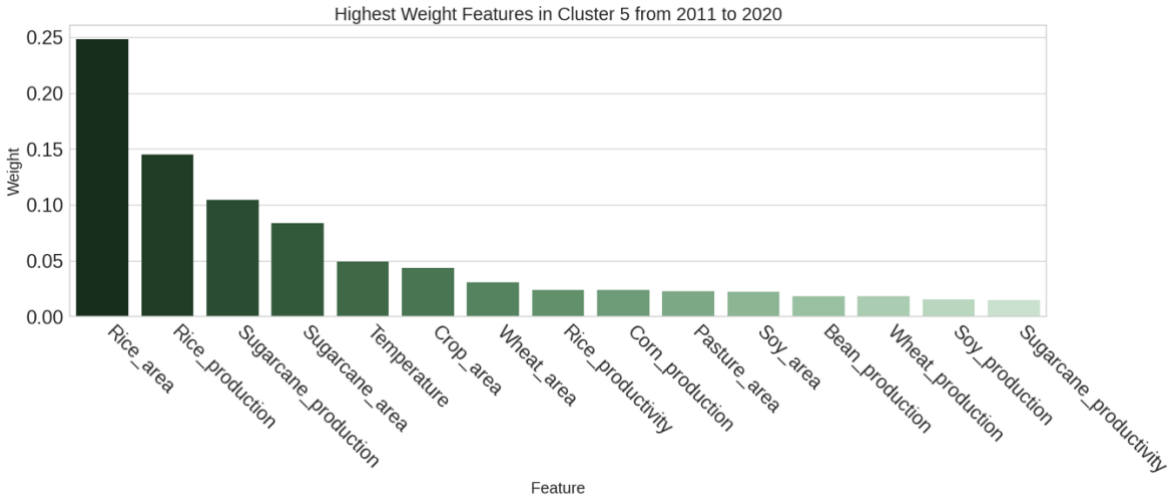
Graph 4A - Features Weight from 2011 to 2020

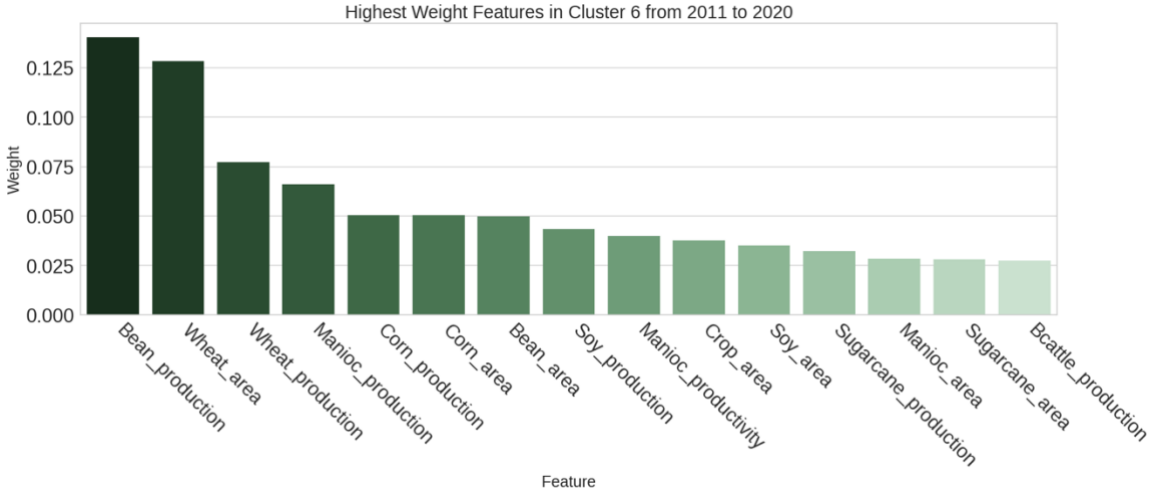


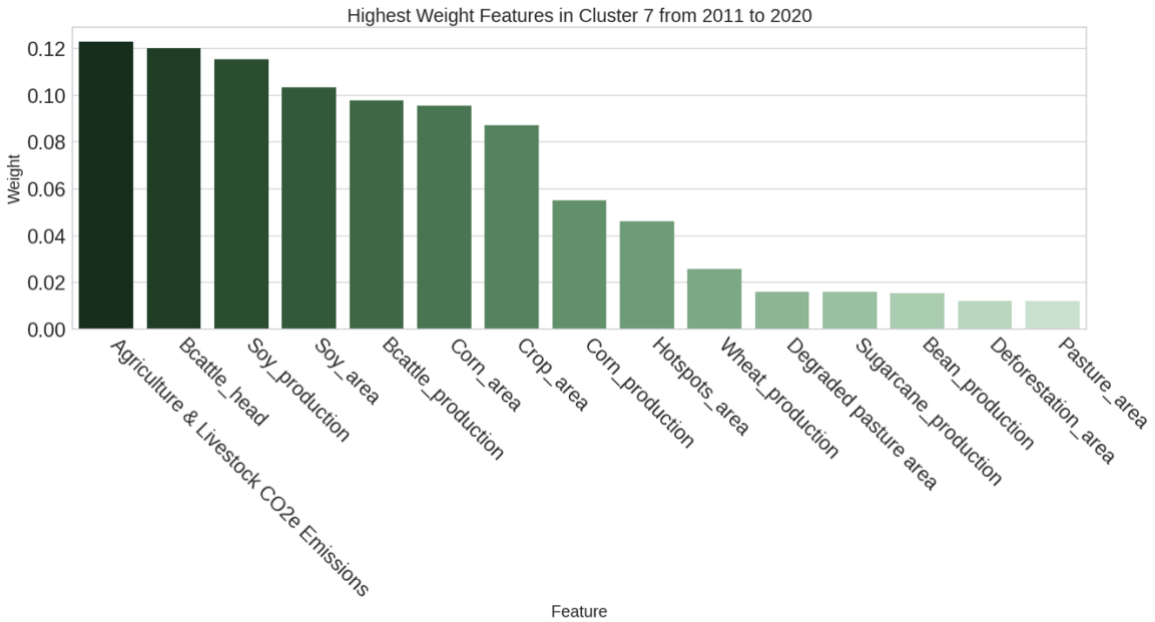

Highest Weight Features in Cluster 2 from 2011 to 2020
Weight
0.150
0.125
0.100
0.075
0.050
0.025
0.000
Corn_productivity
Agriculture & Livestock CO2e Emissions
Bcattle_production
Bcattle_head
Rice_area
Bean_productivity
Corn_production
Dcattle_head
Pasture_area
Degraded pasture area
Rice_production
Sorghum_productivity
Crop_area
Soy_production
Sugarcane_production
Feature

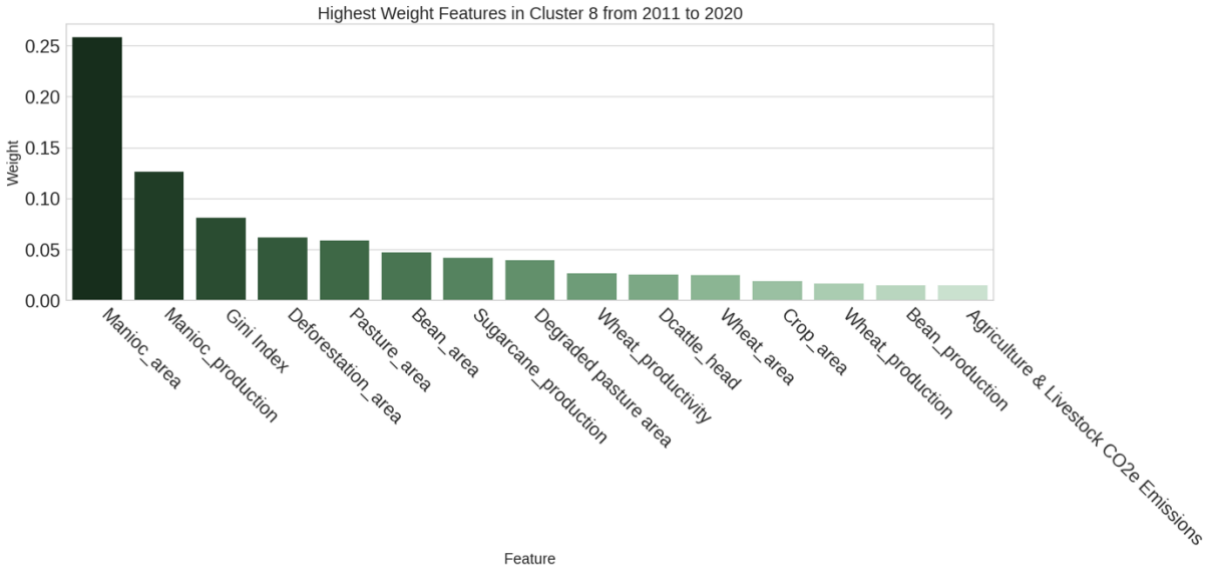

Highest Weight Features in Cluster 3 from 2011 to 2020
Weight
0.25
0.20
0.15
0.10
0.05
0.00
Gini Index
GDP (R$)
Sugarcane_production
Sugarcane_area
Bean_productivity
Soy_area
Temperature
Crop_area
Bcattle_production
Sorghum_area
Dcattle_production
Manioc_productivity
Manioc_production
Hotspots_area
Sorghum_production
Feature

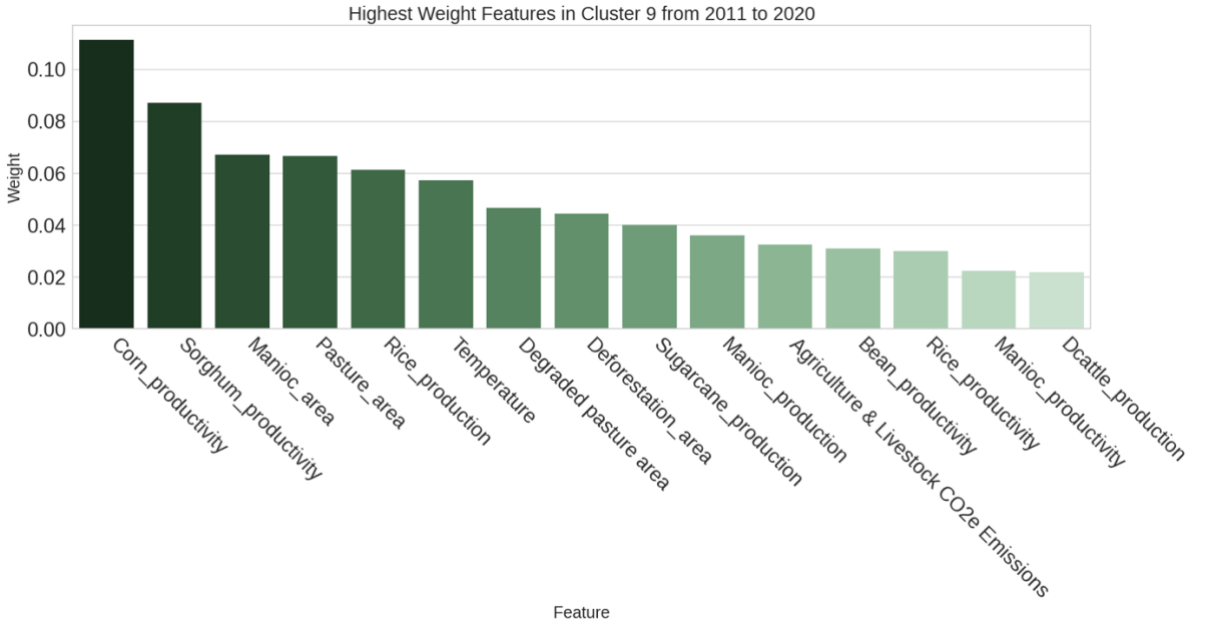

Highest Weight Features in Cluster 4 from 2011 to 2020
Weight
0.20
0.15
0.10
0.05
0.00
Sorghum_production
Sorghum_area
Dcattle_head
Sugarcane_production
Sugarcane_area
Agriculture & Livestock CO2e Emissions
Bean_production
Dcattle_production
Corn_area
Bcattle_head
Degraded pasture area
Gini Index
Soy_area
Pasture_area
Crop_area
Feature


Highest Weight Features in Cluster 5 from 2011 to 2020
Weight
0.25
0.20
0.15
0.10
0.05
0.00
Rice_area
Rice_production
Sugarcane_production
Sugarcane_area
Temperature
Crop_area
Wheat_area
Rice_productivity
Corn_production
Pasture_area
Soy_area
Bean_production
Wheat_production
Soy_production
Sugarcane_productivity
Feature


Highest Weight Features in Cluster 6 from 2011 to 2020
Weight
0.125
0.100
0.075
0.050
0.025
0.000
Bean_production
Wheat_area
Wheat_production
Manioc_production
Corn_production
Corn_area
Bean_area
Soy_production
Manioc_productivity
Crop_area
Soy_area
Sugarcane_production
Manioc_area
Sugarcane_area
Bcattle_production
Feature


Highest Weight Features in Cluster 7 from 2011 to 2020
Weight
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Agriculture & Livestock CO2e Emissions
Bcattle_head
Soy_production
Soy_area
Bcattle_production
Corn_area
Crop_area
Corn_production
Hotspots_area
Wheat_production
Degraded pasture area
Sugarcane_production
Bean_production
Deforestation_area
Pasture_area
Feature





Source: elaborated by the author