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IMPLICAÇÕES SOCIOAMBIENTAIS DO ORDENAMENTO TERRITORIAL DE FLORESTAS PÚBLICAS: UM ESTUDO DE CASO NA AMAZÔNIA BRASILEIRA

Iranilda Moraes[1] | Claudia Azevedo-Ramos[2]

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[1] PhD in Socio-Environmental Development (UFPA).
Federal Institute of Pará - IFPA
Belém - PA, Brazil.
E-mail: iranilda.smoraes@gmail.com

[2] PhD in Biological Sciences (UNICAMP).
Professor at the Federal University of Pará.
Belém - PA, Brazil.
claudia.azevedoramos@gmail.com

ABSTRACT

The article analyzes land-use planning and governance of undesignated public forests (UPF) in the Brazilian Amazon, focusing on the Mamuru-Arapiuns Glebas (MAG), an area of 1.3 million hectares in the state of Pará. Brazil has 310.5 million hectares of public forests, 64 million of which remain without a defined designation, primarily in the Amazon, making them vulnerable to deforestation and land grabbing. The objective of this study was to identify and discuss the socio-environmental implications of land-use planning and the allocation of UPF, using the MAG as a case study, especially considering the lessons learned about the challenges faced in improving the management and protection of these territories. The methodology adopted was qualitative and descriptive, based on the analysis of secondary data, such as reports, maps, minutes of public hearing and scientific articles. The approach was guided by the theory of participatory territorial governance, which highlights the interactions between local actors and public institutions. The study revealed that, although the allocation process has promoted benefits such as land regularization and improvements in management, it has not been able to completely prevent forest losses, in addition to the persistence of conflict areas and/or areas without allocation, highlighting the need for continuous adjustments both downstream and upstream of the public forest allocation process to make it more effective. The study highlights the importance of participatory processes, the need for political will and strategic planning in the governance of public forests to protect the Amazon and its natural resources.

Keywords: Land-use Planning. Governance. Undesignated Public Forests. Amazon.

RESUMO

O artigo analisa o ordenamento territorial e a governança de florestas públicas não destinadas (FPND) na Amazônia brasileira, com foco no Conjunto de Glebas Mamuru-Arapiuns (CGMA), uma área de 1,3 milhões de hectares no estado do Pará. O Brasil possui 336,8 milhões de hectares de florestas públicas, sendo 55,3 milhões sem destinação definida, principalmente na Amazônia, o que as torna vulneráveis ao desmatamento e à grilagem. O objetivo deste estudo foi identificar e discutir as implicações socioambientais decorrentes do ordenamento territorial e da destinação de FPND, utilizando o CGMA como estudo de caso, em especial considerando os aprendizados sobre os desafios enfrentados para melhorar a gestão e proteção desses territórios. A metodologia adotada foi qualitativa descritiva, fundamentada na análise de dados secundários, como relatórios, mapas, atas de audiências públicas e artigos científicos. A abordagem foi orientada pela teoria da governança territorial participativa, que destaca as interações entre atores locais e instituições públicas. O estudo revelou que, embora o processo de destinação tenha promovido benefícios como regularização fundiária e melhorias na gestão, ele não conseguiu evitar completamente as perdas florestais, além da persistência de áreas conflituosas e/ou sem destinação, evidenciando a necessidade de ajustes contínuos tanto a jusante quanto a montante do processo de destinação de florestas públicas para torná-lo mais eficaz. O estudo sublinha a importância de processos participativos, a necessidade de vontade política e de um planejamento estratégico na governança de florestas públicas para proteger a Amazônia e seus recursos naturais.

Palavras-chave: Ordenamento territorial. Governança. Florestas Públicas Não Destinadas. Amazônia.

INTRODUCTION

One of the greatest challenges for Pan-Amazonian countries has been protecting this vast forested area and its indigenous and traditional communities from land speculation, illegal resource exploitation, and deforestation. In Brazil, the Amazon has been undergoing significant forest cover loss, leading to drastic landscape changes (INPE, 2020; Sampaio et al., 2017).

One of Brazil's strategies to enhance Amazon protection has been keeping forests under public domain, with different categories of conservation and sustainable use designated for traditional communities. However, many public forest areas still lack an official designation, increasing the risk of deforestation. Assigning these areas to a specific protection category is often a complex and time-consuming process, involving multiple stakeholders and continuous learning.

This study focuses on a participatory land-use planning effort within a 1.3-million-hectare public forest area in Pará, Brazil. It examines the assignment of different protection and uses categories and discusses the socio-environmental consequences of these designations.

Brazil holds approximately 336.8 million hectares of public forests, covering 39.6% of its national territory. The Amazon alone accounts for 291.5 million hectares—86.5% of all registered public forests (SFB, 2025). Among these, roughly 55.3 million hectares remain undesignated, with 92% located in the Brazilian Amazon, emphasizing the need for a comprehensive management strategy.

The absence of land-use planning and land tenure security for these undesignated public forests (UPF) opens doors to land grabbing and unsanctioned resource exploitation. These areas are often referred to as "no man's land" or "lawless lands" due to recurrent invasions and loss of forest cover (Azevedo-Ramos et al., 2020; Azevedo-Ramos; Moutinho, 2018). Assigning these lands to specific use categories, such as conservation units, indigenous lands, rural settlements, or forest concessions, represents a legal pathway to safeguarding them.

Several of these land-use designations also incorporate incentives for sustainable forest use (Pereira et al., 2011; SFB; IPAM, 2011). The forest concession system, for example, integrates public forests into a sustainable forest-based economy while ensuring ecological conservation, generating employment and income, and reducing land grabbing, illegal activities, and environmental degradation (Fanzeres, 2014; SFB; IPAM, 2011).

In 2008, a 1.3-million-hectare undesignated public forest area in Pará, known as the Mamuru-Arapiuns Glebas (MAG), was selected for forest concessions. Consequently, it became necessary to establish land-use planning for traditional communities and create conservation units.

The land-use planning of MAG was essential to mitigating conflicts and allocating public forest lands for specific uses, promoting a forest-based economy through concessions. The need for forest concessions ultimately drove land-use planning in this region, helping resolve long-standing disputes over natural resource use by facilitating dialogues and defining designated land-use categories for different stakeholders under state government leadership. This governance strategy made Pará the first state in Brazil to grant forest concessions outside conservation units. However, more than a decade after its land-use planning process, questions remain regarding whether these public forest designations effectively reduced socio-environmental impacts.

This study aims to identify and analyze the socio-environmental implications of land-use planning and the designation of UPF, using MAG as a case study. It focuses on lessons learned and challenges in improving the management and protection of these lands. This issue is particularly relevant as the allocation of public forests in the Amazon is increasingly recognized as a key tool for safeguarding large forest areas and their resident populations (Azevedo-Ramos et al., 2020; Azevedo-Ramos; Moutinho, 2018; Moutinho; Azevedo-Ramos, 2023), and it is becoming a more structured policy agenda for federal and state governments.

The following sections first provide an overview of the importance of public forest designation for land-use planning. Next, they present the study area and methodology, followed by a detailed examination of MAG's land designation process and the current status of assigned lands since 2011. Finally, the study discusses the impacts of land-use planning and concludes with key lessons learned.

PUBLIC FORESTS: WHAT ARE THEY AND HOW DO THEY CONTRIBUTE TO LAND-USE PLANNING?

Public forests are natural or planted forests located across various Brazilian biomes on public lands under federal, state, or municipal jurisdiction (BRASIL, 2006). These forests are classified into three categories: designated public forests, undesignated public forests, and vacant lands.

Designated public forests have a specific purpose, including protected areas, rural settlements, and military zones. Undesignated public forests, on the other hand, have not yet been assigned a particular use. Vacant lands refer to areas without formal identification or governmental appropriation (SFB, 2023), but they are still considered public property under Brazilian agrarian law, which states that all land originates as public land (Rocha et al., 2019).

The allocation of public lands must align with agricultural policy and the national agrarian reform plan, as established by the 1988 Federal Constitution. However, vacant lands or lands acquired by state governments through discriminatory actions (land appropriation) that are necessary for protecting natural ecosystems are declared unavailable for other uses.

In this regard, the Public Forest Management Law (Law 11,284/2006) establishes three approaches to forest governance that guide the allocation of public forests in Brazil: i) the creation of national, state, and municipal forests; ii) the allocation of public forests to local communities; e iii) forest concessions.

Forest concessions allow for the sustainable management of forest resources (including timber, non-timber products, and ecosystem services) under contracts signed between the concessionaire and the granting authority (the State). These concessions are awarded through a bidding process, which defines rights and obligations for all parties involved over a predetermined period outlined in both the public notice and the concession agreement. The public forest management authority is responsible for monitoring and ensuring compliance with contractual provisions (SFB, 2023).

Federal, state, and municipal forests are categories of sustainable-use Conservation Units and are created under the National System of Nature Conservation Units (Law No. 9.985/2000). Conservation units are divided into two groups: sustainable-use units and strict-protection units.

The allocation of public forests to local communities primarily occurs, for instance, through the establishment of Extractive Reserves and Sustainable Development Reserves, both considered sustainable-use conservation units. Public forest use can also be granted through settlement projects aimed at sustainable forestry, agroextractivist activities, or similar initiatives.

In undesignated public forests, the absence of a defined use and a responsible management institution facilitates illegal land occupation and unauthorized resource exploitation, raising concerns and calls for government action (Azevedo-Ramos; Moutinho, 2018; Moutinho; Guerra; Azevedo-Ramos, 2016).

In the Brazilian Amazon, approximately 50.8 million hectares of public forests remain undesignated for any legal use or protection (SFB, 2025). In the first quarter of 2021 alone, 33% of deforestation in the region occurred within public forests lacking formal tenure (Alencar et al., 2021). Between 2010 and 2015, deforestation in undesignated public forests resulted in the emission of at least 200 million t CO_2 (Moutinho; Guerra; Azevedo-Ramos, 2016), nearly half of Brazil's annual emissions from the energy sector (SEEG, 2020). Land-use-driven deforestation exacerbates greenhouse gas emissions, making it more challenging to meet national and global climate targets (Zarin et al., 2016).

Given the vast extent of undesignated public forests in the Amazon, the region remains highly vulnerable to predatory activities that jeopardize conservation, sustainable land-use planning, and ecological integrity. Scholars advocate for the urgent need to allocate these forests to legally recognized categories to ensure their preservation while maximizing their socioeconomic benefits (Azevedo-Ramos et al., 2020; Azevedo-Ramos; Moutinho, 2018; Moutinho; Azevedo-Ramos, 2023).

Public forest allocation plays a crucial role in preventing deforestation, ensuring the availability of legally sourced timber, and fostering governance strategies that include social participation. Effective policies must integrate land rights protections for traditional communities, mitigate territorial disputes, and promote sustainable forestry production (Ribeiro; Moraes; Azevedo-Ramos, 2017).

Recognizing that forest policies are essential for advancing sustainable socio-economic development in the Amazon (Azevedo-Ramos; Moutinho, 2018; Nepstad et al., 1999; Souza; Barreto, 2000), several measures have been implemented since the 1980s, including conservation units, forest concessions, and land regularization initiatives under the Forest Code. These policies aim to regulate land-use activities and establish governance structures in Amazonian regions.

In 2000, the Brazilian government's National Forest Program set ambitious goals to expand forest production areas fivefold, targeting 50 million hectares of federal, state, and municipal forests within the Legal Amazon over a decade (Veríssimo; Barreto, 2005). The plan aimed to supply current and future timber demands through a well-managed network of public and private forests. These efforts were reinforced in 2006 with the enactment of Law No. 11.284, known as the Public Forest Management Law, which provided the legal framework for forest concessions and established the Brazilian Forest Service as the federal agency responsible for managing public forests (BRASIL, 2006).

The enactment of the Public Forest Management Law can be seen as a regulatory measure designed to curb deforestation, enhance forest valuation, and promote sustainable forestry through structured management practices, particularly through forest concessions (Remor, 2009).

Brazilian states also oversee forest management through their respective institutions and regulations. In Pará, for instance, the management of public forests falls under the jurisdiction of the Institute for Forest Development and Biodiversity of the State of Pará (PARÁ, 2007). Currently, Pará has slightly more than 11 million hectares of undesignated public forests, with 82% under federal jurisdiction

and the remaining 18%—around 2 million hectares—under state control (IDEFLOR-Bio, 2017). In 2008, Pará's state-level undesignated public forests covered over 4.2 million hectares (IDEFLOR-Bio, 2009).

LAND-USE PLANNING

Territory is a collective and multidimensional construct, shaped by multiple territorialities, as argued by Saquet (2008). It refers to spatial-temporal processes that define specific portions of space. From a broad perspective, territory can be understood as "[...] the substance of forms and material and immaterial relations, of movement; it signifies both material and immaterial appropriation and domination, across patches and networks." (Saquet, 2008, p. 90) (our translation).

The production and reproduction of social relations—and consequently, power dynamics within a given territory—can be revealed through cartographic representations (Raffestin, 1993). Maps are abstractions of the world, always created from a particular viewpoint (Assis, 2010). As such, they expose divergences between distinct types of rationality (Leff, 2010), highlighting practical conflicts regarding territorial allocation and usage, often intertwined with cartographic disputes.

Various actors construct territorialities by defining and redefining territories. As Sack (2011, p. 76) explains, territoriality is a geographic strategy that involves "[...] an attempt, by an individual or group, to affect, influence, or control people, phenomena, and relationships by asserting control over a specific geographic area." (our translation). In his view, territoriality represents the geographic expression of social power.

Land-use planning, as a structured process, involves strategies to address distortions, divergences, or even conflicts between ecological and socio-economic attributes within a given space (Sanchez; Silva, 1995). Moraes (2005, p. 46) emphasizes that land-use planning functions as "a cross-sectoral and interinstitutional coordination tool aimed at achieving integrated and specialized public policy action." (our translation).

In regional contexts marked by territorial disputes and power struggles between the various actors associated with the different forms of use and appropriation of territories and access to their natural resources, the adoption of participatory and transparent practices in defining fair territorial planning becomes imperative.

In Dallabrida's view (2006), this type of strategy depends on the constitution and formation of a new socio-territorial bloc (a group of actors located historically and territorially), which, through public-private concertation processes (State and civil society), contemplate the democratic-participatory character and seek to build pacts through the articulation of different actors and their different proposals and world views, resulting in a "socio-territorial pact".

Thus, the practice of dialogue and public-private engagement, incorporating various socio-territorial power networks, can positively influence governance (Dallabrida, 2006). Governance, in this context, is understood as a new model of policymaking and administration based on networked interaction between public institutions, associations, markets, and community groups. It seeks collective regulation through negotiation and cooperation, prioritizing the common good and democratic principles (Cançado; Tavares; Dallabrida, 2013).

In Pará, multiple stakeholders with competing interests in land and natural resources have engaged in ongoing territorial conflicts in the MAG region. Land-use planning and land allocations have been proposed as mechanisms to resolve these disputes and enhance forest governance. Throughout the planning process, various social actors presented competing proposals, each reflected in distinct cartographic representations that embodied their specific interests.

In scenarios of territorial conflict, land-use planning theoretically serves as a foundational tool for resolving land disputes. It is inherently linked to spatial planning and incorporates strategies to mitigate distortions, divergences, or conflicts arising from ecological or socio-economic factors (Sanchez; Silva, 1995).

METHODOLOGY

This study employed a descriptive qualitative approach (Gil, 2019), focusing on the analysis of secondary data related to land-use planning and the governance of undesignated public forests, based on a case study in the MAG region. The methodology was grounded in the theory of participatory territorial governance (Dallabrida, 2006), which emphasizes interactions between local actors and public institutions to understand power dynamics and strategies for the use and conservation of natural resources.

For data collection, documentary sources were selected to contextualize the land designation process in MAG and provide insights into its socio-environmental impacts. The selection was guided by three main criteria: relevance – ensuring the data was directly linked to land-use planning in the area; reliability – prioritizing sources such as government agencies and peer-reviewed scientific publications; and temporality – restricting the dataset to the period from 2008 to 2022 to capture changes in the process over time.

The data collection techniques included a non-systematic literature review, document analysis, and case study methodology (Lakatos; Marconi, 2003). The non-systematic review provided a broad and exploratory perspective on the topic, encompassing scientific articles, dissertations, and institutional reports related to MAG. Document analysis covered records of public hearings, preliminary environmental reports, official maps, and relevant legislation. Additionally, MAG was examined as a case study, allowing for an in-depth evaluation of land-use planning implications at a localized scale.

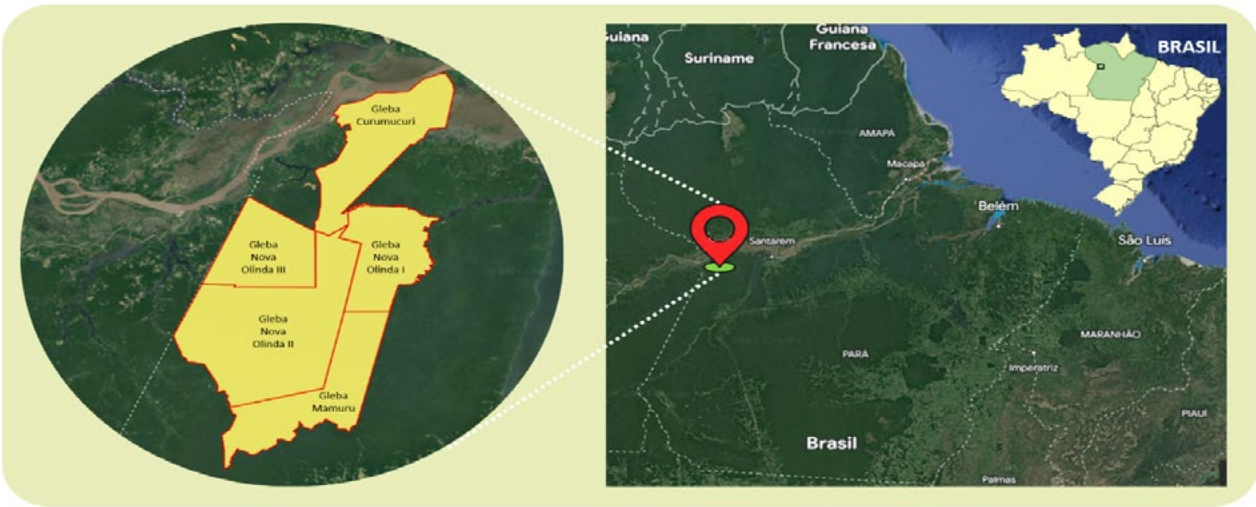
Initially, the data was categorized into subtopics such as land designation, socio-environmental impacts, and participatory governance. Subsequently, methodological triangulation was applied to cross-reference information from different sources, ensuring the consistency and integrity of the findings (Santos et al., 2020). Finally, the impacts of land designations were identified and assessed in light of their social and environmental consequences, including changes in forest cover and the mitigation of territorial conflicts.

MAMURU-ARAPIUNS GLEBAS

The Mamuru-Arapiuns Glebas consists of five state-designated land parcels: Curumucuri, Nova Olinda I, Nova Olinda II, Nova Olinda III, and Mamuru (Figure 1). It is located in the western portion of the state of Pará, spanning the municipalities of Aveiro, Santarém, and Juruti. MAG is bordered to the north by the Amazon River, to the south by the Amazon National Park and the Andirá-Marau Indigenous Land, to the east by the Tapajós-Arapiuns Extractive Reserve and to the west by the state of Amazonas (ITERPA, 2009).

The land parcels were officially registered under the name of the State of Pará by the Land Institute of Pará, totaling approximately 1.3 million hectares. This area holds significant potential for natural resource extraction, particularly in the timber and mineral sectors (Assis, 2010). Historically, the region has been inhabited by riverine communities and is surrounded by protected areas rich in biodiversity. The forests remain largely intact, with limited deforestation, and access has traditionally been difficult due to the near absence of roads—rivers serving as the primary means of connection between communities and municipal centers (IDEFLOR-Bio, 2009).

Figure 1 | Location of the Mamuru-Arapiuns Glebas, Pará State, Brazil



Elaborated by: Authors

Until the mid-1990s, the corridor along Federal Highway BR-163 (Cuiabá–Santarém), which borders the MAG, served as a frontier for the expansion of cattle ranching and logging companies from northern Mato Grosso. This expansion occurred as pastures and forests in neighboring municipalities became increasingly depleted (Castro; Monteiro; Castro, 2007).

According to Assis (2010), the region's economic potential was shaped by broader regional development dynamics, including the expansion of soybean monoculture—particularly after 2000, when Cargill S/A's port in Santarém began operations. These developments intensified land grabbing and land speculation, fueled further by the paving of BR-163 and the establishment of a large-scale mining complex operated by Alcoa S/A in Juruti. These forces triggered conflicts between competing logics of land use and territorial appropriation.

Although MAG are state lands, they had not been assigned to a specific public forest category. It was not until 2008 that institutional discussions on land use and land-use planning were initiated. The Pará state began the process of allocating the 1.3 million hectares within the Mamuru-Arapiuns Glebas. This marked the beginning of dialogue with local stakeholders, aimed at reaching a consensus on the appropriate designation and governance of these public forests.

LAND-USE PLANNING IN THE MAMURU-ARAPIUNS GLEBAS

Law No. 11.284/2006 created an opportunity for land-use planning in the MAG by incorporating the participation of traditional communities (Assis, 2010; Peixoto; Figueiredo, 2016). In 2008, the territorial block composed of non-designated parcels in the Mamuru-Arapiuns region represented the largest contiguous area of public forests in the state.

The MAG was deemed critical with respect to issues such as deforestation, land grabbing, unregulated timber extraction, and the presence of mineral deposits and mining—as well as the coexistence of traditional and indigenous communities alongside colonization by small and medium-scale agricultural producers (IDEFLOR-BIO, 2009). Furthermore, the suspension of several irregular private forest management plans sparked a series of conflicts in the region, conflicts that also affected traditional communities and their livelihoods. These disputes fueled discussions on land use planning that had been evolving since the 1990s and intensified following the enactment of Law No. 11.284/2006.

In response, the MAG was selected with the aim of enhancing governance within Pará's largest UPF complex. The state implemented a participatory regional planning process as a governance instrument designed to mitigate long-standing territorial disputes, secure land regularization rights for traditional populations, establish new conservation units in ecologically sensitive areas, and assess the economic viability of areas earmarked for forest concessions. However, the vast territorial scope, the socio-environmental complexity, and the initial lack of scientific knowledge about these areas posed significant challenges to the planning process. These obstacles necessitated a collaborative management approach among the land agency, environmental management agency and the forest management agency.

Extractivist communities, indigenous groups from the Maró Indigenous Land, and various other stakeholders with interests in creating new protected areas, implementing forest concessions, and regularizing the land tenure of small private landowners contested control over the forest areas. These issues were debated by the three state agencies with the goal of constructing a multifaceted land use mosaic that balanced the protection of traditional communities, the conservation of biodiversity, long-term planning for economically promising areas, and the assurance of land ownership rights. This collaborative process also facilitated the development of participatory diagnostic projects and the formulation of economic strategies in partnership with local communities (Ribeiro; Moraes; Azevedo-Ramos, 2017).

As a precautionary measure to prevent land invasions while the land-use planning process in the MAG was still underway, a Provisional Administrative Limitation Area was established via Decree No. 1,149/2008. This measure prohibited clear-cutting and any other form of forest degradation, except for those activities carried out by traditional communities (Assis, 2010). From 2008 onward, numerous studies—addressing physical characterization, socio-environmental research, the forest product market, forest inventories, fauna analyses, and community development projects—were conducted through partnerships among the state government, universities, and non-governmental organizations. These efforts produced the bulk of the information that underpinned the drafting of the mandatory Preliminary Environmental Report (IDEFLOR-BIO, 2009).

The land-use planning process in the MAG sought to resolve territorial conflicts under the following institutional guidelines: (i) securing the formal titling of areas used by traditional communities; (ii) respecting documented rights; (iii) developing local plans to bolster extractivist and family farming economies; (iv) creating new conservation units; and (v) delineating areas for forest concessions (Monteiro; Gama, 2012). Debates over the fate of more than one million hectares were held both within the framework of the State Forestry Commission and during public hearings, with at least 12 planning proposals being submitted by 37 stakeholders. This illustrates that the struggles over territorial appropriation and natural resources in the MAG also extended into the realm of cartographic representations (Ribeiro; Moraes; Azevedo-Ramos, 2017; Ficher; Assis, 2020).

In 2011, the participatory effort undertaken by the state of Pará to organize a forest area covering more than 1.3 million hectares culminated in the designation of areas for: (i) traditional communities (312.7 thousand hectares); (ii) biodiversity protection (127.5 thousand hectares); (iii) land regularization for small private landowners (226.6 thousand hectares); (iv) a Training Center (34 thousand hectares); and (v) forest concessions (253.3 thousand hectares). This new design completely reconfigured the territorial arrangement (Moraes; Azevedo-Ramos, 2025; Ribeiro; Moraes; Azevedo-Ramos, 2017).

THE EFFECT OF DESIGNATIONS: CURRENT STATUS AND SOCIO-ENVIRONMENTAL CONSEQUENCES

From a territorial allocation standpoint, social designations—specifically for traditional communities and small producers—were prioritized over those aimed at economic use and environmental protection. This prioritization enhanced communities' land rights. To reach this outcome, all interested groups had to make concessions regarding their initial demands. But what is the status of these designations after more than a decade? Next, we characterize the current state of each designation category resulting from the land-use planning process and examine their impact on the forest cover in the MAG.

Before the legal framework for forest concessions was established in 2006, only a small fraction of exploited forests in Brazil employed internationally recognized sustainable forest management techniques (Peixoto; Figueiredo, 2016). In 2011, the state of Pará launched its first forest concession bidding in the MAG and signed three concession contracts (Concessions I, II, and III – Lot 1), covering a total area of approximately 150,000 hectares across parts of the municipalities of Santarém, Juruti, and Aveiro (IDEFLOR-BIO, 2017). Subsequently, two additional areas (Concessions IV and V – Lot 2), encompassing around 102,000 hectares, were made available for concession; however, the bidding processes for these areas were unsuccessful.

In 2022, the contract for Concession II was terminated due to the death of the concessionaire, in accordance with a contractual clause. The remaining concessions (labeled as I and II in the text) continue to operate despite reports of occasional encroachments into the areas. Meanwhile, the

areas corresponding to Lot 2—still lacking signed contracts and an effective concession—have become targets for unauthorized activities such as timber theft. Despite the inherent challenges in managing forest concessions, the area allocated for this purpose has maintained its forest cover and remains available for new contracts.

In the area designated for small producers, resource use is restricted exclusively to sustainable forest management and/or agroforestry systems, with deforestation strictly prohibited. Forest cover loss in this zone is primarily linked to intensification in forest management activities, which began around 2012 as a direct result of Management Plans approved by the environmental management states agency. Between 2012 and 2018, 56 licenses were issued to regularized landowners, covering nearly 63,500 hectares for forest management (Moraes, 2021). Overall, this designation has succeeded in harmonizing land use with the state's forestry management policy for the region. Nonetheless, some uncertainties remain concerning the legality of the land titles used in the property regularization process (Assis, 2012).

The area allocated for traditional communities comprises seven settlements that have benefited more than 2,200 families. Notably, two settlements stand out for exceeding 100,000 hectares each—the Agro-Extractivist Settlement Projects' Curumucuri and Mamuru. After these settlements were established, forest cover losses can be largely attributed to deforestation for agricultural purposes and to authorized timber extraction—activities permitted under these designations when conducted in accordance with relevant standards.

Some designations encountered implementation challenges, leading to delays or non-fulfillment. At the time of planning, the Maró Indigenous Land—managed at the federal level—remained unrecognized; it was only in 2024 that significant progress was made with the publication of a declaration ordinance. This administrative act officially acknowledges the territorial rights of indigenous communities and defines the area's boundaries. However, further steps—such as physical demarcation and the final ratification of the indigenous land—remain pending. This delay or failure to regularize land rights for traditional peoples creates opportunities for local land conflicts and increases these communities' vulnerability.

The area set aside for biodiversity protection remained in a preliminary study phase for nearly a decade, as experts deliberated on creating and selecting the most appropriate type of Conservation Unit that would both safeguard the area and align with its socio-environmental context. Even after its designation, unauthorized human activities persisted, contributing to further forest cover losses (Moraes; Azevedo-Ramos, 2025). Only in 2023 was the Mamuru State Ecological Station Mamuru) established to protect the springs and tributaries of the Mamuru river and to contribute to the preservation of the region's ecosystems and biodiversity (PARÁ, 2023).

The implementation of a Forest Training Center in the area designated for that purpose has not yet materialized. In the interim, this area has been subject to both authorized and unauthorized logging, as well as bauxite mining by Alcoa World Alumina S/A, which holds overlapping mining rights. The establishment of the Training Center was identified as a goal in Pará's Multi-Year Plans - four-year government planning instrument - for 2020–2023 and 2024–2027 (SEPLAD, 2023); however, to date, only the Preliminary Environmental Report and the area demarcation have been completed (IDEFLOR-BIO, 2025). Its actual construction and operationalization remain an aspiration of the forestry sector.

It is also important to note that, despite the classification of public forests into various use categories under the MAG, the area known as Gleba Nova Olinda III still remains without a designated use. A long-standing legal battle between the states of Amazonas and Pará over jurisdiction of this parcel—resolved only in 2016 in favor of Pará—is considered one of the reasons that this designation has yet to be finalized. Since that resolution, forest cover losses in this area have been primarily linked to logging (both authorized and unauthorized), possibly as a spillover effect from activities displaced from designated zones.

Counterintuitively, despite an increase in local governance, forest cover loss in the region has accelerated following the land-use planning process. The annual rate of forest cover loss before the planning (2006–2010) was 1,708 hectares per year; this rate increased to 2,014 hectares per year in the first period post-planning (2010–2014) and further escalated to 7,690 hectares per year in the second period (2014–2018) (Moraes; Azevedo-Ramos, 2025). The landscape dynamics in the MAG have been marked by persistent forest cover loss alongside an increase in logging, agricultural,

and, to a lesser extent, mining activities. In summary, the transformation of the landscape was characterized by intensified anthropogenic activities and significant tree cover loss concurrent with the initiation of the designations, though deforestation has been concentrated in those categories where it is partially allowed. For example, the highest forest cover losses between 2006 and 2018 were recorded in the northern and northeastern portions of the MAG, where most of the settlements are located (Moraes; Azevedo-Ramos, 2025).

SOCIO-ENVIRONMENTAL IMPLICATIONS

Maintaining the public domain of Brazilian forests through their designation into legally prescribed categories—thereby safeguarding land rights, preserving the forests and their ecological services, and enhancing the value of their forest assets—necessarily imposes upon the State the responsibility to protect and manage public forests. This effort must be carried out in concert with civil society in order to reduce the land conflicts and tensions that are so prevalent in the Amazon, as well as to curb the insecurity and speculative land practices that significantly hinder regional development.

The designations—and, in an ad hoc manner, the land-use planning of the MAG—originated from the proactive involvement of the State of Pará. Beyond selecting areas for forest concessions, the state aimed to manage social conflicts in the municipalities of Juruti, Aveiro, and Santarém, extending its influence from the Santarém plateau to all areas affected by the BR-163 road corridor (Albuquerque, 2009).

In any given region, society is structured through networks of socio-territorial power actors who endeavor to build fundamental consensuses—agreements that reflect common decisions—through a process known as social concertation. This process involves diverse actors engaging in decentralized territorial management via voluntary conciliation and mediation (Dallabrida, 2006).

The MAG has proven to be a territory marked by disputes among various stakeholders, each advocating different approaches to resource use and territorial appropriation, highlighting different types of rationality (Leff, 2010). Some actors aim to maximize commercial benefits derived from forest resource exploitation through managed timber extraction, while others focus on enhancing social reproduction conditions, as seen in areas designated for traditional communities.

The various land-use planning proposals put forward by the involved actors reveal a clash between divergent visions and methods for appropriating both the territory and its resources. This conflict unfolds through a blend of interests and meanings, evident in the way nature is utilized both materially and symbolically (Acselrad; Coli, 2008; Assis, 2010). Moreover, an invisible struggle over natural resources persists in regions with weak governance, profoundly impacting local communities (Pereira et al., 2010).

Although stakeholder engagement in agreements concerning natural resource use and local governance has been encouraged, several limitations have emerged. Evaluating the quality of the participatory process has proven difficult, given the lack of information regarding the relative number of stakeholders in each interest group and the conditions necessary for effective participation. The State may not always act neutrally and can exert asymmetrical power during conciliation processes. Unequal participation and the distinctive characteristics of the actors may introduce biases in information access, ultimately rendering the process of consensus-building unbalanced. This dynamic calls for continuous learning and requires institutionalized checks and balances to ensure equity—a line of inquiry that, while beyond the scope of this study, remains essential.

Furthermore, certain conflicts in the region persist, such as the designation of Gleba Nova Olinda III and the ratification of the Maró Indigenous Land. Although the boundaries of the Maró Indigenous Land were declared in 2024, the physical demarcation required for its full ratification still remains pending. Additional challenges in managing and implementing some designation categories have also been reported (Moraes; Azevedo-Ramos, 2025).

Land-use planning in the MAG has evolved into an intriguing experiment in forest governance, driven by state power. The practice of social concertation—leveraging diverse socio-territorial networks—has significantly bolstered governance, a critical foundation for successful territorial development processes (Dallabrida; Becker, 2003). Overall, the designated land uses have contributed to spatial organization and a reduction in conflicts, as evidenced by the general alignment of land use with the specified designations more than a decade after their implementation.

In theory, improved governance is expected to lead to reduced deforestation rates (Wehkamp et al., 2018). In this context, the designation of public forests represents a critical first step toward better governance of these areas (Azevedo-Ramos et al., 2020; Azevedo-Ramos; Moutinho, 2018; Moutinho;

Azevedo-Ramos, 2023). However, as observed, both the category of designation and the efficacy of management implementation can influence deforestation dynamics in a region—an aspect that requires careful consideration by decision makers during land-use planning processes.

Thus, while land-use planning may have contributed to minimizing land disputes in the MAG, it has concurrently facilitated its occupation and increased forest cover loss—primarily due to logging and agricultural expansion—as designations were consolidated, particularly after 2014. In practice, implementing geographic land use is ambitious and complex, often facing obstacles that result in significant delays before full implementation or consolidation is achieved (Siebrecht, 2020). The MAG experience clearly demonstrates that executing a public policy—such as the land-use planning and designation of public forests—demands a continuous process of refinement and optimization.

CONCLUSIONS

The land-use planning process and the public forest designations implemented in the MAG have demonstrated how such public initiatives can help resolve longstanding conflicts over natural resource use. This effort resulted in a new territorial configuration for more than 1.3 million hectares of state public forest that remained undesignated until 2010. The revised layout of these forest tracts, achieved through social concertation and land use designation tailored to the needs of the beneficiaries, has significantly reduced land disputes and illegal economic activities in the region.

The territorial and cartographic conflicts underlying the MAG planning process—in which different stakeholder groups presented varying proposals—highlight the contest for natural resource use, reflecting diverse approaches to governing and reproducing social interests across groups.

The active involvement of stakeholders in negotiating natural resource use and practicing governance—where both society and the State deliberated on development policies—underscored the State's essential role. Rather than imposing solutions, the State acted as a mediator, leading the participatory planning process in the MAG to its conclusion.

In this case study, the State of Pará's initiative to foster a forest-based economy through forest concessions served as a catalyst for land-use planning and improved local governance. However, the region has concurrently emerged as a fresh front for various forms of timber exploitation. This

development calls for increased transparency and monitoring in forest management.

The study outlined the socio-environmental implications and challenges encountered during the designation of public forests in the MAG. It demonstrated that the process of land-use planning and allocating more than 1.3 million hectares of public forest resulted in a spatial reconfiguration that includes areas designated for traditional communities, small producers, biodiversity conservation, forest concessions, and other specific purposes. Among the benefits were land regularization for traditional populations, the creation of new conservation units, and the promotion of sustainable land use practices. Nevertheless, challenges persist—such as managing areas still awaiting designation, addressing governance issues, resolving land disputes, and curbing increased forest cover loss in certain zones. These findings underscore the need for ongoing improvements in territorial management, more effective monitoring, and stronger participatory processes to ensure the region's conservation and development objectives are met.

Given the significant volume of public forest in the Brazilian Amazon, the challenge of designating such vast areas and categorizing them appropriately remains a critical concern for decision-makers. The MAG experience offers several valuable lessons: first, strong political will is essential; second, participatory processes tend to mitigate future risks; and third, planning for both the implementation of designations and the management of the territory afterward is just as crucial as formulating the designations themselves.

REFERENCES

ACSELRAD, H.; COLI, L. R. Disputas cartográficas e disputas territoriais. In: ACSELRAD, H. ET AL. (Ed.). **Cartografias sociais e território**. Rio de Janeiro: UFRJ/IPPUR, 2008. p. 13–43.

ALBUQUERQUE, G. P. **Análise de conflitos do sistema de concessões florestais no Brasil**. 2009. 239 f., il. Dissertação (Mestrado em Desenvolvimento Sustentável) -Universidade de Brasília, Brasília, 2009.

ALENCAR, A. *et al.* **Amazon on fire deforestation and fire in undesignated public forests**. BRASÍLIA: [s.n.]. Disponível em: <https://ipam.org.br/wp-content/uploads/2021/04/Amazon-on-Fire-7-en.pdf>. Acesso em: 23 jul. 2021.

ASSIS, W. F. T. Conflitos Territoriais e Disputas Cartográficas: Tramas sociopolíticas no ordenamento territorial do Oeste do Pará. In: ACSELRAD, Henri. **Cartografia Social e Dinâmicas Territoriais: Marcos para o debate**.1ª ed. Rio de Janeiro, RJ: IPPUR/UFRJ, 2010. p. 163–193.

AZEVEDO-RAMOS, C. et al. Lawless land in no man's land: The undesignated public forests in the Brazilian Amazon. **Land Use Policy**, v. 99, n. January, p. 104863, 2020. https://doi.org/10.1016/j.landusepol.2020.104863.

AZEVEDO-RAMOS, C.; MOUTINHO, P. No man's land in the Brazilian Amazon: Could undesignated public forests slow Amazon deforestation? **Land Use Policy**, v. 73, n. November 2017, p. 125–127, abr. 2018. https://doi.org/10.1016/j.landusepol.2018.01.005.

BRASIL. **Lei nº 11.284, de 2 de março de 2006**. Dispõe sobre a gestão de florestas públicas para a produção sustentável e dá outras providências. Disponível em: <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/lei/l11284.htm>. Acesso em: 29 ago. 2020.

CANÇADO, A. C.; TAVARES, B.; DALLABRIDA, V. R. Gestão Social e Governança Territorial: interseções e especificidades teórico-práticas. **Revista Brasileira de Gestão e Desenvolvimento Regional**, v. 9, p. 313–353, 2013. https://doi.org/10.13140/RG.2.1.4722.2244

CASTRO, E.; MONTEIRO, R.; CASTRO, C. P. Atores Sociais na Fronteira mais avançada do Pará - São Felix do Xingu e a Terra do Meio. **Papers do NAEA (UFPA)**, v. 180, 2007. http://dx.doi.org/10.18542/papersnaea.v13i1.11559

DALLABRIDA, V. R. Governança territorial: a densidade institucional e o capital social no processo de gestão do desenvolvimento territorial. In: Seminário Internacional sobre Desenvolvimento Regional, 3., 2006, Santa Cruz do Sul. **Anais...** Santa Cruz do Sul: Edunisc, 2006. v. 1. p. 1-19. Disponível em: <https://www.unisc.br/site/sidr/2006/textos3/04.pdf>. Acesso em: 29 maio. 2020.

DALLABRIDA, V. R.; BECKER, D. F. Governança Territorial: um primeiro passo na construção de uma proposta teórico-metodológica. **Desenvolvimento em questão**, v. 1, n. 2, p. 73–97, 2003. https://doi.org/10.21527/2237-6453.2003.2.73-97.

FANZERES, A. **Elementos, dados e fatos para análise da Governança Florestal e situação da produção e comércio de madeira legal no Brasil**. Cambridge: TRAFFIC. 2014. Disponível em: <https://www.traffic.org/site/assets/files/8712/madeira-legal-no-brasil.pdf>. Acesso em: 28 maio 2020.

FICHER, W.; ASSIS, T. Pode o subalterno mapear e incidir no planejamento regional? Conflitos territoriais e disputas cartográficas no ordenamento fundiário do oeste do Pará. **Revista Brasileira de Estudos Urbanos e Regionais**, 12 jun. 2020. https://doi.org/10.22296/2317-1529.rbeur.202017

GIL, A. C. **Métodos e Técnicas de Pesquisa Social**. São Paulo: Atlas, 2019.

IDEFLOR-BIO. **Plano Anual de Outorga Florestal do Estado Do Pará 2009**. Belém: IDEFLOR-BIO, 2009. Disponível em: <https://ideflorbio.pa.gov.br/concessao-florestal/paof/>. Acesso em: 9 out. 2020.

_____. **Plano Anual de Outorga Florestal do Estado Do Pará 2017**. Belém: IDEFLOR-BIO, 2017. Disponível em: <https://ideflorbio.pa.gov.br/concessao-florestal/paof/>. Acesso em: 9 out. 2020.

_____. **Plano Plurianual de Outorga Florestal do Estado do Pará 2024 2027**. Belém: IDEFLOR-BIO, 2025. Disponível em: <https://ideflorbio.pa.gov.br/concessao-florestal/paof/>. Acesso em: 15 abr. 2025.

INPE. **PRODES - Programa de Cálculo do Desflorestamento da Amazônia**. Disponível em: <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes>. Acesso em: 29 ago. 2020.

ITERPA. Regularização Fundiária da região Mamuru-Arapiuns. In: **Seminário IDEFLOR: O potencial florestal dos novos marcos de gestão Púbica, comunitária e privada no Oeste Paraense**. Santarém: ITERPA, 2009.

LAKATOS, E. M.; MARCONI, M. A. **Fundamentos de Metodologia Científica**. São Paulo: Atlas, 2003.

LEFF, E. **Saber Ambiental: racionalidade, complexidade, poder**. Rio de Janeiro, RJ: Vozes, 2010.

MONTEIRO, R.; GAMA, J. R. DE V. **Conflitos socioambientais e ordenamento territorial em contexto de gestão florestal no Pará**. In: 5° Encontro da Rede de Estudos Rurais, UFPA. **Anais**...2012.

MORAES, A. C. R. DE. **Ordenamento Territorial: uma conceituação para o planejamento estratégico**. In: Para pensar uma política nacional de ordenamento territorial: Oficina sobre a Política Nacional de Ordenamento Territorial. **Anais**... Brasília-DF: Ministério da Integração Nacional, Secretaria de Políticas de Desenvolvimento Regional (SDR), 2005.

MORAES, I.; AZEVEDO-RAMOS, C. Influence of land-use planning on public forests' vegetation cover: Insights from the Brazilian Amazon. **Regional Science Policy & Practice**, v. 17, n. 6, p. 100197, 1 jun. 2025. https://doi.org/10.1016/j.rspp.2025.100197

MORAES, I. S**. Ordenamento territorial e governança florestal no oeste do Pará: o caso do Conjunto de Glebas Mamuru-Arapiuns**. 2021. Tese (Doutorado) - Universidade Federal do Pará, Belém, 2021.

MOUTINHO, P.; GUERRA, R.; AZEVEDO-RAMOS, C. Achieving zero deforestation in the Brazilian Amazon: What is missing? **Elementa: Science of the Anthropocene**, v. 4, p. 000125, 16 set. 2016. https://doi.org/10.12952/journal.elementa.000125.

MOUTINHO, P.; AZEVEDO-RAMOS, C. Untitled public forestlands threaten Amazon conservation. **Nature Communications** 2023 14:1, v. 14, n. 1, p. 1–4, 1 mar. 2023. https://doi.org/10.1038/s41467-023-36427-x.

NEPSTAD, D. C. et al. Large-scale impoverishment of Amazonian forests by logging and fire. **Nature**, v. 398, n. 6727, p. 505–508, 8 abr. 1999. https://doi.org/10.1038/19066.

PARÁ. **Lei. 6.963, de 16 de abril de 2007**. Dispõe sobre a criação do Instituto de Desenvolvimento Florestal do Estado do Pará -IDEFLOR e do Fundo Estadual de Desenvolvimento Florestal - FUNDEFLOR, e dá outras providências. 2007. Disponível em: <https://www.pge.pa.gov.br/sites/default/files/repositorio/2007/lo6963.pdf>. Acesso em: 29 ago. 2020.

___. **Decreto n° 3.314, de 5 de setembro de 2023**. 2023. Dispõe sobre a criação da Estação Ecológica Mamuru, nos Municípios de Aveiro e Juruti, no território sob jurisdição do Estado do Pará. Disponível em: < https://semas.pa.gov.br/legislacao/files/pdf/362067.pdf>. Acesso em: 15 abr. 2025.

PEIXOTO, R.; FIGUEIREDO, K. **Luta, reconhecimento e conquista da Terra Indígena Maró (PA)**. 30ª Reunião Brasileira de Antropologia. **Anais**...João Pessoa, Paraíba: 2016.

PEREIRA, D. et al. **Fatos florestais da Amazônia 2010**. Belém: Imazon, 2010. 124p.

PEREIRA, D. et al. **Oferta e demanda de áreas para manejo florestal no Estado do Pará**: O Estado da Amazônia. Belém-PA: IMAZON, 2011. Disponível em: <https://imazon.org.br/publicacoes/oferta-e-demanda-de-areas-para-manejo-

florestal-no-estado-do-para/>. Acesso em 29 ago. 2020.

RAFFESTIN, Claude. **Por uma Geografia do. Poder**. Tradução de Maria Cecília França. São. Paulo (SP): Ática, 1993.

REMOR, A. R. **A concessão florestal como política pública para o desenvolvimento sustentável do setor florestal na Amazônia**. 2009. 106 p. Dissertação (Mestrado profissional interinstitucional em Economia) – Faculdade de Ciências Econômicas, Universidade Federal do Rio Grande do Sul, 2009.

RIBEIRO, J. R.; MORAES, I. S.; AZEVEDO-RAMOS, C. Contribution of State Forest Concessions to the Governance of Conflict Areas in Pará, Brazil. In: GONÇALVES, M. V.; MERCÊS, S. S. (Eds.). **Natureza, Sociedade e Economia Política na Amazonia Contemporânea**. Belém: NAEA, 2017. p. 283-303.

ROCHA, I. et al. **Manual de Direito Agrário Constitucional: lições de Direito Agroambiental**. 3ª ed. Belo Horizonte: Fórum, 2019.

SACK, R. Significado de territorialidade. In: DIAS, L. C.; FERRARI, M. (Eds.). **Territorialidades humanas e redes sociais**. Florianópolis: Insular, 2011. p. 20–35.

SAMPAIO, S. M. N. et al. Dinâmica da cobertura vegetal e do uso da terra na mesorregião Nordeste paraense. In: CORDEIRO, I. M. C. C. et al. (Eds.). **Nordeste Paraense: panorama geral e uso sustentável das florestas secundárias**. Belém: EDUFRA, 2017. p. 131–159.

SANCHEZ, R.; SILVA, T. C. Zoneamento ambiental: Uma estratégia de ordenamento da paisagem. **Caderno de Geociências**, v. 14, p. 47–53, 1995.

SANTOS, K. DA S. *et al.* O uso de triangulação múltipla como estratégia de validação em um estudo qualitativo. **Ciência & Saúde Coletiva**, v. 25, n. 2, p. 655–664, 3 fev. 2020. https://doi.org/10.1590/1413-81232020252.12302018

SAQUET, M. A. Por uma abordagem territorial. In: SAQUET, M. A.; SPOSITO, E. S. (Eds.). **Territórios e territorialidades: teorias, processos e conflitos**. 1ª ed. São Paulo: Expressão Popular: UNESP, 2008. p. 73–94.

SEEG. **Sistema de Estimativa de Emissão de Gases**. Disponível em: <http://plataforma.seeg.eco.br/total_emission>. Acesso em: 9 out. 2020.

SEPLAD. **Plano Plurianual 2024-2027 do Estado do Pará**. 2023. Disponível em: < https://www.seplad.pa.gov.br/plano-plurianual-ppa-2/#1679921793817-197f16aa-9da9>. Acesso em: 15 abr. 2025.

SFB. **Cadastro Nacional de Florestas Públicas - Atualização 2024**. 2025. Disponível em: <https://www.gov.br/florestal/pt-br/assuntos/cadastro-nacional-de-florestas-publicas/cadastro-nacional-de-florestas-publicas-atualizacao-2024>. Acesso em: 15 abr. 2025.

____. **Plano Anual de Outorga Florestal - PAOF 2024**. Brasília: SFB, 2023. Disponível em: <https://www.florestal.gov.br/plano-anual-de-outorga-florestal/63-concessoes-florestais/1939-plano-anual-de-outorga-florestal-publicacoes>. Acesso em: 15 abr. 2025.

SFB; IPAM. **Florestas Nativas de Produção Brasileiras**. Brasília-DF: SFB IPAM, 2011. Disponível em: <https://www.florestal.gov.br/publicacoes/568-relatorio-tecnico-florestas-nativas-de-producao-brasileiras>. Acesso em: 29 ago. 2020.

SIEBRECHT, N. Sustainable Agriculture and Its Implementation Gap—Overcoming Obstacles to Implementation. **Sustainability**, v. 12, n. 9, p. 3853, 8 maio 2020. https://doi.org/10.3390/su12093853

SOUZA, C.; BARRETO, P. An alternative approach for detecting and monitoring selectively logged forests in the Amazon. **International Journal of Remote Sensing**, v. 21, n. 1, p. 173–179, 25 jan. 2000. https://doi.org/10.1080/014311600211064.

VERÍSSIMO, A.; BARRETO, P. Florestas Nacionais na Amazônia Brasileira: Oportunidades e Desafios. In: ZARIN, D. J. (Org); ZARIN, R. P.; SAMPAIO, P. D. (Trad.). **As Florestas produtivas nos neotrópicos: conservação por meio do manejo sustentável?** Brasília-DF: IEB-Instituto de Educação do Brasil, 2005. p. 55–66.

WEHKAMP, J. et al. Governance and deforestation - a meta-analysis in economics. **Ecological Economics**, v. 144, n. August 2017, p. 214–227, fev. 2018. https://doi.org/10.1016/j.ecolecon.2017.07.030.

ZARIN, D. J. et al. Can carbon emissions from tropical deforestation drop by 50% in 5 years? **Global Change Biology**, v. 22, n. 4, p. 1336–1347, abr. 2016. https://doi.org/10.1111/gcb.13153.