FROM EXTRACTIVISM AND ILLEGALITIES TO A CIRCULAR BIOECONOMY IN THE AMAZON REGION

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The Amazon is a vast region, but with many shortcomings. It presents one of the worst human development indicators in Brazil. This article shows that while the Amazon does not have an adequate policy to make the region economically viable, conservationist measures will be ineffective to protect the forest. A few responsible investments have not been sufficient to promote the region's economic development and there is an urgent need to preserve nature and increase the Amazon population's quality of life, eliminating deforestation and illegal extractive activities. It has been difficult to identify investments that bring real value in terms of sustainability to other options than extractive products. The analysis results showed how a combined effort between public and private initiatives is essential to increase the environmental social governance of companies that are doing business in global value chains, improve the institutional environment, catalyze sustainable measures to create a thriving sustainable circular bioeconomy in the Amazon region. To this end, this document addresses aspects related to responsible investments, circular bioeconomy, international markets, deforestation reduction, commodity production, land use regularization, and bioinputs extraction and cultivation.

Keywords: Amazon; circular bioeconomy; sustainable development; deforestation.

AMAZÔNIA, DO EXTRATIVISMO E ILEGALIDADES À BIOECONOMIA CIRCULAR

A Amazônia Legal brasileira é uma região de grande dimensão, porém com diversas carências, apresentando um dos piores indicadores de desenvolvimento humano no Brasil. Este artigo evidencia que, enquanto a Amazônia não tiver uma política adequada para tornar a região economicamente viável, medidas conservacionistas serão inócuas para manter a floresta em pé. Os investimentos responsáveis não têm sido suficientes para promover o desenvolvimento econômico da região. Destaca-se a necessidade de preservar a natureza e aumentar a qualidade de vida da população amazônica, eliminando o desmatamento e atividades extrativas ilegais. Tem sido difícil identificar investimentos que tragam ganhos reais de sustentabilidade e melhor opção financeira que os produtos extrativos. Os resultados da análise mostraram ser preciso um esforço combinado entre iniciativas públicas e privadas para aumentar a responsabilidade ambiental social e corporativa das empresas que compõem cadeias de valor global, melhorar o ambiente institucional, catalisando medidas sócio

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e ambientalmente responsáveis para a criação de uma bioeconomia circular sustentável pujante na região amazônica. Para tal, o texto aborda aspectos relacionados a investimentos responsáveis, bioeconomia circular, mercado internacional, redução do desmatamento, produção de *commodities*, regularização fundiária e extração e cultivo de bioinsumos.

Palavras-chave: Amazônia; bioeconomia circular; desenvolvimento sustentável; desmatamento.

AMAZONIA, DEL EXTRACTIVISMO Y LA ILEGALIDAD A LA BIOECONOMÍA CIRCULAR

La Amazonía es una región inmensa y con varias necesidades, tiene uno de los peores indicadores de desarrollo humano. Entonces, este artículo sostiene que mientras la Amazonía no tenga una economía próspera en la que sea más rentable mantener la naturaleza de la selva amazónica en pie, las medidas de conservación serán inocuas. As inversiones responsables, que interrumpen la financiación de prácticas ineficientes y contaminantes, no son condición suficiente para promover el desarrollo económico de la región, es necesario preservar la naturaleza y aumentar la calidad de vida de la población amazónica. El texto analiza los desafíos de invertir en iniciativas realmente efectivas que traen ganancias reales de sostenibilidad y aborda el desafío de competir con el bajo precio de los productos extraídos o cultivados ilegalmente. Solo un esfuerzo combinado entre iniciativas públicas y privadas, dirigido específicamente a aumentar la responsabilidad ambiental, social y corporativa de las empresas que producen en la cadena de valor global, puede mejorar el entorno interno para facilitar inversiones sostenibles y la creación de una bioeconomía circular próspera en la región Amazonas. Para abordar este tema, es importante considerar algunas particularidades como las relacionadas con las inversiones responsables, la bioeconomía circular, el mercado internacional, reducción de la deforestación, producción de commodities, regularización de tierras y la extracción y cultivo de bioinsumos.

Palabras clave: Amazonía; bioeconomía circular; desarrollo sostenible; deforestación.

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1 INTRODUCTION

The new documentary *Amazon on Fire* (*Amazônia em Chamas*),[4] from 2020 – despite sharing the same title in Portuguese with *The Burning Season,*[5] from 1994, which presents a biography of Chico Mendes permeated by economic and political conflicts in the region –, considers only the global chain of meat consumption as the main cause of deforestation, delegating to consumers the obligation to change their meat-inclusive diet to a vegetable-based one, as a way to solve a problem that is much more complex. Meat consumption brings benefits to the individual's diet, besides the fact that its impacts are just part of a much more complex problem, and Brazil do not need the Amazon

4. Available at: <https://www.imdb.com/title/tt12063420/?ref_=nv_sr_srsg_0>.
5. Available at: <https://www.imdb.com/title/ tt0109351/?ref_=fn_al_tt_1>.

to produce meet, there are a lot of degraded land and underexploited farms elsewhere in the country.[6]

What is actually missing is not a new menu, but a broader policy focused on development drivers that include the regional economic, social, and cultural reality, recognize the brutal social inequalities and the importance of indigenous people and traditional communities (IPTC) as the ones that hold knowledge associated with the uses of biodiversity and guarantee maintenance of the environmental services that contribute to the continuity of the nutrients, carbon and water cycles (Monteiro, 2014).[7] Opposite to that the region needs a robust set of policies to create the means of convert the outstanding biological possibilities of the region into valuable technology to benefit first the Amazon people and then Brazil and the world, assuring the place of IPTC as actors in equal conditions within the new profitable production chains to be developed. Without that, any measure will fall short to protect the most diverse biome (Biodiversity A-Z, Unep and WCMC, 2020) on the planet, both in terms of bioinputs (many yet to be discovered) and steady ecological services.[8]

Inconsistently to this goal, the movie proposes free-trade deviations, either through sanctions or through the use of protectionist measures in the global meat trade, this will only result in economic inefficiency. Likewise, the measures prescribed by the aforementioned documentary, in addition to creating non-tariff barriers to international trade by reducing competition, they damage the reputation of companies that have produced sustainably and indiscriminately exposes them to undue retaliatory measures. Diametrically opposed to that, this paper argues that a combined effort between public and private initiatives to increase the environmental, social and corporate governance (ESG) of companies producing in the global value chain may improve the domestic environment and facilitate sustainable investments and the establishment of a vibrant circular bioeconomy in the region that has primarily to benefit the Amazonian people as beneficiaries.

6. The number of properties in Brazil that could benefit from better practices is very significant, for example the low carbon agriculture plan estimates that 72 million hectares (Brasil, 2021) will benefit from the plan until 2030 (this is almost half of the arable land of the whole Europe, which is around 163 million hectares), and yet this is only a fraction of the production in Brazil that can produce more with less environmental impact.

7. Some initiatives have been put in place but with too few resources, for example the National Policy for Sustainable Development of Indigenous Peoples and Traditional Communities, since 2008, do not receive direct public funding (Saragoussi, 2021).

8. The region main attribute is protecting the forest: vegetation plays a fundamental role in the cycles of nutrients, carbon and water and to provide biodiversity to be sustainably exploited by high-tech biobased industries. It is a mistake to think of the region as an agricultural frontier, its soil is not suited for usages that are not integrated to the forest, and nowadays the region produces only 12% of the Brazilian agricultural production (including part of Mato Grosso, without the state the numbers drop to less than half), and it is very concentrated the top fifteen cities correspond to more than 56% of the soy and 82% of the açai production (Serigati and Possamai, 2022).

The present work considers that a basic assumption for this is to increase and transform the way in which the economy uses the bioinputs – a type of bio-based products: animal, plant or microbial, contributing to a renewable production system and a sustainable biomass production. Therefore, in this context, biotechnology is essential. It boosts the potential of production by increasing productivity and circularity of the bioinputs, producing more with less and reducing residues. This, at the same time, will bring economic and social development to the region as a positive externality, increasing the geopolitical importance of Amazonian countries as holders of this biodiversity's technological potential, and therefore benefiting from the correlation between development, technology and power, that are experienced even if the investment capacity is limited, as it is in the region when compared to the budget of other countries (Cunha, Queiroz and Martínez, 2021).

There are important initiatives already underway, but the public power could encourage even more strategic sectors, for biotechnology development to transform biomass production into a more economically profitable activity, both in a direct or indirect ways. Besides that, several production practices and technologies that have been available for a long time and are widely practiced in other regions of the country would bring more profitability than the extensive cattle ranching that has usually been established in the region after deforestation.

This unprofitable cattle ranching production, with low productivity and high negative impact on the environment also generates extremely fast soil degradation given the peculiar agronomic characteristics of the region, particularity that has been identified since the 1970s (Falesi and Serrão, 1997) but are seldom taken into consideration.

The substitution or adaptation of cattle raising activities is not a trivial task though, particularly in the Amazon region, where agronomist technical assistance is rare, public training is limited and inspection as to the adoption (or not) of sustainable management has not been successful. However, efficient measures need to be identified and implemented, given the advance already observed in the consolidation of inappropriate activities to promote sustainability, and this in a short-term horizon, as pointed out by scientific studies that monitor the ongoing transformations and their consequences (IPCC, 2021).

In a global context and especially in the Amazon, the transition to a sustainable circular bioeconomy requires technological changes, appropriate public policies, available sustainable, standardized and certified biomass, and, above all, the ability to attract substantial investments. To discuss this issue, it is important to consider the existence of mechanisms such as the Amazon Fund, the

new Fundo de Investimento nas Cadeias Produtivas Agroindustriais (Fiagro), and the new possibilities for investments with ESG requirements.

However, some laggards pull back the use of these resources preventing them to meet their purpose.

The Amazon Fund, created in 2008 by the Brazilian president's Decree No. 6,527 (Brasil, 2008) and managed by the National Bank for Economic and Social Development (Banco Nacional de Desenvolvimento Econômico e Social – BNDES), is composed of donations destined to non-reimbursable investments in the prevention, monitoring and combat of deforestation, as well as the conservation and sustainable use of the Amazon biome forests. But since the Brazilian federal government unilaterally changed the fund's governance structure and eliminated the steering committee that selects the projects to be financed, the fund's disbursement was blocked. The equivalent of R$ 2.9 billion, donated by Norway and Germany, remained frozen in a federal government account for over two years. Actions such as these need to be confronted and avoided.

Since 2009, when it started operating, the fund has supported 102 projects, disbursed R$ 1.3 billion and received R$ 3.4 billion in donations from Norway, Germany and Petrobras (a Brazilian oil company). It is a pioneering initiative to finance actions for Reducing Emissions from Deforestation and Forest Degradation (REDD+) and "receive voluntary donations for non-reimbursable application in actions to prevent, monitor and combat deforestation, conservation and sustainable use of the Legal Amazon" (BNDES, 2021).

Fiagro, on the other hand, is an investment fund in agro-industrial productive systems, recently created by the Brazilian Federal Law No. 14,130, from March 29, 2021, to enable the financing of agribusiness also by foreign individuals, by allowing them to acquire fund's shares, so that the investor can profit from the revenues of Brazilian agribusiness, without necessarily being a rural producer. This new fund has the potential to enable the Amazon region to receive voluminous national and international resources, what is expected to be very positive, whether in terms of greater competitiveness of regional productive activities, or the reduction in pressure on deforestation. Currently, foreign direct investment in land is very restricted in Brazil (Brasil, 1971).

Furthermore, the Central Bank of Brazil has been promoting through public consultation and regulation the sustainable standards and ESG criteria to be adopted in investments made in the country (CMN[9] Resolution No. 4,943/2021). Such harmonization is necessary, given the large variation in performance, quality, and credibility of current standards that impact financial

9. Conselho Monetário Nacional.

risk management resulting from socio-environmental issues. The complexity lies precisely in mapping what is really relevant for sustainable development and is not greenwashing[10] or any kind of ploy for unfair competition.

Such changes are very positive because unregulated capital lead to the "tragedy of the commons" if the same historical extractivism patterns are maintained (Hardin, 1968; Levin et al., 2012; Ostrom, 1990), and no competition monitoring take place, demanding the compliance with ESG commitments, the follow-ups through reports, standards settings and consistent compliance with certifications for market agents in the different links of the production chain.

Important to mention that this article, when mentioning Amazonia, is referring to the Brazilian administrative legal concept that corresponds to the Legal Amazon formed by the federal states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, Tocantins and Mato Grosso, and also by some municipalities of the state of Maranhão. This area of 5,217,423 km² corresponds to about 61% of the Brazilian territory (IBGE, 2007).

In addition to this introduction, section 2 discusses changes that promote investments and incentives; section 3 presents the concept of a sustainable circular bioeconomy and the valorization of Amazonia; section 4 describes several problems generated by the economic system in Amazonia; section 5 shows a correlation between deforestation and the evolution of agriculture and cattle ranching in the region; and section 6 discusses the nature of public policies and private initiatives by companies and civil society to curb, if not eliminate, extractive activities, uncurling them to natural resources uses integrated with nature, therefore stimulating regional development. Additionally, section 7 presents successful and creative initiatives for regional recovery. Finally, the conclusion highlights viable solutions to enhance and preserve the Amazon through bioeconomy.

2 INVESTMENTS AND INCENTIVES TO CHANGE REGIONAL ECONOMIC PATTERNS

Several forms of responsible investments are expected to be redirected (or unlocked, as discussed above) to introduce resources to increase the competitiveness and scale of ESG projects on food, feed, bioenergy, and fiber production projects in the Amazon. After all, these sectors and region need capitalization to intensify its production methods, invest in technology, adopt qualified management of productive activities in areas of the economy most vulnerable to climate change.

10. It characterizes a sustainable or beneficial positioning to the environment by corporate means without reflecting any practices that are actually aligned with sustainable development requirements, but the search for advantages in the construction of marketing strategies. In reality, the environmental benefits do not occur and are only intended to create a false impression of sustainability, inducing the consumer to purchase products or services and believe that they are contributing to environmental and/or animal causes.

Moreover, in Brazil, the agricultural and livestock activity corresponds to one third of the economy (Cepea and CNA, 2021).

ESG investments in the agri-food sector, in particular, contribute to the achievement of the Sustainable Development Goals established in the Agenda 2030, by enabling the meeting of food security challenges linked to sustainable production, protection and regeneration of ecosystems, decent work creation, and livelihood opportunities for those who need it the most. Similarly, mechanisms that promote responsible investments in agriculture and food systems can help overcome market failures, and correct systemic inefficiencies that discourage private initiatives. This is one of the main economic challenges today.

Broadly speaking, there are three major theories that underlie this type of intervention. The first is "planetary boundaries", which identifies risks of abrupt and non-linear environmental changes on a continental or planetary scale if certain boundaries are crossed, such as climate change (due to the increase in the concentration of CO_2 in the atmosphere and the accumulation of other greenhouse gases like methane). Equally relevant are other frontiers such as ocean acidification; stratospheric ozone; the nitrogen cycle (which can be fixated by agriculture); the phosphorus cycle; global freshwater use; land use change; loss of biological diversity; chemical pollution, and atmospheric aerosol loading (Rockström et al., 2009).

Besides that, ecosystems that need protection are embedded in different levels of social organization, and these natural and social capital, coexist at multiple levels on a spatial scale ranging from very small to global (Brondízio, Ostrom and Young, 2009) and their externalities (positive and negative) flow from one ecosystem to others at smaller or larger scales. Unfortunately, proposals to tackle the problems, regulate, monitor or enforce rules, are frequently focus on a single level (i.e. national governments) and are exclusive to one area (land use regulation detached from labor force or social inclusion measures, for example). It is very challenging to integrate local, regional, national, and international levels to solve interdisciplinary and systemic problems.

Considering these concepts, public policies of different types, natures and private ESG initiatives are required to reverse the limits that have not yet been crossed (mitigation), prepare for the consequences that will come as a result of what has already been crossed (adaptation), and enable the impacts to be minimized and the economy to return to normal as soon as possible after disasters (resilience). Filling these gaps will require major advances in international, national, public and private coordination for governance and management, in an integrated approach, away from sectoral analyses, aimed at minimizing negative externalities while maximizing positive ones.

The second theory has a delicious name, doughnut, but conceptually it reflects an indigestible reality. The theoretical contribution starts from the same worrying scenario explored by the planetary boundaries' theory, which recommends the need to break out of the constant search for growth; to redesign currency, finance, and business to serve people and thus create economies that are regenerative and distributive by design. The inspiring message is to transform economies which need to grow, regardless of whether they bring common good, into economies that make people thrive, bring comfort and abundance, whether they grow or not (Raworth, 2017).

Meanwhile, the carbon footprint theory (Wackernagel and Rees, 1996; Wackernagel and Beyers, 2019) enables the product and service life cycle analysis methodology, which revolutionizes the metrics to provide better impact identification and thereby externalities pricing, whether positive or negative. According to the current footprint that humanity is leaving, we will need 1.65 planets to continue to exist, i.e., the current consumption patterns of society is therefore 65% greater than the planet's capability to provide inputs and absorb waste.[11] Life cycle assessment (Tukker, 2000) is an analytical tool specifically designed to assess the environmental impacts related to an entire production chain. It is, for example, the theoretical foundation of the RenovaCalc metric used in the RenovaBio, the Brazilian bioenergy policy to estimate decarbonization credits (Matsuura et al., 2018).

Regardless the economic theory, responsible investments alone are not enough to promote the region's economic development, while trying to preserve nature and increase the Amazon population's life quality. In fact, it is very hard to invest in really effective initiatives that bring real sustainability benefits and manage to overcome the enormous challenge of competing with the low prices of illegally extracted or illegally cultivated products.

Therefore, to face this new socio-environmental economic reality, new paradigms become necessary. Some very public incentives need to be very well directed and planned to really stimulate sustainable sectors, with a focus on small producers and small and medium-sized enterprises (SMEs). Still, it is important to consider the risk that public interventions in the economic domain may have unexpected effects, cancel out other policies, or even become disguised measures to harm free competition.

And this is precisely what the Food and Agriculture Organization (FAO) concludes when mapping different legislations in 54 countries (Bulman et al., 2021). It discovered that between 2018-2020 there were US$ 720 billion per year in payments to agriculture, with more than a third of this originating on

11. Available at: <https://www.footprintnetwork.org/>. Acessed on: July 2, 2021.

the price that was paid by consumers, while the remaining US$ 447 billion was paid by taxpayers in the form of budget transfers. About three-quarters of the total support, $ 540 billion, was directed to individual producers, both in price guarantees and through direct payments. This represented an average of 18% of gross farm income for producers in Organisation for Economic Co-operation and Development (OECD) countries and 12% of gross farm income in the twelve emerging economies reported.

Additionally, US$ 102 billion in expenses were paid as general services provided to the sector, which includes US$ 76 billion of public investments in science and technology, biosecurity, and infrastructure (Bulman et al., 2021). The way incentives to agriculture have been provided, they are only distorting the market and doing little to foster food security, nutrition, decent livelihoods, encourage sustainable practices, or environmental services. Wherever these policies are widely practiced, like in the European market, price guarantees and direct transfers to producers are the worst forms of subsidies, because they raise the price of land, increase products price, and stimulate inefficient production practices, often more polluting, preventing better allocations of resources.

3 CIRCULAR BIOECONOMY

One possibility for responsible investments to have the capacity to reverse the inefficient practices that are widely spread in the Amazon is to strengthen the local bioeconomy. First of all, it is necessary to place value on this natural and cultural treasure located mostly in Brazilian soil. And as a result, a greater commitment to the use of science (already developed or to be evolved) to solve previously identified problems, converting it into creative solutions and a bit of the "startup" philosophy and ambitious spirit to generate innovations using bioinputs.

To this to happen the local system reconstruction needs massive economic resources, given the size of the degradation caused by decades of unmonitored extractivism. Thus, the goal is to preserve the structure of available resources in order to benefit the region and restore the destroyed systems. Therefore, it is fundamental to have alternatives to leverage the investments already made and to attract future ones, stimulating the cultivation of food, feed, bioenergy, and fibers, applying what scientists have developed over the last decades as best practices for soil, water, and biodiversity use.

This increases the likelihood of progressively reducing net greenhouse gas emissions; restoring degraded ecosystems and increasing the systems' ability to produce. However, the concept of circular bioeconomy is not consensual. Currently, widely different and sometimes diametrically opposed views coexist, for example: one advocating the ability of technology to solve current problems

and maintain hyper-consumption patterns (Elkington, 2020) and another proposing to redesign the economy and its metrics to decouple prosperity from growth (Jackson, 2009). As usual, when researchers cannot reach a consensus, it is necessary to look at each proposal from a different angle. The first case can be of significant importance in contexts where the resources being produced are essential to human survival. However, the logistics required for product transportation of several types will certainly have negative effects regarding the preservation and emission reduction. The second case seems somewhat contradictory in socioeconomic terms.

The great challenge seems to be identifying a formula that can rescue the riches of the region, respecting social and environmental aspects, and convincing investors of the intrinsic value to the recovery of the damaged biome. A second challenge would be to manage the economic value generated by forestry activities or those related to the local environment.

If it is acceptable to define the circular bioeconomy as an economic concept that integrates the circular economy and bioeconomy synergies, focusing on using natural inputs in closed cycles, the solution lies in selecting scientific developments that bring the greatest benefits in terms of more productivity, less residues or better environmental services. In this regard, the bioeconomy can be the answer to counter economic stagnation while putting the world back into economic growth patterns, overcoming the limits of non-renewable resource depletion and lack of sinks for pollution and greenhouse gas emissions (Giampietro, 2019).

The bioeconomy is placed in the broader context of the green economy (Unep, 2011), and focuses on the use of renewable raw materials and application of research, development and innovation, and biotechnology in industrial ways in sectors such as food, pharmaceuticals, chemicals, and biofuels. The focus of the bioeconomy is to create opportunities for economic growth in bio-based sectors, given the achievement of sustainable development goals, the challenges of food insecurity in raw material supply, and increasing environmental constraints at distinct levels of authority.

Summarizing many concepts, circularity is "what" it is intended to achieve: to decouple the need of resources from their finiteness. Thus, techniques that allow several alternative applications of the same input are fundamental because they multiply the possibilities of benefiting from the same natural resources that is already produced or extracted, optimizing their use. On the other hand, bioeconomy is the "how" circularity can be achieved, that is, which biophysical processes should be improved to achieve the expected result of reusing the same biomass several times (Giampietro, 2019).

According to the World Circular Bioeconomy Forum, designing products and services with bio-based and sustainable raw materials creates renewable, recyclable and biodegradable products on the market, slowly replacing fossil-based with bio-based carbon. Using natural fiber-based materials for long-lasting applications with the potential to be reused and recycled creates the development of more sustainable materials in the future.

Producing bio-based chemicals and polymers with high-performance functionality for long-term use, with full recycling at the product's end of life, must be combined during the transition period with recycling systems for carbon-based materials from fossil sources. But renewable carbon is a major link to a bio-based circular economy, and there are three sources: agricultural (biosphere), (re)captured (with technology from the atmosphere) or recycled, also with technology. Renewable carbon can replace the use of any additional fossil carbon from the geosphere (WCBEF, 2020).

Biomass used in renewable carbon is divided into primary biomass, when it comes directly from fields and forests, or as biogenic waste-derived biomass and side-streams, for example, generated as waste by the agriculture, energy and forestry sectors, as well as by food, animal feed and chemical industries, wood and paper production, and household waste. Using this type of "organic waste" in a technologically sophisticated way is the key to a bio-based economy to become circular (WCBEF, 2020).

Although the circular bioeconomy is a solution to save and rationalize natural resources use, it is still far from the Brazilian reality as detailed in the following sections. The economic activity in the Amazon is marked by illegalities and irresponsibility that compromise forest coverage maintenance and natural resource optimization in Brazil. It is essential to improve productive practices across the region, such as management per square meter (for example, in the case of legal timber production) and education and training for agricultural producers, so that they can expand production without the burden of forest loss and consequences that are already well known, ensuring compliance with legal issues related to the regulatory environment and sustainable production.

4 ILLEGALITIES, INSPECTION AND PUNISHMENT CHALLENGES

Alongside the development of preventive policies focused on the circular bioeconomy, which foresees changes to expand product's supply while maintaining the biological properties and respecting the natural capital of the Amazon, it is essential to solve the biggest environmental problem in the Amazon for the conservation policies to succeed: deforestation.

Thinking of the terms "illegality" and "Amazon" together brings the reader back to the serious deforestation rates in the area and their environmental implications that compromise biodiversity, climate, and water security. It is estimated that 98.9% of deforested areas in 2020 have evidence of illegality (Azevedo et al., 2021). In the same year, more than a third of the felled forests overlapped with legal reserves, Permanent Preservation Areas (PPAs), or river springs, all of which are protected by law under the Forest Code (Brasil, 2012). By April 2021, only 5% of the deforested areas in 2019 and 2020 had inspection and accountability identified by the Brazilian Institute for the Environment and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – Ibama), which demonstrates the country's fragility in intervening for the conservation of biomes (Azevedo et al., 2021).

Additionally, the assessments disclosed by the Instituto Centro de Vida (Manzolli et al., 2021) show that the Vegetation Suppression Authorization (Autorização de Supressão de Vegetação – ASV), required for rural landowners to clear areas in accordance with the cases foreseen in the legislation, contain precarious, inadequate or incomplete information, which makes it difficult to differentiate legal from illegal deforestation, a fundamental element for halting deforestation and natural ecosystem rupture. This (mis)information compromises the enforcement agencies ability in combating deforestation (Azevedo et al., 2021).

4.1 Logging and mining

Logging commerce is still a link that strengthens criminal acts that circumvent legislation and inspection in deforested areas. According to Imazon (Souza Jr. and Cardoso, 2020), in the state of Pará alone, a Brazilian Federative Unit that maintains the highest deforestation rates in the country, 38,000 hectares of forests were exploited for logging activities between August 2017 and July 2018. From this amount, only 30% had operational Forest Exploitation Permits (Autorizações de Exploração Florestal – AEFs) at the time. The remaining 70% correspond to irregular felling.

Illegal timber shipments are being supported by corrupt practices, a recurring action usually targeted by the Ministry of the Environment, Ibama, the Federal Police, and other public agencies working jointly to combat corruption in the forestry sector. The lack of enforcement and, again, insufficient information related to forest product support impunity for environmental violations and facilitate the shipment of illegal timber. The recent dismantling and institutional weakening of the environmental inspection agencies, such as Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) and Ibama, jeopardizes the inspection capacity of the public agencies, and highlights a worrying aspect for the maintenance of the Amazon's native forests. It also reflects the precariousness of the current forest

monitoring and control systems that complicates the pinpointing of the wood's legal origin.

According to Lovejoy and Nobre (2018) if the effects of both climate change and logging activities that weaken the forest ecosystems' resilience are added to the impacts of forest's clear cut, the Amazon's tipping point toward "savannization" and possible desertification of affected areas may be at the range close to what has already been deforested so far, which compromises the region's productive capacity and the ecosystem services maintained by the forest, such as water security. Abramovay (2020) adds that about 20% of Amazon territory has already been deforested, in 1960 this amount was 1%, so the risk of Amazon desertification seems closer than previously estimated.

Besides illegal and destructive logging, illegal activities, including those in protected areas, threaten forest areas through clandestine mining and land grabbing. Clandestine mining is the result of unauthorized deforestation to open up areas for mineral exploitation, such as gold and diamonds. The environmental impact is not restricted to deforestation, but also to the contamination of nearby areas by mercury from digging up the exploited soil. Among other aspects, social effects of mining are also accentuated by the dispute for land occupied by indigenous people, which raises violence and illnesses to the traditional populations. Another critical point is that the extractive activity does not generate significant advances for the region in the long term. Mining impacts on health, education, and gross domestic product (GDP) per capita indicators in the Amazon are temporary and dissipate within three to five years, i.e., they do not stimulate regional development on the long term (Instituto Escolhas, 2021).

Studies conducted by the Amazon Environmental Research Institute (Instituto de Pesquisa Ambiental da Amazônia – Ipam) (Fellows et al., 2021) show that there are overlapping Rural Environmental Registers (Cadastros Ambientais Rurais – CARs) on indigenous territories, which is illegal and should be inspected by the environmental agencies and restrained by the police. Because CAR is self-declared, and illegal registrations in indigenous territories increased 75% between 2016 and 2020. This data illustrates the advance of squatting on indigenous lands. Furthermore, studies estimated that also illegal mining increased deforestation and fires in these areas by 2.6 and 2.2 times, respectively. Historically, lands occupied by autochthonous populations have the lowest deforestation rates in the Amazon, which demonstrates forest conservation by the indigenous population.

Besides operating illegally, economic activities in the Amazon, such as logging and mining, are maintained through informality, for gold, niobium, tantalum, bauxite and manganese and other minerals. It was estimated that in 2010, 60% of the economically active population in the Brazilian Amazon worked in the

informal market, including slave and child labor, without guaranteed benefits and social rights (ARA, 2011). IBGE data (2020a) confirms this statistic and details that 61.6% of Brazil's Northern population have informal jobs.

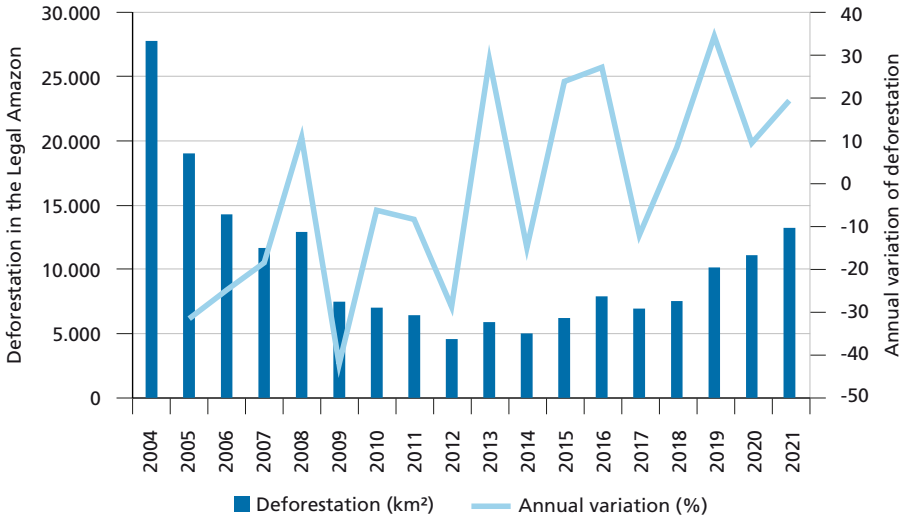
This proves that the Amazon's growth pattern in recent decades has discouraged the strengthening of regional development regarding social aspects, especially for marginalized populations. Living conditions in 98.5% of the region's municipalities are worse than those in other regions of Brazil (Abramovay, 2020). The author analyzes the Social Progress Index to explain the performance of the Amazon, which is associated with a development model strongly marked by deforestation, extensive use of natural resources, and social conflicts. Therefore, there is no significant improvement in the population's living standards, only environmental damage that compromises the regional production itself. These conclusions reinforce the idea that reducing forest areas to promote logging or mining activities is not a socially desirable way to improve the population's living conditions. On the contrary, predatory practices inhibit a sustainable economy to take place and stimulate the perpetuation as an economy of the nature destruction.

Deforestation can be considered an attack on human rights, limiting the ability of the government to provide its services. Two studies by Ipea confirm that. The first shows that municipalities located in deforestation areas in the Amazon suffer more from violence than other cities of the same size and economic importance, with a 51.9% worsening in the homicide rate while other municipalities maintained a percentage of only 2% (Cerqueira et al., 2013). The second analysis indicates that for every 1% of forest lost annually in the Amazon, there is a 23% increase in the incidence of malaria cases and an 8% to 9% increase in leishmaniasis cases (Saccaro Junior, Mation and Sakowski, 2015).

Despite the perceptible democratic weakness and lack of governance in preserving the Amazon facing a crime chain, some instruments, developed by the public sphere recognize the importance of the biome preservation for the country's economy and geopolitics. The program for monitoring the Amazon forest by satellite (Programa de Cálculo do Desflorestamento da Amazônia – Prodes) provides annual mapping to gather and analyze data on deforestation, while the Real-Time Deforestation Detection System (Sistema de Detecção de Desmatamentos em Tempo Real – Deter) monitors deforested areas on a daily basis. Prodes and Deter supervise, in this order, the vegetation cover in the Legal Amazon and in Brazil. Public data management on deforestation has stimulated the development as part of the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (Plano de Ação para Prevenção e Controle do Desmatamento na Amazônia Legal – PPCDAm), which

contemplates several measures that made it possible to reduce deforestation in the biome between 2004 and 2012, as shown in graph 1.

GRAPH 1
Deforestation in the Amazon region (2004-2020)



Source: Inpe (2021).
Authors' elaboration.
Obs.: The 2021 data available is only until November.

Maintaining adherence to the country's legal framework regarding environmental rules, especially those about land use in the country, effective public monitoring, and assuring biome preservation is fundamental to sustaining the existing command and control mechanisms, since the institutional weakening of enforcement agencies seems to be closely related to the surge in illegal deforestation, as observed by the increasing deforestation rates since 2019.

4.2 "No man's land" and the squatting cycle

Besides logging and clandestine mining, land without an owner is also a deforestation vector. Given Brazil's continental dimensions and the existence of sparsely populated areas, there has been a growing amount of irregular property rights in the country. The indefiniteness of who owns what also contributes to a growth in unlawful land grabbing and untitled occupation. In Brazilian Amazon alone, 49.8 million hectares of forests are considered undesignated areas, i.e., public properties owned by the Union, or the States destined for sustainable resource use or for creating conservation units (Azevedo-Ramos et al., 2020). In the country's legal system, undesignated lands can be directed to rural production

and for agrarian reform, especially by IPTC usages, but historically, these public forests have been vulnerable to land speculation.

The slowness and complexity in designating lands, as explored by Oliveira and Ferreira (2021), is justified by the technical difficulty in demarcating them accurately and the delay of the responsible agencies recognition of what has been self-declared. According to Azevedo-Ramos et al. (2020) the federal and regional government sometimes do not recognize any official agencies responsible for managing and protecting undesignated lands. Therefore, these "no man's lands" highlight the vulnerability of forests to deforestation and the appropriation of public lands by illegal settlers.

The squatting cycle comprises five stages and the final purpose of land appropriation is future sale for speculative purposes. The first stage begins with forest felling and timber sales, especially those with the highest commercial value. The second stage is marked by the burning of the deforested region to create pastureland. Low-productivity cattle raising marks the third phase, in which cattle raising is a way to ensure land ownership without the need for large investments, which is explained by the risk of losing the value invested with the possible contestation of property rights that was obtained illegally. The cattle are then transferred to another encroachment area, and the production of monocultures, such as soybeans, begins. Agricultural activity defines the fourth stage and is usually yields a higher financial return for the invaders, consequently, it adds land value for the fifth stage consolidation, which ends the cycle with the land sale (Perosa, 2014).

Understanding this cycle is important for two reasons: first, to identify a coordination that involves squatters, miners, and loggers, and can rely on municipal, state, and national political organizations for support. Second, to disassociate at least part of the agricultural and ranching production from deforestation practices. The development of agribusiness activities may be a consequence of other economic motivations, such as land occupation that may increase its value in the future. This deforestation cycle creates a time lag between the moment when deforestation occurs and when the land is used for agribusiness activities, suggesting that the incentives for illegal deforestation are not, at least immediately, aimed at agricultural demands, except if the agricultural frontier's expansion raises future monetary gains expectations for deforesting agents.

With the establishment of CAR, regulatory agencies have improved the ability to access rural property data in the country. This has shed light on compelling evidence of squatting due to the large overlap of private properties self-declared in the system, overlap corresponds to 50% of the entire area registered in Brazil (Oliveira and Ferreira, 2021). In other words, the same property has been registered more than

once, in half the cases. Azevedo-Ramos et al. (2020) state that 11.6 million hectares of public lands have been registered in the CAR as private. In theory, the registration should be inspected by state agencies, but this does not usually occur, and the "no man's land" squatter sells the land before even receiving the registered title.

Among the negative effects of illegal occupation, two of them draw attention: inefficient production, from the perspective of land use and natural resources; and command (penalization) and control (monitoring) policies implementation. Production in these illegal areas makes it impossible to obtain financial support for technology adoption as well as to promote changes in the infrastructure to certify the products' origin, leaving them on the fringes of formal markets. Moreover, due to this inexistence of well-defined properties, it is difficult to point the culprits of environmental crimes and bring them to justice. Criminal organizations' activities are a natural consequence of these serious circumstances that the Amazonians are subjected. Would the laws that criminalize public land invasion be enforced, with exemplar penalties, arrests and destruction of the equipment used in the illicit activities, the signals and expectations issued about future actions would have a better chance in preventing illegal activities and land grabs.

A better landholding regulation as a public policy, based on well-defined and fair criteria, would allow economic dynamism by providing legal security as well as stimulating environmental care through land use allocation to farmers and IPTC and sustainable management of the extraction of resources. By allowing a long-term vision, these types of land's concessions would have defined purposes for productive and not speculative activities, which leads to a partial reduction in deforestation and a possible gain in public revenues. It is also important to highlight the social and distributive benefits, such as the possibility of improving inspection by regulatory agencies and ensuring preservation areas. This issue is discussed further in the next section.

4.3 The omissive state and undefined defendant: the worst combination for enforcing the law

Agrarian conflicts over natural resources and land properties in the Amazon result in violence, deaths, and the victimization of farmers and squatters who remain within the government negligence and omission. This region suffers from a disorganized land occupation, where areas that should be destined for creating conservation units and demarcated as IPTC lands have presented an occupation process without technical criteria. In this case, land rights distribution is considered an immediate solution, including for deforestation, since not all production on public lands is due to criminal activities that contribute to illegal deforestation and theft of undesignated lands. Land tenure regularization programs seem to be

a solution for the identification and transfer of domain or ownership of public lands to squatters who meet the legal requirements.

Discussions on landholding regularization in the Amazon between 2008 and 2009, which resulted in Provisional Measure No. 458, from February 10, 2009,[12] were responsible for the establishment of Law No. 11,952, from June 25, 2019, which promotes the regularization process of rural and urban areas located in the region's remaining public lands. Created by the Legal Land Program (Programa Terra Legal), an amnesty mechanism was created for properties up to 1,500 hectares where occupation had occurred until 2004. The program was expanded in 2016,[13] increasing the area of properties fit for regularization and extending the timeframe for land occupation to 2011. The same thing occurred in 2019,[14] expanding the area of properties eligible for regularization, and with a new flexibilization of the date for the beginning of occupation activities to 2018. Since it was not approved by the established deadline, the 2019 Provisional Measure lost its effectiveness, but there is already a similar bill,[15] regarding landholding regularization, under evaluation.

The expected program outcome, and from its modifications, is the reduction of producers' uncertainty, who will have property titles and therefore be obliged to keep the land in productive use to guarantee income and economic inclusion. Another expected result is the decrease in criminal invasions and deforestation on public lands. On this last aspect, Azevedo-Ramos et al., (2020) argue that in the absence of effective land governance (elevating the risk of squatting), deforested areas on public lands between 2010 and 2015 increased by 25% of the total accumulated in Amazon forests. Robinson, Holland and Naughton-Treves (2014) add that undesignated lands are particularly vulnerable to deforestation.

Title issuance is also suitable for identifying, holding accountable, and punishing those who deforest and commit for environmental crimes. However, since the regularization of illegally acquired lands is possible, i.e., legitimizing squatting practices, the opposite effect can occur, stimulating new illegal occupations while expecting to obtain a title.

To substantiate land regularization, aligned with deforestation reduction and environmental liability recovery purposes in rural properties, Brito et al. (2021) discuss some actions for current landholding practices to be aligned with the Amazon Forest preservation and break with the landholding illicit culture: i) establish transparent processes and social control for public land allocation, which makes it possible to prioritize conflict or environmental conservation

12. Available at: <planalto.gov.br/ccivil_03/_Ato2007-2010/2009/Mpv/458.htm>.
13. Law No. 13,465, from July 11, 2017. Available at: <https://bit.ly/34ZgN1b>.
14. Provisional Measure No. 910, from December 10, 2019. Available at: <https://bit.ly/3GUJxWe>.
15. Bill No. 510, from April 27, 2021. Available at: <https://bit.ly/3GL0ToF>.

areas. Currently, society does not know which public areas are being designated and who receives land titles; ii) prohibit privatization of predominantly forested areas, especially when there is overlapping in traditional or IPTC lands areas. Forest areas should only be allocated for forest sustainable management concessions according to Federal Law No. 11,284, from March 2, 2006, that demands that only 20% forest cover can be legally deforested, the rest (80%) of the property vegetation have to be maintained intact, this is a rule applicable to any rural property in the Amazon region; and iii) set a time limit that restricts the occupation date of public lands subject to titling. This aims to prevent land grabbers from occupying land in an articulated manner expecting to regularize illicit areas in the future.

In sum, recent changes in land use throughout the Brazilian Amazon suggest a record number of fires, a series of omissions, and disempowerment undertaken by the federal government (Ferrante and Fearnside, 2019). A possible high-level involvement of politicians in the environment ministry with illegal logging companies highlights the need for improved governance for the region, including the role of a consortia of state governments, civil society, and national and international investors. A new sense of urgency around protecting the Amazon now exists, with recent research indicating that deforestation could become a source of water stress for other regions, including the Midwest, critical for agribusiness, as well as reputational risk for products that cannot be traced (Follador et al., 2021; Rajão et al., 2020). The debate about agricultural production and deforestation is discussed in the next section.

5 DEFORESTATION ON THE PLATE OR OFF THE TABLE?

The agri-environmental agenda in the Brazilian Amazon must listen to the consumer markets call to promote control measures, land title regularization and undesignated land allocation. Government can take advantage of private initiatives that coordinate economic activities seeking sustainability in supply chains, demanding or validating tracking systems for example already being deployed by business to guarantee ESG compliance and therefore market access and better pricing.

In agriculture and cattle ranching, sustainable production is at the forefront worldwide, and international players are demanding a production source that decouples deforestation from agribusiness, and increasing the production practices that spare natural resources (Soendergaard et al., 2021). Particularly in the Amazon, this is a sensitive subject for agribusiness development, since deforestation concerns the image of the whole country's agricultural production abroad and is a priority on large companies' agendas.

As a major world power in agribusiness production and supply, Brazil makes intensive use of natural resources as a productive input, being the only country, among the ten largest greenhouse gases emitters, whose emissions are dominated by agriculture and cattle raising (34% of emissions) and changes in land use (26%). Worldwide, these two elements are responsible for only 11% and 6% of emissions, respectively (Oliveira and Ferreira, 2021).

For more than a decade, two initiatives that bring together rural producers, agribusiness processing and marketing companies, and non-governmental organizations (NGOs) have tried to reconcile production in rural areas with consumer demand for sustainable products (Soendergaard et al., 2021). The Soy Moratorium of 2006, articulated by Greenpeace and sponsored by the entities Associação Brasileira das Indústrias de Óleos Vegetais (Abiove) and Associação Nacional dos Exportadores de Cerais (Anec) and by the six largest soybean traders in the country (the Big Six) signed an agreement in which the companies affiliated to the organizations would not purchase grain from deforested areas.

Similarly, a joint action between the Federal Public Ministry (from the operation "Legal Meat") and the country's large meat retailers (the G4) resulted in signing the Terms of Conduct Adjustment (Termos de Ajustamento de Conduta – TACs) in 2009. The initiative became known as the Meat Moratorium and foresaw that meat processors would not buy products from cattle ranching performed in irregularly deforested areas.

Both actions achieved their purpose of reducing deforestation rates by targeting producers who practiced illegal deforestation. The 2005-2006 soybean harvests went from 1.14 million hectares to 5 million hectares in 2018-2019, with a 260% increase in the area produced in the Amazon biome since 2006. However, only 1% of the area output corresponds to cultivation in newly deforested areas.[16] A decrease in the number of properties conducting cattle ranching activities linked to deforestation practices was also reported, falling from 26% in 2009 to 4% in 2013 (Gibbs et al., 2016). Despite the optimistic results, evaluations by the Public Prosecution Service[17] detail that private initiatives have not stopped "cattle ranching advance". Fraud practices,[18] corruption in inspections,[19] and illegal farmers' sales with a consumer market guarantee, help to ensure soybean and meat sales.

Regarding livestock products, even with the efforts of the large slaughterhouse groups, part of the meat produced in the embargoed properties in the Amazon

16. Available at: <https://bit.ly/3sEnkXz>.
17. Available at: <https://bit.ly/3oPM8ui>.
18. See Soendergaard et al. (2021).
19. See more at: <https://drive.google.com/file/d/12KS78YZ68bIuHwYqtrREaYAxzbbdCx0O/view>.

region is sold through alternative channels and remains in supply chains that are not compatible with the G4 proposal. Additionally, the very sector categorization makes it difficult for slaughterhouses to access information. The cattle supply chain includes fattening and full cycle farms (often qualified as direct suppliers), where producers manage the entire production cycle (from birth to slaughter); as well as breeding farms and feedlot operations, which involve intermediate fattening cycles (often characterized as indirect suppliers), in which case producers are partially involved in the animal's cycle (Soendergaard et al., 2021).

Forest fires in the Amazon in 2019, increased deforestation in 2019 and 2020, and accelerating global climate change have attracted and maintained international headlines for Brazil (as exemplified by *The Economist's* 2019, 2020 stories). This inevitably sets the country's agribusiness agenda. What worries private agents is that the country's recent statistics are the result of weakening public control mechanisms. Even if land use change in the Amazon biome occurs for other purposes, such as the already mentioned real estate speculations (land grabbing), logging and mining, the pressure of illegalities falls on grain traders and meatpackers all over the country.

Soendergaard et al. (2021) add that the agricultural frontier expansion throughout the country occurs outside the Amazon but given that a small number of rural properties and municipalities in the area account for a large share of the deforestation, the agricultural sector across the country has become vulnerable to negative repercussions to different extents. An example is the suspension of Brazilian tannery purchases by two large foreign clothing groups (Andreoni and Maheshwari, 2019).

Eliminating illegal deforestation in the Amazon may seem like an unattainable goal, but it is important to reiterate exhaustively that initiatives such as the Soy Moratorium and the Meat Moratorium represent efforts that can be extended to reducing Amazon deforestation, qualifying as concrete and definitive solutions for a preserved and sustainably productive region. The solution includes market regulation, inspection, innovation, company and consumer accountability, and technology to increase productivity without expanding farmland.

Fiagro's national and foreign investments in Brazilian agribusiness is a possibility for producers to invest in rural properties and in production activities in the agribusiness sector. By applying third party resources and being a state-regulated action, the proposal is to expand the production range with the best governance practices to ensure the program's good reputation, including environmental responsibility. If this does not occur, the funds' mismanagement, especially if questioned by any control agency, can compromise the whole group of investments.

Based on Law No. 14,119, from January 13, 2021, which defines criteria and actions for the National Policy of Payment for Environmental Services (Política Nacional de Pagamento por Serviços Ambientais – PNPSA) there is also a promising niche in the green market and sustainable agribusiness to stimulate producers to participate in capital markets and investors to enter the agribusiness, both made possible by Fiagro. This means that investments for agribusiness growth are expected to be matched by an increase in funding for environmental services and investments, and an increase in resources for ecosystem services maintenance.

Payments for environmental (or ecosystem) services include a number of positive externalities on biomes, such as carbon dioxide retention in soils, restoration of degraded pastures, and vegetation preservation that might otherwise be deforested. Monetizing these services can occur in two ways: by commercializing the environmental services surplus (as occurs with carbon markets in international voluntary and regulated mechanisms); and by internalizing environmental benefits in prices of goods (Oliveira and Ferreira, 2021). Regarding bioproduction, by allocating a portion of land for conservation, producers and investors contribute to environmental maintenance and benefit from hydrological cycle regulation, for example. In the meat and soy chains, producers can benefit from a differentiation strategy, by attributing value to quality and traceability in the production chain links, and therefore obtain financial returns via a pricing surplus.

A suggestion to change production arrangements to include environmental services is the reason for the launching of the "Carbon Neutral Meat" line by a retail chain in partnership with Embrapa. The sustainability attributes are guaranteed by the certified cattle raised in Crop-Livestock-Forest Integration (Integração Lavoura-Pecuária-Floresta – ILPF) systems. Regarding bio-economy, this system reduces dependence on the use of fossil-based pesticides, since the integration between varied species optimizes protection against pests and promotes better soil quality management and increased productivity, with yield levels equal to or higher than those of traditional monocultures.[20] This productive model can be called regenerative agriculture because it minimizes the negative production effects through the recovery of areas currently occupied by degraded pastures (Oliveira and Ferreira, 2021).

Considering the circular economy, the "Carbon Neutral Meat" can be understood by land sharing strategies, which recommend maintaining the relationship between agricultural production and natural resource conservation, ecosystem services, and biodiversity. Integrating productive areas with environmental protection regions is a way to favor energy and biomass flow exchange, with more productive land use. Cattle raising in ILPF systems is an example of how this occurs (Abramovay, 2020).

20. Available at: <https://bit.ly/3LAdkXM>.

6 AGROFORESTRY SYSTEMS, INTEGRATED LIVESTOCKS AND FOREST MANAGEMENT

Integrated crop-livestock-forest systems are a sustainable agriculture system based on land use intensification for food, fiber, and energy production and are a priority issue in Brazilian government public policies, receiving resources from the Low Carbon Agriculture Plan (Brasil, 2016). They have been most applied in the Brazilian Cerrado, but in the Amazon biomes they are also applicable mainly where there has already been deforestation and the land are degraded.

Through the technologies fostered by this plan and in its next implementation phase, which started in 2021, the ABC+ Plan, productive chains are encouraged to adopt resilient systems that control greenhouse gas emissions and offer certified low emission or carbon neutral products, based on scientific evidence and with an integrated landscape approach (Brasil, 2021).

To support this program, the 2021-2022 Brazilian crop plan (Plano Safra) foresees R$ 5.05 billion for pasture recovery, ILPF, direct planting, waste treatment, among others. This corresponds to an increase of 102% compared to the resources provided in last year's harvest. Resources for the Inovagro and Moderagro programs were also increased. A study by the Federal University of Goiás estimated that only the pasture recovery reached 26.8 million hectares between 2010 and 2018 (Parente, Mesquita and Oliveira-Santos, 2020).

According to Agroicone estimates, about 45% of this landscape recovery financing was done with resources from the Plano Safra (Lima, 2021) and the remaining with funds from producers or from financings outside the agricultural policy. This is especially important for medium-sized producers (focus of the ABC Program), who demand investments in technologies and technical assistance to enable the innovation needed to align farming with socio-environmental attributes of sustainable agricultural production.

ILPF is a concrete example to reduce emissions intensity, restore soils and landscapes, increase resilience and adaptation. This option can be leveraged through sustainable finance. The Sustainable Agriculture Finance Facility (SAFF)[21] estimates that Brazil has 180 million hectares of pastureland, half of which can be considered degraded and unproductive. To recover these areas, the program offers five credit lines with terms adapted to distinct stages of ILPF implementation, foreseeing the continuous evaluation of outcomes using indicators that allow monitoring the achievement of the proposed objectives to increase cattle productivity by triple. In other words, this represents the opportunity to have

21. Available at: <https://www.climatefinancelab.org/project/sustainable-agriculture-finance-facility/>.

three times more production without cutting any tree, only promoting better agronomical techniques on degraded and unproductive land.

The Development Bank of Minas Gerais is the first Brazilian public bank to issue sustainable bonds and publish a framework with eligibility criteria for financing environmental and social projects (BDMG, 2020). With this, it aims to guide and stimulate no-till farming, biological nitrogen fixation, agroforestry systems, ILPF, waste management and biodigesters, organic production, and sustainable forest management.

The Reca Project's Smallholder Agroforestry Association and Agricultural and Forestry Cooperative is a good example of how it is possible to make it economically viable to plant trees and care for them, without getting caught in the vicious cycle of cutting down the forest, establishing pastures that quickly deplete the soil nutrients, because they are tropical, tend to be poor and therefore will demand more and more costs with fertilizers. Preserved forest maintains biodiversity, protects soil and water, captures carbon in its trees, mitigates climate change, and can be exploited as a source of food, fiber, and energy. The farmers of Reca approach this ecosystem by densely planting up to forty species in their recreated rainforest plots, and thereby obtain raw material for food products that are sold online all over Brazil: such as fruit juice, pulp, palm heart, oils, and butters.[22]

7 AMAZON FIRST FOR THE AMAZON PEOPLE

Considering all that has been discussed, it is clear that development cannot be guided by expropriation and extractivism. Infrastructure and public spending in the Amazon need to generate human development, health, sanitation, education, science and technology. However, the focus has been on a series of unfinished interventions in national integration projects or that make feasible the speculative land sale and the illegal outflow of resources to the international market.

This is a short-sighted vision regarding long-term objectives that, if it made sense in an era of mercantilism or imperialism, are obsolete for creating a new economic paradigm that allows human beings to coexist with nature. And even in commercial value terms, they are entirely counterproductive. The low price of a ton of iron ore, for example, is infinitely lower than the milligram of a medicine or substance of very high added value that can be achieved through the use of biodiversity with science and technology. Just as illegalities occur in logging and commodity production, biopiracy corresponds to a form of undervaluing natural resources and expropriation of the Amazon.

22. Available at: <https://www.projetoreca.com.br/produtos/categoria/polpas/>.

7.1 Non-biopiracy biotechnology

The bioeconomy involves the large-scale use of biotechnology, with science and technology applied to living organisms, as well as their parts, products and models, to alter living or nonliving materials for producing knowledge, goods and services. At this point, the economic transition will depend on technology advances, coordinated public policies, competitive costs and, mainly, biomass availability. And this is something the Amazon has in abundance.

Brazil has recently joined the Nagoya Protocol (UN, 2011), which has been operating internationally since 2014, as part of the legal regime created by the umbrella treaty of the Convention on Biological Diversity (UN, 1992). Brazil is a supplier and user of biodiversity genetic resources, therefore, the benefit distribution system in force nationally since 2015, should protect the resources and the interests of traditional peoples, while facilitating access to foster biotechnology innovation and development essential to the agribusiness development (Brasil, 2015).

Particularly for the Amazon, protecting biodiversity and traditional knowledge has a number of implications, mainly because it directly affects the interests of the pharmaceutical, food, seed, cosmetic, and pesticide industries. In some cases, these industries rely on traditional knowledge to access the resource, make minor modifications, patent, and manufacture new products based on the collected data, without sharing the benefits. This creates a type of systemic injustice that is difficult to regulate (Pogge, 2002; 2010).

The Amazon is home to 22% of the vascular plant species, 14% of the birds, 9% of the mammals, 8% of the amphibians, and 18% of the fish that inhabit the tropics, a single gram of soil may contain more than 1,000 genetically distinct fungi, according to Science Panel for the Amazon.[23] Scientists describe a new species every two days in the region, but many groups are still little known, and the techniques for understanding the ecology and geographical distribution of most species in the Amazon are rudimentary. In other words, it is a treasure trove for science and innovation that can be exploited by local and foreign researchers.

And as a result, the concept of fair and equitable benefit sharing, which comes from the international biodiversity law, the international human rights law, and the law of the sea, becomes more important. It considers the nature of the benefits to be shared; the activities from which the duty to share arises; the beneficiaries; and justice and equity as the justification for distributing the gains.

Extracting genetic resources illegally, that is, without fairly distributing the benefits with the communities and the country from which they are extracted, is strongly linked to environmental degradation, decreases tax collection, and thus

23. Available at: <https://www.theamazonwewant.org/amazon-assessment-report-2021/>.

compromises public spending and social investment to improve the life quality of the Amazon people. Besides having as its immediate effects deforestation, biodiversity depletion, and the impoverishment of individuals and communities that depend on these resources to sustain their existence, it also reveals a loss of traditional knowledge that has been built up over generations, which could, in the future, lead to new chemicals or pharmaceuticals development.

The Nagoya Protocol seeks to establish a multilateral framework for sharing biodiversity resources, creating: biological diversity conservation, sustainable use of its resources, and fair and equitable sharing of the economic benefits arising from genetic materials use. The idea is that access to a genetic resource originating from a country (in situ), which gives birth to a product, creates an obligation to share benefits in order to contribute to biodiversity conservation. For the Amazon region, this multilateral system has the potential to contribute a lot to regional development, but it needs to be well applied, otherwise it can become another front for organized crime activities such as native species trafficking (Denny, 2022).

Natural resource extraction is one of the activities that present challenges to international regulation and law enforcement, so it is vulnerable to criminal activity. The conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits derived from genetic resources use are especially challenging. Biopiracy is not a legal term in Brazil, but it means appropriation of biological resources and knowledge of those resources for purposes that do not meet the approval or consent of groups or individuals who have some prior claim on the resources or knowledge. Thus, patenting a chemical product or medicine without equitable benefit sharing with the communities and country from which the original substances were extracted can also be considered biopiracy (Denny, 2021).

The lack of legal qualification for biopiracy weakens the state's ability to control it. In the absence of specific legislation, biopirates extend their claws over the Amazon and take the riches of genetic heritage and traditional knowledge without giving anything in return (Pozzetti and Mendes, 2014). Without criminal legislation, the way to punish these conducts is a civil one, and conviction is limited to proof as to the perception of advantage by the defendant. The economic value achieved through products originating from the genetic resources and traditional knowledge of Amazonian peoples, for example, fits as a measure to be punished. Again, this framework qualifies as one more to the implementation challenge.

7.2 The market alone will probably not solve the problem

International direct investments, responsible funds, market-driven voluntary governance founded on sustainability reports, standards and certifications are unlikely to be sufficient to fill the void left by the state. Public policy tools remain the most effective way to induce change in market agents' behavior and even to promote improved corporate ESG compliance.

The development of a rich set of global finance and market-driven interventions has been the outcome of difficulties in implementing international legal regimes, given the asymmetry between the capacities of national states and their sovereignty. Fund creation (such as the Global Environmental Fund), climate bonds such as Green Bonds,[24] panda bonds, in China (Climate Bonds Initiative),[25] also multistakeholder eco-labeling, market-driven and audited voluntary certifications governing commodity production, voluntary reporting to track corporate social and environmental responsibility initiatives, are some examples (DeBoer et al., 2020).

Some studies, however, have found strong empirical evidence that these market tools generally turn out to be less than the creators and supporters expected, generating high compliance costs without delivering effectively transformative practical results in moving toward greater sustainability (Grabs, 2020). Increasing deforestation, biodiversity loss, and social inequality are among some of the unintended effects.

As for the Amazon, the conflicts of interest are so diametrically opposed that only a coordinated multi-agency public policy with a robust budget allocation can effectively foster the creation of circular bioeconomy opportunities. A regional coordination initiative among nine state governors of the Amazon region seeks to articulate efforts among the different environment secretariats to reinforce with public policies the voluntary and market tools available for private governance of the socioenvironmental issue in the region. This is a paradiplomacy initiative (Farias and Rei, 2016; Granziera, Rei and Gonçalves, 2020) to act internationally in pursuit of regional interests.

In this sense, the Consortium of Governors of the Legal Amazon (formed by Acre, Amapá, Amazonas, Maranhão, Mato Grosso, Rondônia, Roraima and Tocantins) is directly in contact with the ambassadors of the United States, European Union, United Kingdom, Germany and Norway among others (Semas, 2021) to articulate public-private partnerships, national and international, so that the Amazon develops its bioeconomy and thus contributes to the planet's climate security.

24. Available at: <https://www.unpri.org/>.
25. Available at: <https://bit.ly/3g2Nmha>.

Part of this effort is the Green Recovery Plan (Plano de Recuperação Verde – PRV) for the Amazon, which aims to unblock the resources of the Amazon Fund, which has existed for fifteen years but has been contingent for more than two years. There are approximately R$ 2 billion in this fund to combat illegal deforestation and forest fires. Besides these areas of activity, the PRV seeks to leverage sustainable economic development and improve the life quality of IPTC.

The main economic contribution of this consortium is the effort to recover Brazil's reputation for receiving international and corporate resources, since while the Amazon fund is paralyzed, there is no justification for raising new resources or creating new initiatives (Walendorff, 2021). Furthermore, once the resources are released, the consortium will have fundamental importance in defining priorities among actions that combat illegal burning and deforestation, while also contributing to the generation of employment and income for the 30 million Amazonians.

Other countries, mainly those in Europe, have mobilized themselves to metaregulate the partnership with private initiative. There are several examples in the European Fit for 55 plan whose goal is to reduce the continent's emissions by at least 55% until 2030, in comparison with 1990 levels (EC, 2021). In general terms, the European measures package recognizes the effectiveness of pricing carbon and controlling economic activities through market regulation to generate structural changes that provide more socially and environmentally responsible products and services that favor the maintenance of standing forests. The initiative package assumes the important role of directing these investments, designing markets, and demanding sustainability standards from their suppliers, including foreign ones.

Similarly, private and market initiatives can be used in the Amazon to reinforce the profitability of desirable activities. Alone, however, private initiatives will not be effective in correcting market failures and generating the necessary socio-environmental results. There is a need for coordination beyond the regional level.

8 CONCLUSION

Under the global spotlight, and especially considering the reports on extreme weather conditions, experienced more frequently by people in different countries, apparently the number of skeptics regarding the existence of some relationship between the way we live, consuming quickly and unlimitedly the product of the extraction and destruction of natural resources seems to have reduced. What is missing, however, is a stronger effort to convince people, based on scientific knowledge, of why it is important to prevent the resources that exist today from being depleted.

It has also increased the frequency with which we hear concerns about the necessity to promote assertive environmental preservation policies with social,

environmental, and corporate responsibilities. But what does this really mean? A major purpose of this article was to summarize and present in an organized way, the several problems that may fit in one way or another under this banner, duly accompanied by their causes and consequences.

However, despite the evident complexity of government policies and public sector initiatives, it is still not possible to conclude that their elaboration is practically a utopian situation, or if it is a puzzle game, with many pieces, representing a challenge to identify and fit the right pieces together. Moreover, it is known that collaborative work allows the game to be finished more quickly.

In Brazil, we already have advances. Investments such as the Amazon Fund and the Fiagro can stimulate a fast transition that encourages the circular bioeconomy and technology advances that guarantee competitive prices, sustainable, standardized, and certified biomass availability, and the investment attraction. After all, the sector needs capitalization to intensify and adopt qualified management of productive activities in areas of the economy most vulnerable to climate change.

We must ask ourselves, however, if for preservation it is necessary to leave nature untouched, or if the alternative may be the best use of resources and investments to be made by the country and the private sector, stimulating the cultivation of food, bioenergy, and fibers, employing what scientists have developed over the past decades as best practices for the use of soil, water, and biodiversity. Thus, creating a new paradigm of coexistence between economic development, conservation, and nature restoration.

It seems reasonable to argue for the second alternative. Since best practices increase the likelihood of progressively reducing net greenhouse gas emissions; restoring degraded ecosystems and increasing the systems' ability to continue producing. In this scenario, the simple preservation of the forest's existence would have a value, which could be traded in a market, where the most experienced traders tend to make the highest profits without continuity. Whereas using biotechnology and techniques to increase circularity would be a form of perennial, self-regenerating conservation that would change the economic paradigms that have been applied.

A great challenge, as considered in the discussions throughout the work, seems to be identifying how to rescue the riches of the region, while respecting social, cultural, and environmental aspects and, at the same time, convincing investors of the value that is intrinsic to the recovery of the destroyed biome. A second challenge would be to manage the economic value generated by the sustainable management of natural resources.

If there is coordination between the different economic segments, including governments, investors, and the private sector, to integrate circular economy and biotechnology synergies, a robust and resilient conservation and recovery process can be created. Focusing on natural inputs utilization in closed cycles, the solution would be in selecting the scientific developments that bring the greatest benefits. An additional advantage, especially for Brazil, is that this conservation and recovery process can rely on good management practices and biotechnology production, such as biological inputs, which have been developed for a long time in national research centers with plenty to attract investments.

Combined efforts between public and private initiatives, focused specifically on sustainability in global value chains, coupled with a responsible set of policies, can create an economic environment that primarily benefits the Amazon people. Breaking with historical patterns of extractivism, mining, and deforestation must be considered emergency measures at this time. Extensive ranching and agricultural or extractive practices practiced without socio-environmental concern in the Amazon have degraded and fragmented the forest. This trend has resulted in a loss of a range of ecosystem services on which the local population depends, especially those that sustain agricultural production, such as biodiversity, water supply, and soil fertility. In addition, the potential for high value-added uses such as via biotechnologies and the development of pharmaceuticals and cosmetics is lost.

To ensure that these efforts are efficient, the State, through mechanisms that promote responsible investments in agriculture and food systems, can contribute to overcome market failures and correct systemic inefficiencies that discourage private initiative. Overcoming this will require major advances in international, national, public and private coordination for governance and management, in an integrated way, connecting essentially sectoral analyses, and aiming to minimize negative externalities while maximizing positive ones.

The establishment of agroecological systems that allow for forest-integrated farming, forest restoration besides generating income for Amazonians contributes to develop more resilient agricultural landscapes. The ILPF, as exemplified in the text, integrates high forest biodiversity with agriculture and cattle ranching and has several credit lines available. These systems are characterized by their high level of complementarity that has proven effective in contributing to climate change adaptation. But they also need investments in better techniques and capacity building.

Thus, unlike what the documentary *Amazon on Fire* proposes, no solution to the region's problems is simple if it wants effective results. The approach needs to coordinate different interests and be based on three pillars: ecosystem integrity, strong governance, and coherent and effective planning

processes. We need the spectacles of social inclusion through science and technology to correct our myopic long-term vision and be able to structure a cutting-edge circular bioeconomy capable of generating economic, social, and environmental development for the Amazon region and thus also for the country and the world.

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