SIMEX AMAZÔNIA BULLETIN

MAPPING TIMBER HARVESTING IN THE AMAZON

August 2020 to July 2021

Highlights

- In this new study we map and assess the legality of timber harvesting in the Brazilian Amazon for the period from August 2020 to July 2021.
- During that period 377,624 hectares of native forests were harvested for timber in the Amazon, which represents an 18% reduction in relation to the previous period (2019-2020).
- The state of Mato Grosso accounted for 73% (277,048 hectares) of the newly logged areas in the biome, followed by the state of Pará with 15.1% (57,079 hectares), Rondônia with 4.3% (16,377 hectares), Amazonas with 4% (14,976 hectares), Acre with 2.9% (10,886 hectares) and Roraima with less than 1% (1,258 hectares).
- Compared with the previous period, increases were seen in the areas harvested in the states of Mato Grosso (18%) and Pará (14%). There were reductions in Rondônia (-76%), Amazonas (-79%), Acre (-60%) and Roraima (-87%).
- An analysis of legality shows that of the total area of timber harvested during the period, 235,196 hectares (62%) were logged exploited with a forest harvesting authorization issued by the appropriate agencies.
- An additional 142,428 hectares (38%) were harvested without proper authorization.
- This unauthorized harvesting occurs mostly (72%) on registered rural properties, followed by Indigenous lands (11%), vacant areas (9%), conservation units (4%), rural settlements (3%) and undesignated lands (1%).
- On the registered rural properties, unauthorized logging occurs in a concentrated fashion: 100 properties accounted for 52% of the illegally harvested area in this category.

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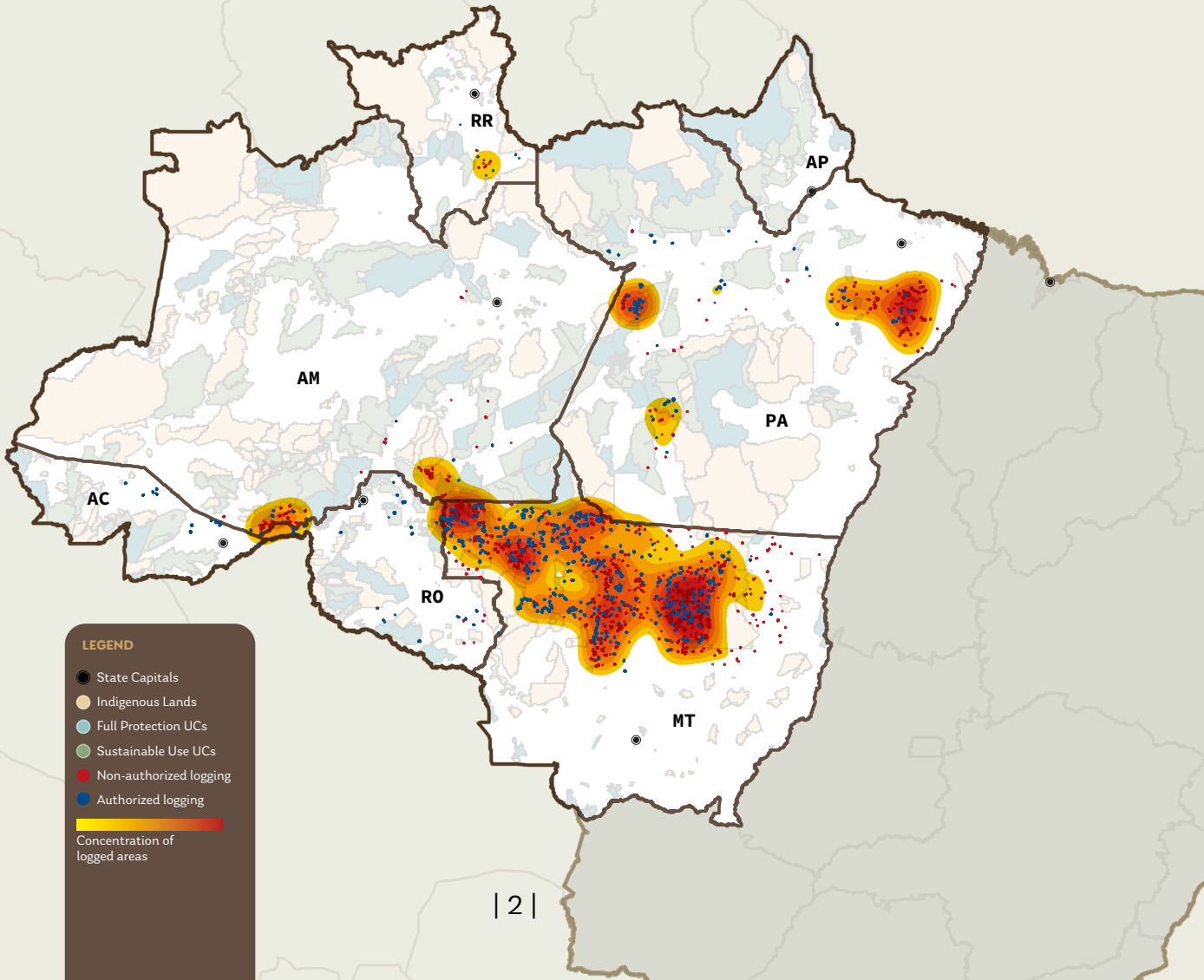
- Among the 10 protected areas most affected by unauthorized timber harvesting are 6 Indigenous lands e 4 conservation units.
- The ten municipalities with more areas logged without authorization represent 49% of all unauthorized extraction for the period. Among these municipalities, 8 are located in Mato Grosso and 2 in Amazonas.
- To mitigate unauthorized logging in the Amazon it is first necessary to provide centralized, updated, and accessible information from forest control systems so as to allow implementation of real-time monitoring routines and the adoption of tools for fraud control, including the traceability of wood products.

FIGURE 1.
SPATIAL DISTRIBUTION OF AUTHORIZED AND UNAUTHORIZED TIMBER HARVESTING IN THE AMAZON IN 2021



Introduction

Native Amazon timber continues to be a unique natural resource that is in high demand on the domestic and international markets. When harvested according to technical guidelines and in line with legislation through sustainable forest management, logging can combine socioeconomic development with forest conservation[1].

According to data from the Sectorial Study of the Brazilian Industry for Mechanically Processed Wood (Abimci), in 2020 the timber sector was responsible for generating more than 150 thousand work positions throughout Brazil. In that same year, the gross value for production by the solid wood industry totaled BRL 26,8 billion, with a trade balance of USD 3,6 billion, representing 5.8% of the total for Brazil[2].

Historically however, the performance of the Amazon timber trade has been paradoxical. That is because over the last 40 years, due to a series of factors it has promoted the impoverishment of forests and the very timber stocks that could ensure its long-term sustainability[3]. At the same time, that scenario has led to a series of environmental damages such as losses in biodiversity and ecosystem services[4] and the emission of Greenhouse Gases (GHGs)[5] that contribute towards worsening the climate crisis[6].

One clear indicator of this scenario is logging done outside of areas authorized for forest management. This unauthorized and illegal harvesting occurs often enough to corrupt the system and prevent the assessment and proof of production authorized by forest management plans. This situation creates unfair competition for companies that work legally, generate foreign exchange for the states and above all, guarantee quality and decent social conditions for workers.

Mapping logging, however, is not a simple task since it is more difficult to detect by satellite images when compared to deforestation. This condition is due to the characteristic of the activity, which consists in removing only certain trees from the forest and, therefore, maintains most of the forest cover in the exploited area. This is different from deforestation, which implies the total removal of the forest and can occur to convert the area to other uses, such as farming and mining.

In 2021, using the SIMEX Network[7] (Timber Harvesting Monitoring System), we were able for the first time to map the logging that occurred throughout the

Brazilian Amazon. As a result, for the period of August 2019 to July 2020, 461,892 hectares of timber harvesting were mapped, of which 50.7% (234.2 thousand hectares) were in the state of Mato Grosso, 15.4% (71 thousand hectares) in Amazonas, 14.9% (68.7 thousand hectares) in Rondônia, 10.9% (50 thousand hectares) in Pará, 5.9% (27,4 thousand hectares) in Acre, 2% (9.4 thousand hectares) in Roraima and less than 1% (730 hectares) in the state of Amapá. However, assessing the legality of logging in this first mapping was possible only for the states of Mato Grosso and Pará, because they provided data bases for timber harvesting authorizations in an appropriate format.

Now, based on access to logging authorizations issued by the appropriate agencies, in an unprecedented manner we were able to assess the legality of the logging detected for the period of August 2020 to July 2021.

We present below the methodology and the results of the mapping and evaluation of the legality of logging in the Brazilian Amazon, highlight logging distribution in the municipalities and categorize the results according to the places where it occurs.

The objective of this monitoring is to show where unauthorized logging is taking place, to understand its dimension and impacts, and provide input in order to inform more effective command and control actions.

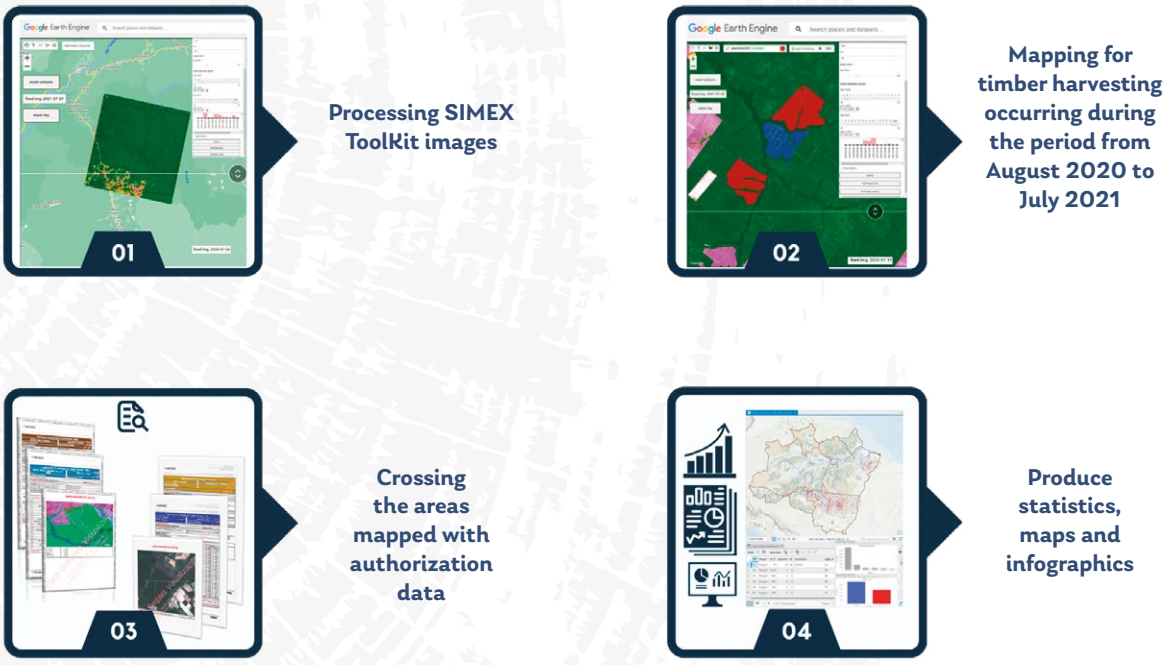
"...based on access to logging authorizations issued by the appropriate agencies, in an unprecedented manner we were able to assess the legality of the logging detected..."

Methodology

We began by processing the Landsat-8 satellite images to generate NDFI (Normalized Difference Fraction Index) images, which highlight changes to the forest canopy resulting from logging. We then mapped logging activities detected in the period from August 2020 to July 2021. Next, we performed a legality assessment based on valid logging permits. Finally, we verified the land tenure categories and the respective municipalities of occurrence and generated statistics and results for the logged areas (Figure 2).

FIGURE 2.
PRODUCTION FLOWCHART FOR MAPPING LOGGING

1. Processing and generation of images that highlight changes that have occurred in the forest canopy due to logging.
2. Identification and mapping of areas with logging between August 2020 and July 2021.
3. Evaluation of the legality of logging based on the logging authorizations, verification of land tenure categories and of the municipalities where the mapped logging occurred.
4. Generating statistics and results.



• Satellite image acquisition and processing

Acquisition and digital processing of satellite images were performed using Google Earth Engine (GEE), which is a cloud platform that facilitates access to high performance computing resources for processing geospatial data that are available for free. With this, the GEE enables generation of land cover and land use classifications more rapidly[8],[9].

Currently, there is a range of orbital sensors that offer images with different spatial, temporal, and spectral resolutions. In this study, we used images from the Landsat-8 satellite with a spatial resolution of 30 meters, and Sentinel-2 images to help interpret areas affected by logging.

Those images are processed digitally on the GEE platform using algorithms adjusted so as to select the best scenes that cover the Amazon Forest area, with a minimal percentage of clouds. This processing makes it possible to generate the spectral mixture model (vegetation abundance, soils, shade and NPV - Non-Photosynthetic Vegetation) and calculate the NDFI (Normalized Difference Fraction Index)[10].

The NDFI is defined by the formula below:

$$NDFI = \frac{(VEGnorm - (NPV + Solos)}{(VEGnorm - (NPV + Solos)}$$

Where VEGnorm is the vegetation component normalized for shade, determined by: VEGnorm = VEG / (1-Shade).

The resulting NDFI images highlight the changes occurring to the forest canopy as a result of timber harvesting and enable them to be interpreted and mapped.

• Mapping of timber harvesting occurring during the period

The mapping period goes from August 2020 to July 2021. This is the same periodicity adopted by the National Institute for Space Research (INPE) in the Program for Monitoring the Brazilian Amazon Forest by Satellite (Prodes) for the annual mapping of deforestation.

To map logging, we analyze the NDFI images, interpreting and delimiting the forest areas with obvious signs of timber harvesting. These signs are presented through the structures and impacts resulting from the activity, such as clearings opened due to falling trees, roads and skid trails, and log storage yards.

Logging areas were detected and mapped in six of the nine states of the Brazilian Amazon: Acre, Amazonas, Mato Grosso, Pará, Rondônia and Roraima. Due to the high percentage of cloud cover in the period being assessed, it was not possible to identify and map logging areas in Amapá, which does not mean that we are affirming that there was no logging in this state during the period.

• Assessment of the legality of the timber harvesting mapped

To assess the legality of the areas logged, we used timber harvesting authorization databases (Autex/Autef) provided by the requisite agencies in each state.

For the states of Amazonas and Roraima the data were obtained through Sinaflor (National System for the Control of the Origin of Forest Products), available on the Siscom platform (Joint System for Environmental Information).

In the states of Acre and Rondônia, besides the Sinaflor data, data from the Sustainable Forest Management Plans (PMFS) and Autex issued by IMAC (the Acre Environmental Institute) and Sedam/RO (State Secretariat for Environmental Development), were respectively used.

In Mato Grosso the databases were obtained from the **Transparency Portal** and the Integrated System for Environmental Monitoring and Licensing (**Simlam-MT**), both managed by the Mato Grosso State Secretariat for the Environment (Sema/MT). In this state, both the mapping and the validation of the legality checks were conducted in technical cooperation between the Instituto Centro de Vida (ICV) and the Geoprocessing and Environmental Monitoring Coordination Center (CGMA) at Sema/MT.

Available in a system similar to the one used in Mato Grosso, the data from Pará were obtained through **Simlam-PA**, managed by the Secretariat of State and Environment of Pará (Semas/PA). We note that the vector data related to the SFMPs were no longer available when this study was being concluded, only the titles of the Authorizations for Forest Harvesting (AUTEF) in PDF format.

With these databases in hand, we individually checked all logging authorizations, crossing their information with the logging activities mapped in order to determine their legality. Thus, for a given harvested area to be considered legally authorized, the exploration must have occurred accompanied by an authorization, within the limits of the area, and within the valid period for the license. With this, we emphasize that we have not adopted criteria related to any logging inside permanent preservation areas (APP) present within the authorized area, as well as whether or not the species and volume authorized for harvesting were correctly logged, or even related to the movement and transport of timber after harvesting.

For unauthorized areas, we cross-checked them with the databases of the Rural Environmental Registry (CAR), the Land Management System (SIGEF) and the Private Terra Legal program data to verify occurrence on registered rural properties. We also checked the incidence of unauthorized logging with the official databases of conservation units, Indigenous lands, federal settlements, and undesignated public lands[11]. Unauthorized logging that did not fall into any of these categories was classified as having occurred on undesignated land (Table 1).

Table 1 - Classification of timber harvesting mapped

CLASSIFICATION OF TIMBER HARVESTING	
Authorized	**Unauthorized**
With logging authorization, within the valid period and authorized area	With logging authorization, but logged outside of valid period or outside of authorized area
	Without logging authorization, on registered rural property
	Without logging authorization, on undesignated public land
	Without logging authorization, in a cartographic vacant space
	Without logging authorization, on Indigenous land
	Without logging authorization, in a conservation unit
	Without logging authorization, in rural settlements

Results

From August 2020 to July 2021, 377,624 hectares of timber harvesting were mapped in the Brazilian Amazon, which represents an 18% reduction in the logged area in relation to the previously mapped period, which came to 461,892 hectares.

To analyze the legality of the logging mapped, 913 logging authorizations issued by the appropriate agencies were verified. This evaluation identified that 62% of the mapped logging area (235,196 hectares) was harvested legally, that is, with a valid authorization and within the authorized area.

Unauthorized logging, in turn, affected 142,428 hectares of forests in the Brazilian Amazon, which corresponds to 38% of the total logging mapped in 2021. Of this total area of unauthorized logging, 103,668 hectares were detected in the state of Mato Grosso alone, which represents 73% of all illegal logging mapped.

• Timber harvesting in the municipalities

The ten municipalities with the largest area of forest harvested under authorization represented 48% of the total legal logging during the period analyzed. The remaining 52% were distributed in 77 other municipalities (Figure 3).

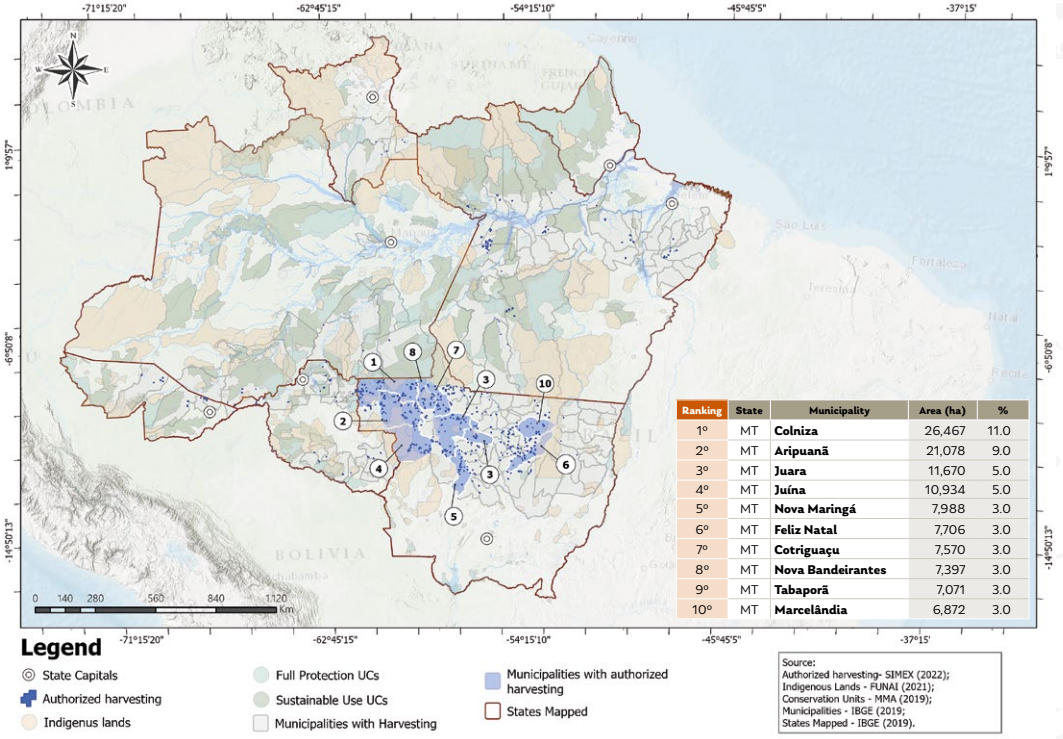
The authorized logging was mapped in 619 polygons, of which 158 (25%) have an area greater than 500 hectares, representing 61% of the legally logged area. The legally logged polygons have a minimum area of 1 hectare, a maximum of 4,108 hectares, and an average of 380 hectares.

The ten municipalities with the largest number of unauthorized forest areas logged represent almost half (49%) of the total illegal logging in the Amazon for 2021. During this period, the remaining 51% was distributed among 91 other municipalities (Figure 4).

Unauthorized logging occurred in 1,154 polygons, with a minimum area of 1 hectare, a maximum of 1,422 hectares, and an average of 123 hectares. This shows that the illegally logged areas have an average area 2/3 smaller than the legally logged areas, but occur with greater frequency during this period analyzed

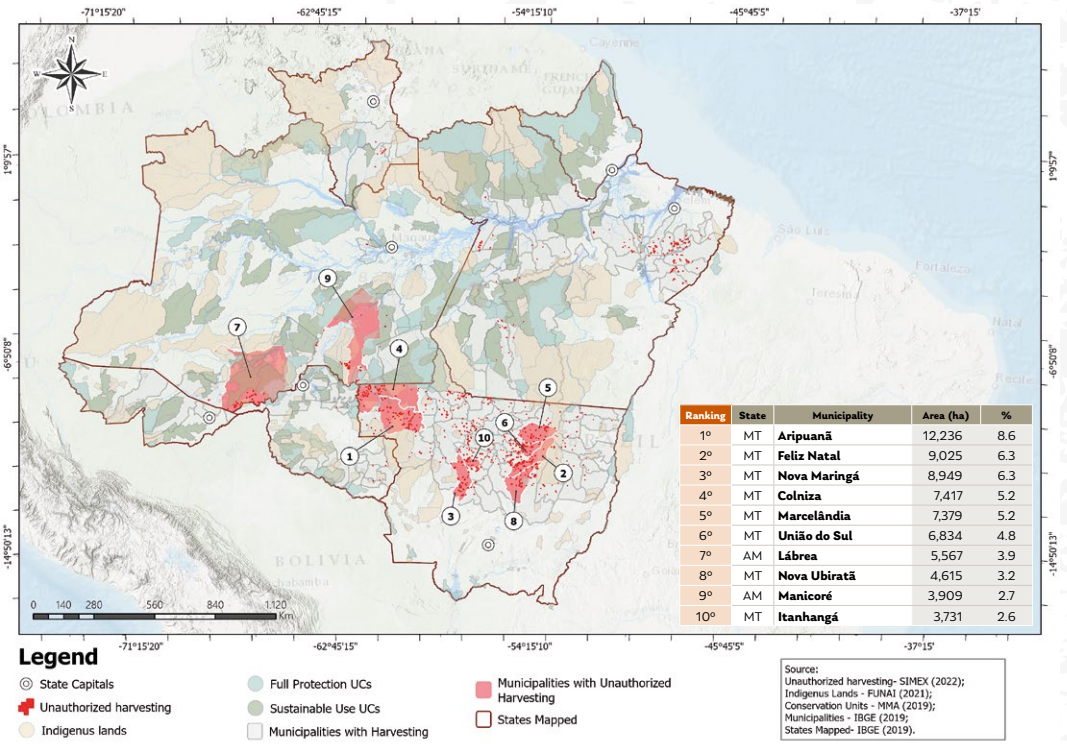
When comparing the ten municipalities that did the most legal and illegal logging, we see that five of them coincide in those activities, these being Colniza, Aripuanã, Nova Maringá, Feliz Natal and Marcelândia, all located in the state of Mato Grosso.

FIGURE 3.
MUNICIPALITIES WITH THE MOST AREAS LOGGED WITH AUTHORIZATION IN THE AMAZON IN 2021



Ranking	State	Municipality	Area (ha)	%
1º	MT	**Colniza**	26,467	11.0
2º	MT	**Aripuanã**	21,078	9.0
3º	MT	**Juara**	11,670	5.0
4º	MT	**Juína**	10,934	5.0
5º	MT	**Nova Maringá**	7,988	3.0
6º	MT	**Feliz Natal**	7,706	3.0
7º	MT	**Cotriguaçu**	7,570	3.0
8º	MT	**Nova Bandeirantes**	7,397	3.0
9º	MT	**Tabaporã**	7,071	3.0
10º	MT	**Marcelândia**	6,872	3.0

FIGURE 4.
MUNICIPALITIES WITH THE MOST AREAS LOGGED WITHOUT AUTHORIZATION IN THE AMAZON IN 2021



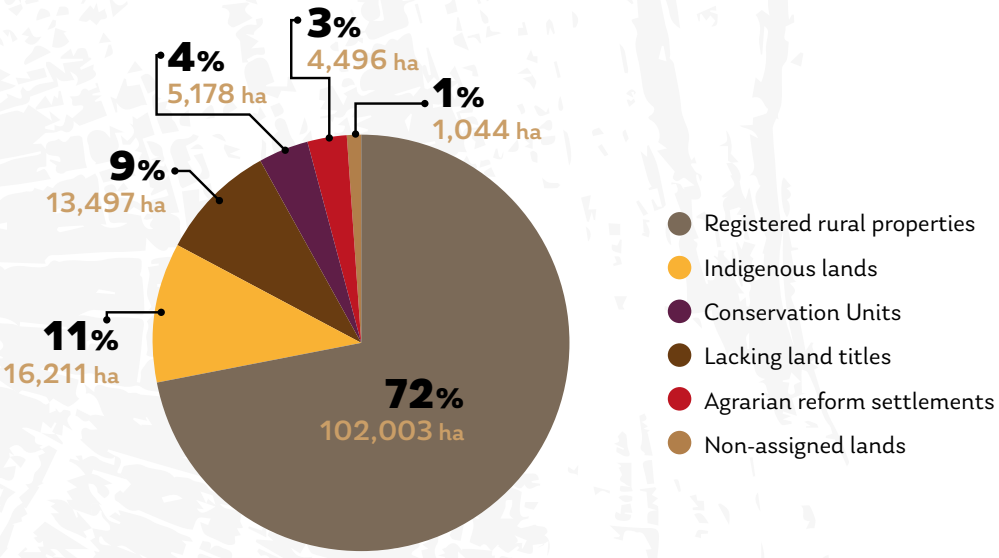
Ranking	State	Municipality	Area (ha)	%
1º	MT	**Aripuanã**	12,236	8.6
2º	MT	**Feliz Natal**	9,025	6.3
3º	MT	**Nova Maringá**	8,949	6.3
4º	MT	**Colniza**	7,417	5.2
5º	MT	**Marcelândia**	7,379	5.2
6º	MT	**União do Sul**	6,834	4.8
7º	AM	**Lábrea**	5,567	3.9
8º	MT	**Nova Ubiratã**	4,615	3.2
9º	AM	**Manicoré**	3,909	2.7
10º	MT	**Itanhangá**	3,731	2.6

• Unauthorized logging by land title category

Of the total area logged in an unauthorized manner, 102 thousand hectares were on registered rural properties (72%), followed by Indigenous lands with 16.2 thousand hectares (11%), 13.4 thousand hectares on vacant sites (9%), 5.1 thousand hectares in conservation units (4%), 4.4 thousand hectares in rural settlements (3%), and 1 thousand hectares in undesignated lands (1%).

Unauthorized logging on registered properties occurred on a total of 783 properties. Of this amount, the 100 properties with the largest areas logged in the period analyzed accounted for 52% of the area illegally logged in this category (Figure 5).

FIGURE 5.
CLASSIFICATION OF UNAUTHORIZED TIMBER HARVESTING IN 2021

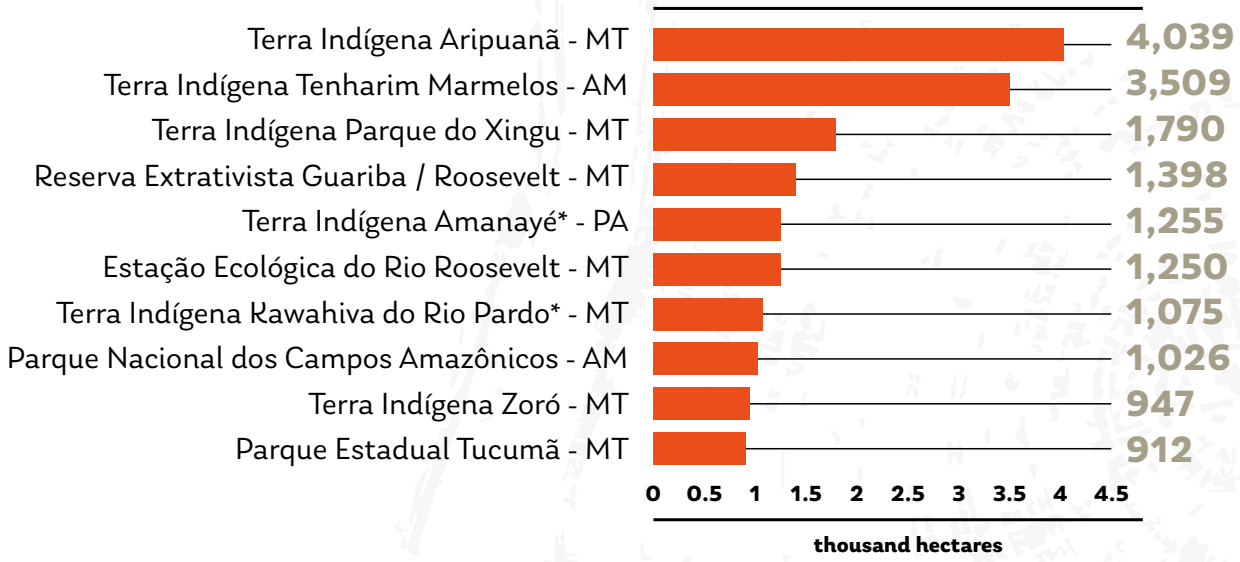


• Illegal logging in protected areas

About 15% of unauthorized logging took place in protected areas, totaling 35 impacted areas, of which 21 were Indigenous lands and 14 were conservation units, with a total of 21,487 hectares illegally logged in these territories.

The 10 protected areas with most unauthorized logging represented 80% of the total area logged in this category. Of these areas, seven are located in Mato Grosso (Figure 6).

FIGURE 6.
PROTECTED AREAS WITH THE HIGHEST UNAUTHORIZED TIMBER HARVESTING IN 2021



*Non-ratified Indigenous Land.

Indigenous lands accumulated 16,211 hectares of illegally logged area in the period analyzed, which represents 75% of all unauthorized logging in protected areas.

Among the Indigenous lands with the most illegal timber harvesting during this period were the Aripuanã IT, with 4,039 hectares, and Tenharim Marmelos IT, with 3,509 hectares logged. These two Indigenous lands, together, represented

47% of the total illegally logged on ITs and 35% of unauthorized logging in protected areas. In 2020, these two Indigenous lands also appeared in the ranking of the 10 most exploited protected areas, with the Tenharim Marmelos IT in second place and the Aripuanã IT in fourth, with 6,330 hectares and 3,082 hectares, respectively their territories harvested illegally.

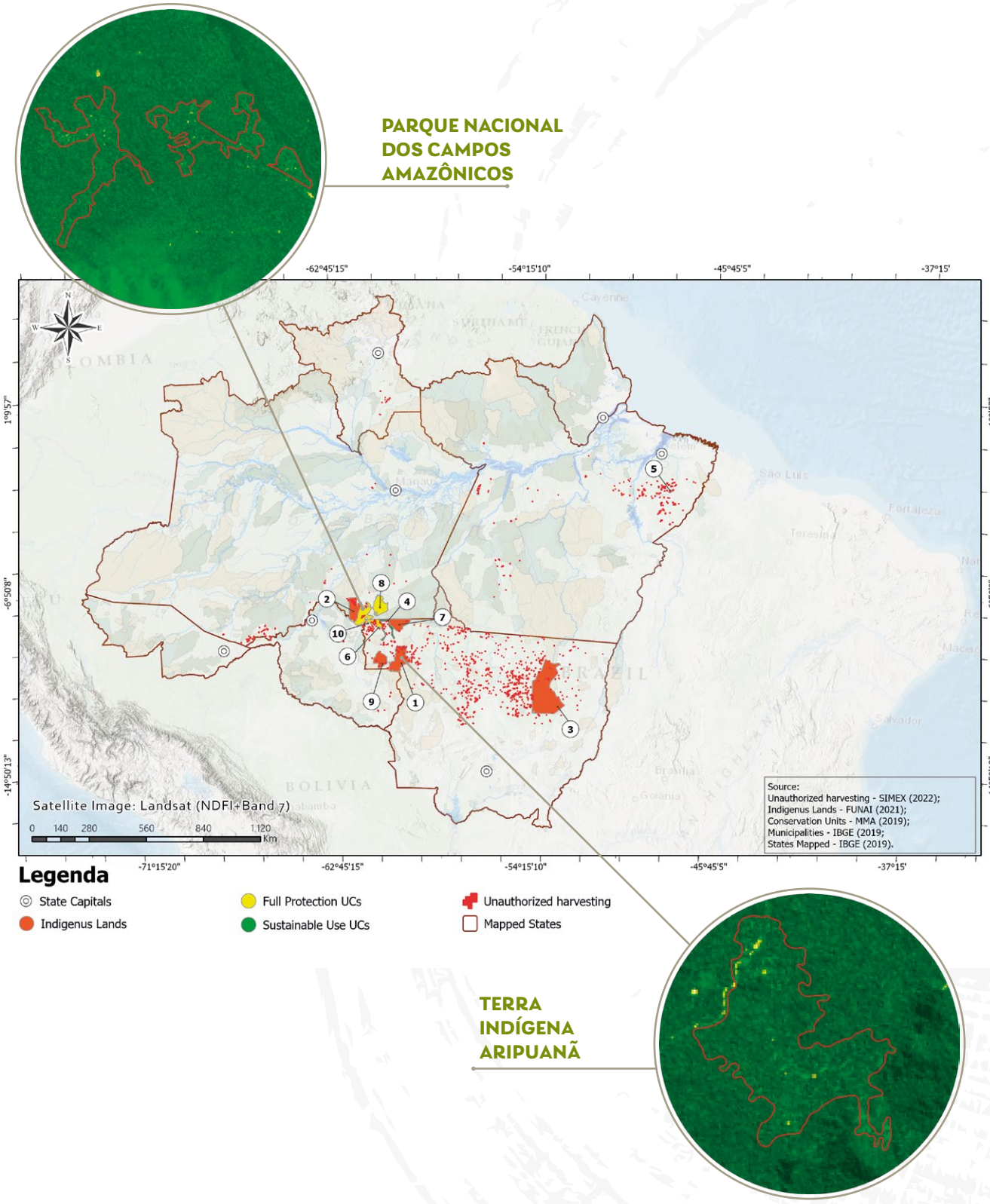
When compared with the mapping for 2020 (total area of 24,866 hectares), the Indigenous lands had a 35% reduction in areas harvested.

In the conservation units, unauthorized logging was detected in 5,276 hectares. Of the 14 Conservation Units affected, the five most heavily logged concentrated 91% of the total area of illegal logging in this land category, 4,783 hectares.

The Guariba/Roosevelt Extractive Reserve was the most affected, with 1,398 hectares of unauthorized logging. In second place was the Rio Roosevelt Ecological Station with 1,250 hectares, followed by the Campos Amazônicos National Park with 1,026 hectares and the Tucumã State Park, with 912 hectares of its territory illegally logged.

In 2020, two of these UCs also appeared in the ranking of the 10 most exploited protected areas in the Amazon. They were Campos Amazônicos National Park in first place 9,657 illegally logged hectares, and Tucumã State Park, which was in fifth place, with 2,877 illegally logged hectares.

FIGURE 7.
UNAUTHORIZED TIMBER HARVESTING IN CONSERVATION UNITS AND INDIGENOUS LANDS IN THE AMAZON IN 2021

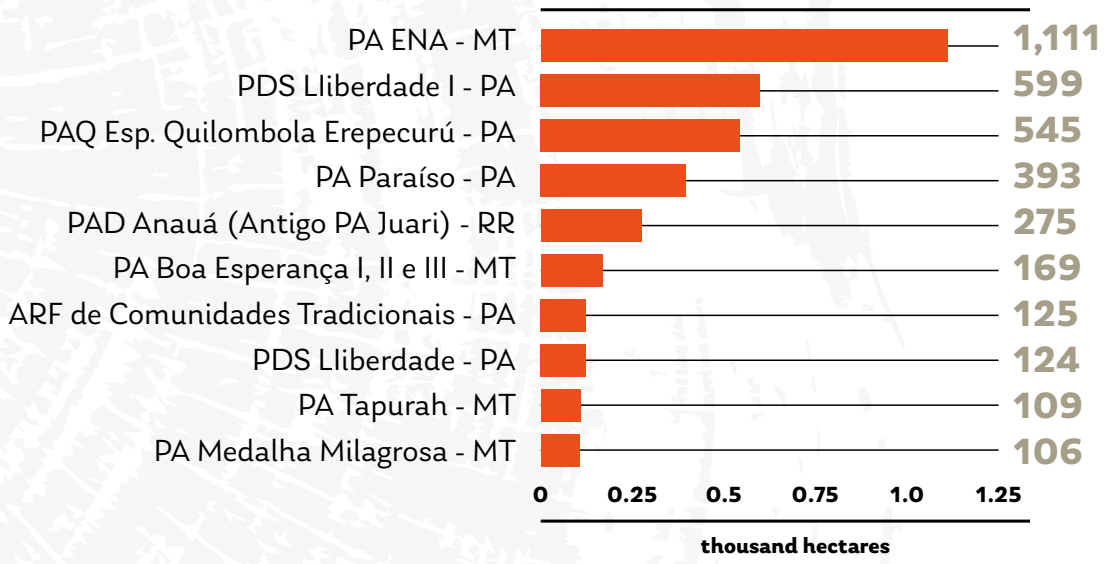


• Illegal harvesting in settlements

In the rural settlement projects, around 3% of unauthorized logging was identified during the period analyzed for a total of 4,496 hectares distributed in 35 settlements in the states of Pará, Mato Grosso, Roraima, and Amazonas. In the states of Rondônia and Acre there was no illegal logging in the federal rural settlement areas.

Among the settlements impacted, PA ENA located in the municipality of Feliz Natal, state of Mato Grosso, was the most critical, with 1 thousand hectares exploited. It concentrated 24.7% of all illegally logged forest area in rural settlements in the Brazilian Amazon. Along with PDS Liberdade I, with 599 hectares, and PAQ Especial Quilombola Erepecurú, with 545 hectares, both located in Pará, these were the settlements with the largest logged areas (Figure 9).

FIGURE 8.
SETTLEMENTS WITH THE MOST ILLEGAL LOGGING IN THE BRAZILIAN AMAZON



Recommendations

In 2022 the SIMEX Network published the report "**A evolução do setor madeireiro na Amazônia entre 1980 a 2020 e as oportunidades para seu desenvolvimento inclusivo e sustentável na próxima década**"(Evolution of the timber sector in the Amazon from 1980 to 2020 and opportunities for its inclusive and sustainable development over the next decade"). This report provides an unprecedented overview of the timber sector in the Brazilian Amazon, with historical information on timber activity in the region, the evolution of its production chain, current management and control mechanisms in place, current behavior of the timber industry, and, in light of this context, prospects for the coming years.

Very detailed recommendations in this report are presented for promoting forest management as a sustainable alternative for the economy of the Amazon region, as well as for directing actions to combat predatory logging.

Therefore, given that 38% of timber harvesting is still conducted without appropriate authorization in the Brazilian Amazon, as presented in this bulletin, we highlight the following recommendations:

- **Ensure and provide Sinaflor with full transparency for integrating state forest monitoring and control systems, in addition to using its own data**. With this, provide centralized, updated, and accessible information, which is essential to ensure more efficient control and a higher level of traceability of timber production.

- **Implement routine real time monitoring of timber harvesting**, using highly detailed satellite images and data on the movement of forest credits associated with logged areas. We also recommend the adoption of automated tools to control potential fraud, such as mechanisms for warning of suspicious movements of forest credits.

- **Record infractions and hold responsible those who engage in unauthorized timber harvesting, including through the use of already existing and regulated technologies for remote registering of infractions**, given that the largest share of irregularities occurs on rural properties that are already registered.

- **Expand inspections in timber processing industries located in municipalities and critical areas of unauthorized harvesting that have already been identified.**

- **Allocate greater investments to the agencies responsible for licensing and monitoring of forest management plans** with the objective of providing promptness and transparency to these processes.

- **Promote engagement by the forest sector and consumer markets in the fight against illegal logging and in valuing products from areas that are demonstrably managed sustainably**, such as concessions and certified enterprises, through campaigns and communication actions.

- **Together with academia and civil society invest in continuous training programs for entrepreneurs, technical leaders, and forest management operators** aimed at implementing good forest management practices that will increase their efficiency against illegal activities.

- **Implement systems and programs that can bring greater control and governance to protected areas**, given that 11% of all logging mapped in this study occurred in Indigenous territories, which besides bringing damage in economic and environmental terms, also violates the customary rights of the resident populations.

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12 In registered rural properties that presented more than 1 hectare of unauthorized timber harvesting.

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